SUSTAINING OFF-RESERVE FORESTS IN GHANA: A GAME-THEORETIC APPROACH

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Abstract

This thesis explores options for resolving the ongoing tenure and compensation conflicts in the off-reserve forests (non-plantation forests outside permanent forest reserves) in Ghana. The ongoing degradation of the forests has been attributed to the prevalent tenure and compensation conflicts among cocoa farmers, the government, and logging concessionaires. Cocoa farmers nurture and preserve naturally growing trees in the off-reserve forests. They even plant indigenous tree species on their farms for the purpose of providing additional shades for their cocoa crops. Yet since 1998, the government has denied farmers any legal rights to the shade trees they retain on their farms. In addition, crops are extensively damaged by logging and transporting activities occurring on cocoa farms. However, most concessionaires fail to adequately compensate affected farmers.

Farmers tend to resort to unsustainable forest practices as a result of these tenure and compensation conflicts. They markedly reduce shade tree density when cocoa crops start bearing pods by cutting down or killing many young trees and engaging in illegal (chainsaw) logging. Thus, the key research question investigated by this thesis is: what is the most optimal policy option for minimising unsustainable forest practices among farmers? To respond to this question, this thesis developed game-theoretic models to predict the future behaviour of some key stakeholders under hypothetical policy scenarios. The predictions of the game-theoretic models were then tested with empirical data collected from farmers and concessionaires in Ghana in 2016.

The current behaviours of the concessionaires and farmers in the off-reserve forests were found to be consistent with the rational-choice model. These stakeholders are behaving in ways that will maximise their expected values in the off-reserve forests. Both the theoretical and empirical results revealed that farmers are less likely to be fully compensated should they pursue compensation on their own. It was found that a credible threat of litigation by a third-party advocate is likely to be the most optimal option to ensure that concessionaires fully and promptly compensate farmers for crop damage. More importantly, the most optimal policy option to motivate farmers to increase tree density and diversity and minimise farmer-driven illegal logging is a policy mix that concurrently provides 40% of stumpage revenue to farmers; ensures full compensation for crop damage through third-party litigation; and strictly enforces the tree harvesting rule using FC-farmer partnerships.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

I give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library Search and also through web search engines, unless permission has been granted by the University to restrict access for a period of time.

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Abbreviations and Acronyms

AAC	Annual Allowable Cut
BoG	Bank of Ghana
CAC	Command-and-Control
Cocobod	Ghana Cocoa Board
CPR	Communal Property Regime
CREMA	Community Resource Management Areas
CRIG	Cocoa Research Institute of Ghana
CSOs	Civil Society Organisations
CSR	Corporate Social Responsibility
DAs	District Assemblies
DCE	District Chief Executive
DFO	District Forest Officer
ER-PIN	Emissions Reduction Program Idea Note
EU	European Union
FAO	Food and Agriculture Organisation
FC	Forestry Commission
FIP	Forest Investment Plan
FLEGT	Forest Law Enforcement, Governance and Trade
FSD	Forest Service Division
FWP	Forest and Wildlife Policy
GCFS	Ghana Cocoa Farmers’ Survey
GDP	Gross Domestic Product
GLSS	Ghana Living Standards Survey
GoG	Government of Ghana
GSS	Ghana Statistical Service
HFZ	High Forest Zone
JSS	Junior Secondary School
MCA	Multi-Criteria Analyses
MLNR	Ministry of Land and Natural Resources

MOP	Manual of Procedures
MTS	Modified Taungya System
NGO	Non-Governmental Organisations
NREG	Natural Resources and Environmental Governance Programme
NTFPs	Non-Timber Forest Products
OASL	Office of the Administrator of Stool Lands
PAs	Protected Areas
PES	Payment for Environmental Services
REDD+	Reduced Emissions from Deforestation and Degradation plus Conservation, Sustainable Forest Management and Enhancement of Carbon Stocks
R-PP	Readiness Preparation Proposal
SPE	Subgame Perfect Equilibrium
SRA	Social Responsibility Agreement
SSS	Senior Secondary School
TC	Traditional Council
TUCs	Timber Utilisation Contracts
TUPs	Timber Utilisation Permits
VPA	Voluntary Partnership Agreement

Chapter 1. Introduction

This chapter provides an introductory background to the whole thesis. It includes background and research problem, research questions and objectives, a brief summary of the research methodology, a justification for the study, and the structure of the remaining thesis.

1.1 Research Background and Problem Statement

Forests in Ghana contribute enormously to GDP, urban and rural livelihoods, crop production and socio-cultural development.[1] Two of the country's four major merchandise exports, cocoa and timber, are directly produced from forestlands. Forests provide fuelwood (firewood and charcoal) which serve as the primary source of cooking fuel for about 74% of households (GSS 2013a). Forests can be found in all three ecological zones in Ghana: the High Forest Zone, the Coastal Savannah and the Northern Savannah. However, much of the forests are found in the High Forest Zone (HFZ) (see Figure 3.1 on p. 33). This is the area where timber production takes place. The HFZ of Ghana covers the southernmost third of the country. It covers about 8.5 million hectares (Ramcilovic-Suominen and Hansen 2012). About 20% of the HFZ has been designated as forest reserves. Also, about 16.5% constitutes the built environment (Ramcilovic-Suominen and Hansen 2012). The remaining 65% (5.5 million hectares) is classified as off-reserve forests (Affum-Baffoe 2009; Hansen *et al.* 2009). The off-reserve forests are non-plantation forests outside the forest reserves.

Cocoa farming in Ghana is usually undertaken in off-reserve forests. Farmers hold freehold or leasehold titles to forestlands in the off-reserve landscape. They are therefore allowed to clear parts of the forestlands for cultivation. In the land clearing process, farmers preserve and nurture naturally-occurring timber and non-timber trees on their farms to provide shade for their crops. They also identify naturally-occurring saplings and coppices during weeding and nurture them to provide shades for cocoa crops. Many farmers plant seeds and saplings of some indigenous tree species at some strategic locations in cocoa farms to ensure uniform shading. In fact, farms and fallow lands constitute 74% of the off-reserve forests as a result of the above agroforestry practices adopted by cocoa farmers (Affum-

[1] Ghana's forest cover is estimated to be 41.0% of its total land area (Food and Agriculture Organisation [FAO] 2015).

Baffoe 2009). They also harbour most of the indigenous timber trees in the off-reserve forests (Boateng *et al.* 2009; Hansen *et al.* 2009; Damnyag *et al.* 2012).

Despite these agroforestry practices by farmers, they do not have any economic rights to the shade trees on their farms. The *Concession Act* of 1962 has vested every naturally-occurring timber tree into the power of the President. As such, it is criminal for anybody to sell or harvest trees without a permit from the government's Forestry Commission (Government of Ghana [GoG] 1962, 1998a). It is thus illegal for farmers to sell or harvest any timber tree on their farms including planted indigenous trees. This is because indigenous timber trees planted by farmers are generally treated as naturally-occurring by the government.[2] Farmers are also excluded from the sharing of stumpage revenue (economic rent) accruing from on-farm logging. The above situation has generated tenure conflicts between farmers and the government.

Logging companies (logging concessionaires) are granted permits (logging concessions) by the Forest Service Division (FSD) of the Forestry Commission (FC) to log timber trees in the off-reserve forests. Concession logging involves construction of access roads into forest areas, felling of trees to logs and haulage of logs to sawmills for processing. Since most off-reserve timber trees are growing on farms, logging activities usually end up damaging crops of the respective farmers on whose farms logging take place (Marfo and Schanz 2009; Hansen 2011). As such, logging concessionaires (hereafter, concessionaires) are legally required to compensate affected farmers based on the economic valuation of damaged crops (FC 1998; GoG 1998a, s. 8 [e]).

Despite the legal requirement for compensation for crop damage, it is vastly reported in the literature that there is widespread non-compliance among concessionaires (Lambini *et al.* 2005; Marfo *et al.* 2006; Marfo and Schanz 2009; Hansen 2011; Otutei 2012). Many concessionaires, in most cases, do not at all compensate farmers for crop damage even where agreements have been reached. Others pay only part of agreed compensation amounts. Consequently, on-farm logging in the off-reserve forests have constantly generated conflicts between farmers and concessionaires (Marfo and Schanz 2009; Otutei 2012; Amoah and Boateng 2014). These conflicts include low levels of compensation,

[2] It is difficult for farmers to prove, beyond doubt, that they planted these trees because planted indigenous trees cannot be differentiated from naturally growing trees on the farm. Farmers usually do not have documented evidence differentiating naturally-occurring trees from planted indigenous trees on their farms.

prolonged payment periods or non-payment of compensation for crops damaged during on-farm logging.

The ongoing tenure and compensation conflicts in the off-reserve area in Ghana have triggered unsustainable forest practices among farmers. Studies (e.g., Acheampong *et al*. 2014; Dawoe *et al.* 2016) show that shade tree density and diversity on cocoa farms are rapidly declining. Farmers lack the economic incentives to nurture and protect on-farm trees due to the absence of tenure to on-farm trees and the neglect of compensation by concessionaires. Instead, they engage in unsustainable practices such as destruction of trees during land preparation, and illegal logging (Owubah *et al.* 2001; Lambini *et al.* 2005; Marfo 2010; Otutei 2012). These unsustainable practices have contributed to the degradation of the off-reserve landscape.

Urgent policy measures are therefore needed to resolve tenure and compensation conflicts in the off-reserve forests in order to induce sustainable practices among farmers. Such measures need to be informed by scholarly studies with in-depth theoretical and empirical analyses of the potential impacts of policy options on the expected behaviour of key stakeholders in the off-reserve forests. Unfortunately, such studies are lacking in the current literature. Though several studies (e.g., Amanor 2005; Hansen and Treue 2009; Hansen 2011; Boakye 2015; Hajjar 2015a; Hansen *et al.* 2015; Oduro *et al.* 2015) have proposed varying options for addressing the conflicts in the off-reserve forests, they have not provided theoretical or empirical evidence on how these proposed options are likely to influence the behaviour of farmers and concessionaires. This situation calls for further studies to explore policy options for inducing cooperative and sustainable behaviour among concessionaires and farmers, respectively.

1.2 Research Questions and Objectives

The primary research question is: *are there any viable policy options for resolving the tenure and compensation conflicts associated with the off-reserve forests*. If there are, which is the most optimal policy option for minimising unsustainable forest practices among farmers? The specific research questions are:

1) What is the rationale behind the current behaviour of concessionaires and farmers in the off-reserve forests of Ghana?

2) Under what policy interventions are concessionaires likely to fully and promptly compensate farmers for crop damage?
3) Under what policy interventions will farmers intensify sustainable tree retention on farms and desist from illegal logging in the off-reserve forests?

In addressing these research questions, this thesis seeks to achieve the following objectives:

a) To provide useful insights into the current behaviour of concessionaires and farmers in the off-reserve forests of Ghana.
b) To evaluate the impact of hypothetical policy interventions on concessionaires' likelihood to fully and promptly compensate farmers for crop damage.
c) To explore the impacts of hypothetical policy interventions on farmers' behaviour in the off-reserve forests in Ghana.

1.3 Research Methodology

The study develops game-theoretic models (using the extensive form) to theoretically explain, predict and prescribe the behaviour of farmers, concessionaires and the government in their off-reserve logging interactions in Ghana. Game theory is a rational choice approach to understanding and predicting the outcomes of strategic interactions of rational individuals within particular economic, social and political contexts (Kreps 1990; Gibbons 1992; Madani 2010).

This study adopts game theory for several reasons. First, game theory provides realistic optimisation of the objectives of self-interested individuals in a particular strategic interaction (Madani 2010). This is what the study seeks to achieve. The study seeks to maximise the collective interests of the mostly conflicting actors in the off-reserve forests whiles allowing them to optimise their individual interests in the game. Such a goal cannot be achieved with alternative approaches such as multiple criteria analyses. Second, game theory does not require the sole use of pecuniary incentives and values in analysing human behaviour. The approach permits the use of non-monetary payoffs in the analyses. This is particularly useful for this study because stakeholders derive essential socio-political costs and benefits from the off-reserve forests that are not easily quantifiable in pecuniary terms. Third, game theory permits the analyses of human behaviour under uncertainties and this will be useful in analysing compensation interactions between farmers and concessionaires. Fourth, the approach allows for the analyses of different aspects of a particular strategic situation by varying the assumptions of the game. This will be useful in examining the effects of different policy scenarios on the behaviour of stakeholders in the off-reserve forests. In short, the demands of the study can best be met using the methodological toolkit provided by the game-theoretic approach.

The thesis proposes the predictions of the game-theoretic models as hypotheses and tests them with empirical data. Both the survey and experimental designs are combined to collect and analyse empirical data to answer the research questions. This thesis reviews relevant academic literature on concepts such as property rights, forest conflicts and game theory. It also reviews literature to contextualise property rights and conflicts in the off-reserve forests. Primary data was collected in a fieldwork in Ghana using cross-sectional surveys. Closed-ended questionnaires were designed to collect correlational data and undertake factorial and repeated measures experiments in the field. The experimental data are used to test the future behaviour of farmers and concessionaires as predicted by the game models.

Primary data are analysed using the Statistical Package for Social Sciences (SPSS) version 22. The study uses descriptive statistics, *t*-tests, one-way ANOVA, paired-sample *t*-test and logistic regression analyses to report results on the characteristics and current behaviour of farmers and concessionaires. The hypotheses derived from the game-theoretic models are tested using multiple linear regression, repeated-measures ANOVA, mixed-design ANOVA and factorial ANOVA.

1.4 Justification for the Study

This study seeks to address some gaps identified in the current literature. An overview of some of these gaps and the contributions of the study to addressing them is given in this section.

1.4.1 Need for additional insights into the current behaviour of stakeholders in the off-reserve forests in Ghana

The off-reserve problem has gained currency in the academic literature (e.g., Hansen and Treue 2009; Hansen 2011; Boakye 2015; Hajjar 2015a; Oduro *et al.* 2015). Most of these studies view ill-defined property rights as the underlying cause of farmers' unsustainable practices (e.g., Amanor 1994, 1996, 2005; Hansen and Treue 2009; Hansen 2011). Researchers have employed various perspectives in explaining the mechanisms through which ill-defined property rights affect the behaviour of key stakeholders. A number of studies have adopted a political economy approach in explaining the behaviour of the government, concessionaires and farmers in the off-reserve forests (e.g., Amanor 1994, 1996, 2005; Lambini *et al.* 2005; Hansen 2011; Hansen and Lund 2011; Damnyag *et al.* 2012). Others have used a political ecology perspective to explain farmers' unsustainable behaviour (Otutei 2012). Some scholars have also employed norms, values and social identity theories to explain farmers' behaviour, especially with regards to illegal logging (e.g., Ramcilovic-Suominen and Hansen 2012; Ramcilovic-Suominen *et al.* 2013; Amoah and Boateng 2014; Ramcilovic-Suominen and Epstein 2015). The usual depiction of the off-reserve management problem, in general, and farmers' behaviour in particular, is that of unfortunate consequences of an unfair tenure and compensation regime. That is, farmers' practices are either resistance to marginalisation, coping strategies in an unfair situation or both. Nevertheless, the prevailing off-reserve situation in Ghana can also be viewed as the expected result of self-interested actors seeking to maximise their gains or minimise their losses in the forest environment. Such a rational choice perspective has largely been ignored in the literature. Hence, this study approaches the off-reserve situation from a rational choice perspective (using game theory) to provide valuable insights into the current behaviour of stakeholders. This can contribute immensely to supplying a key to altering the behaviour of key stakeholders.

1.4.2 Lack of theoretical and empirical evaluation of policy options to rectify the behaviour of farmers and concessionaires

A number of scholarly proposals for overcoming farmers' unsustainable practices in the off-reserve forests in Ghana exists in the current literature. The majority of scholars have proposed the recognition of farmers' right to on-farm trees as a means to inducing sustainable forest practices (e.g., Amanor 2005; Hansen and Treue 2009; Hansen 2011; Boakye 2015; Hajjar 2015a; Hansen *et al.* 2015; Oduro *et al.* 2015). Others have called for the enforcement of the compensation law and actor empowerment to overcome the compensation problem (e.g., Owubah *et al.* 2001; Marfo and Schanz 2009; Amoah and Boateng 2014). However, the current literature is short of studies that undertake in-depth analyses of the behavioural outcomes of scholarly proposals. Currently, there is no known study that provides a theoretical or empirical analyses of or evidence on options to inducing sustainable behaviour among farmers. The literature also lacks studies that evaluate options for ensuring full and prompt payment of compensation by concessionaires.

This gap in the existing literature is worrying since formal and in-depth analyses of policy options are critically needed to influence policy discourses at both local and global levels. Moreover, such studies are required to provide the much–needed academic evidence to inform tenure reforms, bilateral sustainability projects and the emergent REDD+ initiatives in Ghana. Currently, the Government of Ghana (under the REDD+ initiative) is considering off-reserve tenure reforms (Hajjar 2015b). Thus, academic studies are needed to provide both theoretical and empirical evidence on the options for reform and their potential impacts on behaviour. As such, this study employs a game-theoretic approach to examine the behaviour of farmers and loggers under various hypothetical policy scenarios. This is to identify the optimum intervention(s) policymakers can use to induce sustainable and cooperative behaviour among farmers and concessionaires, respectively. With this, the study is the first academic attempt to theoretically and empirically link specific policy options to particular behavioural responses of farmers and concessionaires.

1.4.3 Absence of game-theoretic studies on unique forest settings in Africa

Game theory has been widely used for studying interactions in forest use and control and the development of solutions for sustainable forest management in the developing world. Communal property theorists have applied game theory in analysing the behaviour of user groups around the world (e.g., Ostrom *et al.* 1994; Angelsen 2001; Apesteguia 2001; Cárdenas and Ostrom 2004; Lee *et al.* 2015; Liu *et al.* 2018). Others have used the approach in analysing and resolving problems of collaborative forest management (e.g., Kant and Nautiyal 1994; Lise 2001, 2005, 2007; Burton 2004; Engel *et al.* 2006, 2013; Atmis *et al.* 2007, 2009; Shahi and Kant 2005, 2007, 2011; Engel and Palmer 2008, 2009). Some scholars have also applied game-theoretic analysis to the management of protected areas (e.g., Muller and Albers 2004; Robinson *et al.* 2014a; Soltani *et al.* 2016). However, little attention has been paid to equally important but different forest settings. These neglected forest settings include, but not limited to, sacred groves in Africa and the off-reserve forests in Ghana. None of the existing studies on the management of the off-reserve forests in Ghana has employed this powerful and sophisticated approach in at least explaining the behaviour of key stakeholders. The current study is the first to approach the off-reserve forest management problem from a game-theoretic perspective. By successfully using game-theoretic modelling in the off-reserve area, this study contributes in extending game-theoretic analyses to unexplored areas.

1.4.4 Limited use of proximal antecedents to behaviour in testing game-theoretic predictions on future forest behaviour

A number of the game-theoretic studies on forest management problems have tested their predictions with empirical data (e.g., Chopra *et al.* 1990; Kant and Nautiyal 1994; Ostrom *et al.* 1994; Cárdenas 2004; Cárdenas and Ostrom 2004; Engel *et al.* 2013; Liu *et al.* 2018). Most of these studies have largely relied on experimental or empirical data on current or past behaviour to test model predictions. For the evaluation of hypothetical policy scenarios, however, using empirical data on current or past behaviour to test future behaviour may not be useful. This is because such hypothetical policy scenarios present opportunities or constraints that were absent in past or current situations. Thus, data on expected future behaviour under the policy scenarios is needed to verify theoretical predictions. In such cases, empirical data on 'proximal antecedents to behaviour' (Pomery *et al.* 2009, pp. 894-895) such as behavioural intentions, willingness and expectations may be more appropriate (Armitage and Conner 2001; Ajzen and Fisbein 2005; Pomery *et al.* 2009). The current game-theoretic studies on tropical forest management problems are yet to utilise these proximate predictors in testing future behaviour. This thesis contributes in addressing this gap by testing game-theoretic predictions about future behaviour with empirical data on these behavioural antecedents.

1.4.5 Limited incorporation of socio-political and rent-seeking interests in existing game-theoretic studies on tropical forest interactions

Game-theoretic applications to problems in tropical forest management have overly concentrated on pecuniary incentives and payoffs to the neglect of non-pecuniary incentives. The significant influence of the socio-political preferences and interests of stakeholders on forest behaviour in developing countries has long been recognised by game theorists (Gjertsen and Barrett 2004; Shahi and Kant 2007). Assumptions incorporating these 'other preferences' of players are largely ignored in the analyses of game models in the existing literature. Further, existing models on State-Community forest interactions usually overlook the rent-seeking interests of State actors in developing countries. However, this is too essential to overlook (cf. Alley 2011; Amacher *et al.* 2012). Carefully identifying socio-political and rent-seeking preferences and interests of stakeholders and incorporating them in models, where possible, is more likely to improve the explanatory, predictive and prescriptive powers of game models in forest management. To contribute to addressing this deficiency in the literature, the study incorporates essential assumptions about the socio-political costs and benefits of farmers and concessionaires and the rent-seeking interests of State actors in the game models to make them more reflective of the forest setting in the developing world.

1.4.6 Need for additional evidence to verify some consensuses on forest sustenance

There are a number of agreements in the current literature regarding the sustenance of tropical forests. Prominent among these are, firstly, that recognising the rights of forest dwellers to forest resources are essential to the sustenance of these resources (cf. Agrawal 2001, 2007; Ostrom 2001). Secondly, that forest law enforcement is indispensable to better forest outcomes (cf. Gibson *et al.* 2005; Coleman and Liebertz 2014). Thirdly, that law enforcement alone is not sufficient in inducing sustainable behaviour (Gibson *et al.* 2005). Much of the empirical evidence supporting these assertions have largely come from communal property regimes, collaborative forest management regimes and protected areas. Little evidence has been supplied from other unique forest settings to confirm these assertions. Therefore, this study seeks to supply additional evidence from a rather unique forest management regime such as the off-reserve area to verify some of these assertions.

Further, some scholars posit that a combination of policy initiatives that tackle most of the major sources of unsustainable practices is more likely to be the most effective in sustaining tropical forests (Poteete *et al.* 2010; Yin *et al.* 2016). However, little empirical evidence has been provided in the current literature to support this assertion. This study seeks to empirically verify this assertion by evaluating policy scenarios separately and jointly to observe their comparative effectiveness in inducing sustainable forest practices among forest dwellers.

1.5 Structure of the Thesis

The remainder of the thesis is organised in 9 chapters. Chapter 2 presents the conceptual underpinnings of the study. It reviews the scholarly literature on relevant concepts such as property rights, forest conflicts, and approaches for resolving conflicts and inducing sustainable behaviour. This chapter begins with the definition of key concepts relating to property rights. It then provides a review of the Schlager-Ostrom framework of the typology of property rights and right-holders (Schlager and Ostrom 1992). The chapter proceeds to review key concepts relating to forest conflicts, the theoretical explanations for these conflicts and the impact of forest conflicts on the behaviour of forest dwellers. It follows this with an evaluation of the various policy approaches used to induce cooperative behaviour in forest management.

Chapter 3 contextualises property rights, conflicts and behaviour specific to the off-reserve forests in Ghana. It provides an overview of cocoa agroforestry and logging in the off-reserve area. It follows this with an exposition on the various stakeholders in the off-reserve area. It also provides an overview of land rights and rights to non-timber forest products in the forests. It then utilises the revised Schlager-Ostrom framework to analyse the property right regime underlying on-farm trees in the off-reserve area. This is followed by a discussion of tenure and compensation conflicts in the off-reserve area and their contributions to the decline of shade-tree density and diversity and the pervasiveness of illegal logging in Ghana. It also discusses current attempts and challenges to addressing the off-reserve conflicts. The chapter ends by highlighting a critical research gap in the existing literature on the off-reserve problem.

Chapter 4 provides an overview of game theory: the theoretical framework underlying the study. It begins with a justification of the suitability of game theory to the study. It then proceeds to highlight key concepts, key assumptions and relevant solution concepts. Following this is a critique of the approach in behavioural analyses. The chapter also reviews past studies using game-theoretic modelling on forest management problems in the developing world and discusses some research gaps in the current literature.

Chapter 5 provides a detailed account of the research methodology of this thesis. It starts with an overview of the methodological framework adopted in the study. The chapter then proceeds to provide a general description of the game models analysed in the study and presents, explains and justifies the hypothetical policy scenarios considered in the models. This is followed by an overview of the survey method used in data collection and the experimental designs adopted. A discussion of the data analysis techniques used in the study is also given.

Chapter 6 presents the results of the game-theoretic models to respond to the research questions posed by the study. It provides formal theoretical analyses of the current behaviour of the three main players in the off-reserve area. The options for inducing cooperative behaviour among concessionaires are theoretically examined in this chapter. More importantly, the chapter provides formal theoretical analyses of hypothetical policy interventions for inducing sustainable behaviour among cocoa farmers. It proceeds to propose eight hypotheses from the predictions of the game-theoretic models on the future behaviour of farmers and concessionaires.

Chapter 7 presents results of the empirical analyses of the background characteristics and current behaviour of the survey respondents (farmers and concessionaires). The focus of the chapter is to present empirical results to verify the game-theoretic insights into the current behaviour of farmers and concessionaires presented in Chapter 6. Some of the information presented include socio-demographic and economic characteristics of farmers, farming characteristics, tree retention, illegal harvesting of trees, and the receipt of compensation for crop damage. Others include the profile of concessionaires and concessionaires' compensation interaction with farmers.

Chapter 8 presents the results of the empirical analyses of the future behaviour of farmers and concessionaires. It presents the results of the empirical tests of the hypotheses proposed under the game-theoretic models in Chapter 6. These hypotheses include those relating to farmers' use of strategies to pursue compensation; concessionaires' response to independent actions by farmers; concessionaires' response to external intervention in compensation interactions; farmers' response to hypothetical policy interventions on tree retention; and farmers' response to hypothetical policy interventions to induce compliance with the tree harvesting rule.

Chapter 9 discusses the theoretical and empirical findings of the study. It first discusses the rationale behind the current behaviour of concessionaires and farmers. It proceeds to discuss the results of the game-theoretic and empirical analyses on the options for inducing sustainable behaviour among farmers and those for resolving the compensation problem. The chapter then discusses the comparative effectiveness of the optimal option prescribed by the study. It also discusses the potential distributive impact of the prescribed option.

Chapter 10 provides a summary of the key findings of the study under each of the three research objectives. The chapter proceeds to outline the contributions of the study to the current literature on forest management, game-theoretic modelling in tropical forest management and research on the off-reserve problem. It also discusses the practical implications of the findings on policy making and civil society activism. This is followed by an overview of some limitations of the study and some suggestions for further studies.

Chapter 2. Conceptualising Property Rights, Forest Conflicts and Forest Behaviour

This chapter aims to explore and review the literature on forest property rights, forest conflicts and behaviour. Specifically, the chapter presents an analysis of types of property rights, property regimes and forest management. It further explores the types and causes of forest conflicts and their impacts on the behaviour of forest dwellers. An overview of some policy approaches that are used to resolve forest conflicts and induce sustainable behaviour is then given. This is to provide the conceptual basis for policy options evaluated in subsequent chapters. Much of the review in this chapter centres on property rights because the denial or usurpation of property rights is found to be the underlying cause of forest conflicts (cf. Ibarra and Hirakuri 2007; Coleman and Liebertz 2014). It was also found to be the major factor influencing individual motivations to conserve forests, especially in the developing world.

2.1 Definitions and Types of Property Rights

This section looks at definitions of terms related to the concept of property rights such as tenure, property rights, duties and rules. It also highlights the types of property rights and illuminates the relationship between rights, duties and rules.

2.1.1 Definition of terms related to property rights

Land tenure is the set of property rights and rules that govern the ownership, access, utilisation, management and transfer of land resources under a given condition and over a period of time (Streck 2009; Bruce *et al.* 2010; Corbera *et al.* 2011; Robinson *et al.* 2014b). The two components of tenure are property rights and the institutions that ratify them (Naughton-Treves and Wendland 2014). Property rights have been defined differently as claims, legal guarantees or bundles of rights to an asset. Bromley (1991, p. 2) defines property rights as ‘a claim to a benefit stream that the state will agree to protect through the assignment of duty to others who may covet, or somehow interfere with the benefit stream’. This holds true when the term ‘property’ is conceptualised as an entitlement to a benefit produced by a resource. Based on the concept of benefit stream, Gerber *et al*. (2009, p. 803) have defined property rights as ‘the legal expression of the guarantee of access to a benefit stream in the context of a given legal, political and social order’. Arnot *et al*. (2011, p. 297) view property right ‘as the utility received by a holder of a resource over time that arises from practices such as extraction, consumption and habitation'. These definitions concentrate only on the access and utilisation of resources and pay little attention to issues of ownership, management and transfer and the fact that some rights are *de facto* rights. A more explicit definition of property rights refers to it as a 'bundle of rights' or claims that guides the access, utilisation, management, transfer and ownership of a particular resource (cf. Pearse 1990; Schlager and Ostrom 1992; Acheson 2015; Coleman and Liebertz 2014; Robinson *et al.* 2014b). This bundle of rights forms the basis of the actions taken by right-holders in relation to a particular resource (Singh 2013).

2.1.2 Types of property rights and right-holders

Property rights have been classified differently by different scholars (e.g., Honoré 1961; Schlager and Ostrom 1992; Kundhlande and Luckert 1998; Cole and Grossman 2002; Ribot and Peluso 2003). This study adopts a revised form of the widely applied typology framework developed by Schlager and Ostrom (1992). This typology framework best fits the off-reserve context in Ghana. It can give a better description and in-depth analysis of the rather complex and nebulous property rights regime in the off-reserve forests in Ghana than the others. Schlager and Ostrom (1992) classify property rights into five types. These include access, withdrawal, management, exclusion and alienation rights. These are broadly categorised as operational-level rights and collective-level rights. Naughton-Treves and Wendland (2014) have reclassified these rights as use rights (access and withdrawal), decision-making rights (management and exclusion) and alienation rights.

The operational level rights include access and withdrawal (harvest) rights. An access right grants holders the right of entry into a particular resource without necessarily harvesting from it. The withdrawal right, however, grants right-holders the ability to extract or harvest and use part of the resource. Schalger and Ostrom (1992) point out that in reality, access rights usually come with withdrawal rights because most of the resource users who have access rights have withdrawal rights. Thus, these two are usually inseparable. However, this depends on the context of the property system under consideration. In many cases in the tropics where the forestland has multiple tenures (cf. Kundhlande and Luckert 1998), a farmer may have access right to the forest land without having the right to harvest the timber from the forest, as is the case in Ghana's off-reserve forests. Thus, whereas withdrawal right-holders always have access rights, the reverse cannot be true in some cases.

Collective level rights include management, exclusion and alienation (transfer). Right to management implies the right to regulate the use of the resources and make changes in the resource for improvement in the flow of benefit stream or otherwise. Exclusion right refers to the right of the holder to permit or prevent others from using the resource or enjoying from the benefit generated by the resource. This right confers on the holder the power to determine who can or cannot benefit from the resource, under what circumstances and over which period. Lastly, alienation right gives right-holders the right to transfer their rights, either wholly or partly, to another person or entity. This could be by sale, lease, loan, bequest or gift.

The above rights could be *de jure* or *de facto*. However, *de jure* rights are considered more powerful than *de facto* rights (Schlager and Ostrom 1992). This is because *de jure* rights are legitimately sanctioned by a legal authority (Sikor and Lund 2009; Resosudarmo *et al.* 2014). Again, the *de jure* right-holder is in a position to coerce the legal authority to enforce it (Bromley 2006). However, this is not always the case in tropical countries where the willingness and capacity to enforce *de jure* rights are limited (Campbell *et al*. 2001; Oyono 2004; Hayes and Persha 2010; Bouda *et al.* 2011; Naughton-Treves and Wendland 2014). This notwithstanding, *de facto* rights are more easily challenged than *de jure* rights (Schlager and Ostrom 1992; Ostrom 2003), but the security of both is dependent on the level of enforcement (Gibson *et al*. 2002).

Despite the wide application of the Schlager-Ostrom framework, its sufficiency and appropriateness have been challenged (Bergstrom 2005; Smith 2011). The framework pays little attention to other types of rights that may apply in other forms of tenure or circumstances (Galik and Jagger 2015; Sikor *et al.* 2017). For instance, Galik and Jagger (2015) point out a critical right, *alteration right*, which has not been captured by the Schlager-Ostrom framework. Alteration right refers to the right to convert a resource from one use to another (Galik and Jagger 2015). An example is the conversion of forestland from timber production to agriculture or the conversion of part of an agricultural land to roads. Alteration is different from management right in that management refers to regulation or physical changes to the resources for a continuous flow of the resource without converting it to an entirely different use (Galik and Jagger 2015). Thus, under some practical circumstances, the original model fails to fully capture the numerous rights characterising complex property regimes (Galik and Jagger 2015; Sikor *et al.* 2017)[3].

The above notwithstanding, the insufficiency of the original model is to be expected considering the complexities of natural resource systems themselves. As Hohfeld (1913, p. 16) puts it, 'too close an analysis might seem metaphysical rather than useful'. Subsequently, Galik and Jagger (2015) indicate that the Schlager-Ostrom framework is appropriate if there is no special circumstance justifying its modification. Again, that the framework has been employed to successfully analyse property rights in a wide range of resources and settings attests to its wide applicability. Hence, the Schlager-Ostrom framework is appropriate and could be adapted to suit special circumstances by adding additional rights not originally captured.

Five property right-holders are identified in the Schlager-Ostrom framework. Table 2.1 is a matrix showing these right-holders and their corresponding rights.

Table 2.1 Right-holders and their corresponding bundles of rights

Right-holders / Rights	Owners	Proprietors	Authorised Claimants	Authorised Users	Authorised Entrants
Access	X	X	X	X	X
Withdrawal	X	X	X	X	
Management	X	X	X		
Alteration	X	X			
Exclusion	X	X			
Alienation	X				

Source: Schlager and Ostrom (1992), Ostrom and Schlager (1996) and Galik and Jagger (2015)

The right-holders identified are authorised entrants, authorised users, authorised claimants, proprietors and owners. Authorised entrants only hold rights of entry to the property but can neither harvest the resource nor make decisions regarding the entry and utilisation of the resource. Authorised users can enter the resource but have the additional right to harvesting and using the resource. Authorised claimants, however, can enter and harvest the resource and have the added right of making decisions to regulate access and withdrawal as well as change the physical structures of the resource for improvement. Notwithstanding, they cannot determine who can hold rights to the resource. This

[3] Sikor *et al.* (2017) have also revised the Schlager-Ostrom framework to incorporate Payment for Environmental Services and REDD rights, but the newly added rights are less applicable to the off-reserve forest in Ghana.

exclusion right is held by proprietors and owners. The proprietor can enter and use the resource, make decisions to regulate resource use and, at the same time, exclude others from holding lower-level rights. Lastly, owners hold the ultimate right of alienation in addition to all the lower-level rights. The owner alone has the right to transfer the resource, or its benefit thereof, to another. However, some resource owners are not users and do not control the use of the resource (Singh 2013).

Apart from these right-holders, there are other users who enjoy the resource or its benefits illegally. These are referred to as *squatters* (Schlager and Ostrom 1992). Squatters are users of a resource who hold neither *de jure* nor *de facto* rights to use the resource. Examples of squatters are illegal loggers. These squatters have neither rights nor duties and are thus less concerned about rules governing resource access, withdrawal and management.

2.1.3 Rights, duties and rules

Property rights correlate with duties and both are seen as the products of rules (Schlager and Ostrom 1992). Rules are 'generally agreed upon and enforced prescriptions that require, forbid, or permit specific actions for more than a single individual' (Schlager and Ostrom 1992, p. 250). They condition how users behave towards the resource and towards each other. Duties play a critical role in property rights theory. Accordingly, duties have been defined as 'that which one ought or ought not to do' (Hohfeld 1913, p. 9). They are the responsibilities that individuals have as a result of the particular rights they hold. Without duties, rights are ineffectual (Bromley 1989, 1991; Sjaastad and Bromley 2000; Galik and Jagger 2015). This is because 'rights can only exist when there is a social mechanism that gives duties and binds individuals to those duties' (Bromley 1991, p. 15). Furthermore, 'to possess a right implies that someone else has a commensurate duty to observe this right' (Schlager and Ostrom 1992, p. 250). This implies that for rights to be effective, efficient and equitable, they are to be respected, enforced and affirmed by duty-bearers.

2.2 Property Rights Systems under Forest Management

Forest tenure or property rights regimes consist of sets of property rights and responsibilities for the use of a particular forest. There are four conventional types of forest tenure discussed in the literature. These are open-access, private, communal property and state (public) forest tenure (Bromley 1991; McKean 2000). However, Robinson *et al.*

(2014b) add a fifth regime, customary tenure. They argue that customary tenure is different from communal tenure and thus, the two should not be conflated.

In open access regimes, rules of forest use are non-existent and everyone can access and use the resource. Everyone has the right to access and withdraw the forest resources without excluding others from using the resource (Bromley 1991). Also, no individual has the responsibility to regulate resource access, use and control. Rights are not assigned and duties are not specified for any individual or group (Tenaw *et al.* 2009; Cole and Ostrom 2012). Contrary to open access regimes, private tenure is a regime where an individual or private entity has the exclusive right to use a particular forest and can exclude others from using the forest resource. The rights and duties of resource use and control are specifically assigned to an individual user (Tenaw *et al.* 2009; Cole and Ostrom 2012). The right-holder makes rules of resource use and enforces them.

Communal property regime is where the rights to use, manage and control forest resources are held by a group of users such as a community. These regimes occur when a group of individuals have formed an organisation that at least manages and excludes others from the use of the forest resources or its benefits (Ostrom 2003). The members of the user group can independently access and use these common forest resources and can restrict non-members from appropriating resource units from the forest (Cole and Ostrom 2012). The group members collectively make rules, monitor these rules and apply sanctions to violators (cf. Ostrom 1990, 1999, 2005, 2007; Ostrom *et al.* 1994; Agrawal and Gibson 1999; Agrawal 2001, 2007; Gibson *et al.* 2001; Potetee and Ostrom 2004; Andersson and Agrawal 2011; Singh *et al.* 2011). They also have the duty to observe all rules of resource use and to respect the rights of other members (Cole and Ostrom 2012).

A public forest tenure refers to a property rights regime where the rights to a forest resource are assigned to a public authority for the welfare of the public (Tenaw *et al.* 2009; Cole and Ostrom 2012). The public authority determines who can access and use the forest and makes decisions to regulate and control the use of the forest resources. It also sets the rules of resource utilisation, management and transfer, and has the duty to enforce these rules (Cole and Ostrom 2012).

It is widely accepted in the literature that these conventional typologies are stylised. In reality, most forest regimes overlap and do not fit easily into these conventional categories. This is because a complex array of property rights for individuals, groups, communities, entities and governments co-exist in a given forestland (Cole 2002; Cole and Ostrom 2012; Singh 2013). In most tropical countries, especially in Africa, while governments may claim *de jure* rights over a certain forest, indigenous communities also claim customary tenure over these same forestlands (Sunderlin *et al.* 2014). Moreover, forests comprise of a lot of resources such as lands, timber trees, non-forest timber products (NTFPs), wildlife and watersheds. Therefore, in a particular forest, individuals may hold tenure to forestlands for farming; communities may hold tenure to NTFPs; and the government may hold tenure to the forest trees. For these reasons, Cole and Ostrom (2010, p. 10) conclude that 'there is no such thing as purely private or purely public property'. Nonetheless, the existence of such conventional tenure forms offers a standardised basis for regime analyses at least at the theoretical level.

2.3 Conflicts in Forest Use and Control

Forests are subject to multiple uses, users and interests. This has resulted in conflicts between and among individuals, communities, corporate bodies and public agencies (Adhikari *et al.* 2004; Siswanto and Wardojo 2005; Iversen *et al.* 2006; Yasmi *et al.* 2006; Gerber 2010; Gritten and Mola-Yudego 2010; Ezzine de Blas *et al.* 2011; Mola Yudego *et al*. 2012). For instance, it is reported that forest conflicts are widespread in Asia and affects about 75% of Asia's forests (Yasmi *et al.* 2010, 2013; Gritten *et al.* 2013). The tropical African landscape is also replete with conflicts relating to forest tenure and logging concessions (Oyono *et al.* 2006; Marfo and Schanz 2009; Ezzine de Blas *et al.* 2011; Vedeld *et al.* 2012; Idrissou *et al.* 2013). The following subsections give an overview of the definitions, types and causes of these conflicts.

2.3.1 Definitions and types of forest conflicts

The term conflict is conceptually and empirically broad, resulting in broad and varied definitions. For example, Glasl (1999) defines a conflict as when the actions of an individual or entity serve to impair the actions or activities of another individual or entity. Similarly, the Food and Agricultural Organisation (FAO 2000) regards conflicts as disagreements and disputes in forest use and control. Forest conflicts can thus be viewed as occurring when two parties disagree or dispute over forest use and control due to an action or actions of one party or both.

Forest conflicts occur in different forms at different levels or scopes involving different stakeholders (Eckerberg and Sanstrom 2013; Sandstom *et al.* 2013). In terms of form, forest conflicts are classified as visible and invisible (Gritten *et al*. 2013; Hubo and Krott 2013; Idrissou *et al.* 2013). Visible conflicts are ‘dramatic confrontations’ that attract attention or involve third-party mediations (Idrissou *et al.* 2013, p. 73). These may include one or more of the following: verbal confrontations, threats, blockading, vandalism, litigations and armed conflicts. However, invisible conflicts are ‘hidden or silent’ in nature and are mostly not acknowledged by third-parties (Idrissou *et al.* 2013). It is reported that invisible conflicts dominate in forest use and control and are mostly ecologically disastrous (Gritten *et al.* 2013).

Forest conflicts also exist at the micro-, meso- and macro-levels. However, in terms of conflicts and behaviour, micro-level conflicts are of much significance. They are also dominant in the forest landscape. The common ones are inter-households, intra-community, inter-communities, community-outsider, and inter-agency conflicts (Bose 2013; Satyal Pravat and Humphreys 2013; Yasmi *et al.* 2013). Of these, conflicts between communities and ‘outsiders’ such as other communities, logging companies, plantation estates or public forest officials are widespread in developing countries (Sikor 2004; Hares 2009; Mola-Yudego and Gritten 2010; Idrissou *et al.* 2013).

2.3.2 Causes of forest conflicts

There are three main theoretical perspectives usually applied to explain and understand conflicts. These are structural-functional, neo-institutional and perceptive or ideational perspectives (Eckerberg and Sandstrom 2013; Sandstom *et al.* 2013).

Structural-functional explanations of forest conflicts

The *structural-functional* perspective considers conflicts as consequences of economic and political marginalisation, injustices, environmental change and corruption. Firstly, poor economic management and policies, population pressure and resource scarcity create socio-political inequalities, poverty and reduced livelihoods resulting in intense competition over forest resources (Vedeld *et al.* 2012). In such situations, social and political elites are able to deploy their agencies to marginalise weaker actors and forest communities through exclusionary and illusionary forest policies that serve the interests of dominant power structures. These create tensions in the use and control of forest resources (see Peluso and Watts 2001; Martinez-Alier 2002; Ezzine de Blas *et. al.* 2009, 2011; Sudana 2009; Peet *et al.* 2010; Bawa *et al.* 2011; Bouda *et al.* 2011; Kroger 2011, 2013; Sikor and Stahl 2011; Robbins 2012; Bose 2013; Ravikumar *et al*. 2013; Singh 2013;

Yasmi *et al.* 2013). Secondly, structural factors such as forceful evictions, corruption and lack of accountability spark forest conflicts between local communities and national governments (see Ashby 2003; Oyono 2005; Cerutti and Tacconi 2006; Padhi and Adve 2006; Oyono *et al*. 2006, 2007; Ango and Bewket 2007; Asher and Agrawal 2007; Kumar *et al.* 2008; Agrawal and Redford 2009; Bouda *et al.* 2011; Roy *et al.* 2012; Kumar and Kerr 2013; Bekele and Ango 2015).

Neo-Institutional explanations of conflicts

The *neo-institutional* perspective mainly considers issues of property rights, tenure reforms and decision-making as the underlying sources of conflicts (see Peluso 2002; Conyers 2003; Suzuki 2005; Ibarra and Hirakuri 2007; Sudana 2009; Bose 2013; Ravikumar *et al.* 2013). The lack of rights, non-recognition of existing rights, and unclear tenure lead to conflicts as local users compete for forest resources (see Agrawal and Chhatre 2006; Counsell *et al.* 2007; Mbatu 2009; Coleman and Liebertz 2014; Eisen *et al.* 2014; Lescuyer *et al.* 2015). Further, tenure reforms create new tenure arrangements that usually contradict pre-existing customary arrangements; superimpose formal legislations on customary tenure; and create overlapping rights and roles among actors leading to competing resource claims, dissatisfactions and disagreement, especially, at the local level (see Peluso and Vandergeest 2001; Agrawal and Chattre 2006; Oyono *et al.* 2006, 2007; Sikor 2006; Colchester 2008; Meinzen-Dick and Mwangi 2008; Deininger and Feder 2009; Sjaastad and Cousins 2009; Ezzine de Blas *et al.* 2011; Bose *et al*. 2012; Bose 2013; Lund 2013; Adhikari *et al.* 2014; Coleman and Liebertz 2014). In addition, the lack of participation in decision-making regarding forest use and control usually leads to conflicts. This is because local users challenge the mandates of rule-makers and the legitimacy of rules made (Eckerberg and Sandstrom 2013).

Perceptual or Ideational explanations of conflicts

The *perceptual or ideational* perspective views conflicts as arising from a clash of interest and ideologies and the absence of or weakened social capital. Social capital is seen as crucial in the emergence and management of conflicts. Issues of social capital critical to the upsurge of forest conflicts include trust, reciprocity, interdependence and interpersonal friendship, third-party mediation and corporate social responsibility (CSR) [Idrissou *et al.* 2013; Kroger 2013; Zachrisson and Beland Lindahl 2013]. Trust is considered as the most important social factor because it is seen as the ‘glue’ binding relationships (Eshuis and van Woerkum 2003; Liwicki 2006; Marcus 2006; Tomlinson *et al.* 2009; Idrissou *et al.*

2013). Proponents also hold that conflicts are less likely to occur when interdependence, friendship and corporation are high among forest actors (Idrissou *et al*. 2013; Zachrisson and Beland Lindahl 2013). Likewise, the implementation of CSRs helps to minimise the occurrence of conflicts (Kroger 2013).

Another source of forest conflicts from the perceptual perspective is grievance (Gerber 2010; Kroger 2013). Kroger (2013) identifies three levels of grievance including specific, relative and objectively observable grievances. Specific grievances relate to the entity or agency (such as a logging company) in question and comprise immediate actions or inactions of the entity that could spur dissatisfaction among indigenous communities or forest users. Relative grievances entail experiential dissatisfaction with past entities which condition how locals perceive current entities. Also, objectively observable grievances relate to the capacity and suitability of a forest area for proposed or on-going land-use activities. These grievances usually combine to spark conflicts when social capital fails to prevent the mobilisation of aggrieved people (Kroger 2013).

The last perceptual factor of particular importance in forest conflicts are cultural beliefs and connections. Empirical research reveals that indigenous communities have had historical, cultural and religious attachment to their forests (Ntiamoah-Baidu 2001, 2008; Campbell 2005). Thus, attempts and actions by ‘formal’ and ‘modern’ actors to delegitimise these actions are likely to lead to conflicts (Yasmi *et al.* 2013). These ideational factors have combined to become powerful elements mediating the emergence of forest conflicts in the developing world.

Despite the singular application of these perspectives, factors leading to conflicts in a particular forest area may likely be multidimensional than unidimensional. This necessitates a multidimensional approach to understanding conflicts. Having realised this necessity, Sandstorm *et al.* (2013) reveal that scholars are increasingly moving from a separate application of the approaches. However, it is evident from the above that the denial and or imposition of certain property rights is a cross-cutting factor among the perspectives in explaining forest conflicts. In fact, almost all forest conflicts are sparked by actions or inactions which exclude some people from certain rights or benefits they, hitherto, enjoyed from forests. This shows the *primacy of property rights* in forest conflicts and behaviour. It follows from this that policy measures to resolve forest conflicts should at least consider addressing the issue of property rights to forest resources.

2.3.3 The impacts of forest conflicts on forest behaviour

A synthesis of the three theoretical perspectives for explaining conflicts reveal two broad categories of forest conflicts at the micro level, namely, tenure-related and non-tenure related conflicts. Tenure-related conflicts affect the behaviour of forest dwellers towards forests. Ownership contests among forest actors erode people's moral sense of responsibility to protect forests. Deprivation of ownership and use rights creates perverse incentives for forest dwellers to voluntarily apply their indigenous knowledge and practices to improve forest conditions (Hansen *et al.* 2009; Kumar and Kerr 2013). For instance, indigenous communities in Orissa, India, have refused to apply their 'sophisticated knowledge' for forest conservation and land improvement because of the deprivation of customary rights by the government (Kumar and Kerr 2013). Forest ownership disputes also breed unsustainable forest practices. The usurpation of traditional forest rights results in illegal logging and encroachment of protected areas by forest dwellers (Alemagi and Kozak 2010; Biswas and Choudhury 2007; Mukul *et al.* 2014). Studies reveal that illegal logging is used as a tool for resisting statist usurpation of traditional lands and forests in Cameroon (Alemagi and Kozak 2010), Bangladesh (Biswas and Choudhury 2007; Rasul 2007; Mukul *et al.* 2014), Ecuador (Vasco *et al.* 2017), Ghana (Otutei 2012) and many other developing countries.

Individuals' perception of the legitimacy of a particular tenure influences forest practices. Forest laws that deprive individuals of their livelihoods are perceived as unfair or illegitimate. This perception of unfairness increases the likelihood for non-compliance with forest laws and unsustainable behaviour toward the forest environment (Ostrom 1990; Wilshusen *et al.* 2002; Blader and Tyler 2003; Nielsen 2003; Anderies *et al.* 2004; Tyler 2006; Jenny *et al.* 2007; Cole and Ostrom 2012). It is reported that the marginalisation of indigenous people in the Chittagong Hill Tracts of Bangladesh by the rich and affluent and the government's Forest Department has resulted in the use of abusive forest practices that usually lead to the degradation of forests (Roy 2002). Further, it is posited that non-participatory and non-transparent rule-making processes breed non-compliance with forest rules because individuals view rules as illegitimate (Cole and Ostrom 2010). Compliance with conservation laws is also low if individuals question the validity of rule-makers (Ramcilovic-Suominen and Epstein 2012).

People's attitude towards illegalities or unsustainable practices by their peers or outsiders can be altered by their perception about the legitimacy of forest tenure. Disgruntled individuals are more likely to countenance illegalities by their peers (Rasul 2007). They are also more likely to collude with outsiders to engage in illegal forest practices (Rasul 2007). Further, forest dwellers may have lower incentives to use forests sustainably when they disagree with forest use restrictions imposed by governments (Robinson and Lokina 2011; Singh 2013; Pfaff *et al.* 2014). For instance, Biswas and Choudhury (2007, p. 636) reveal that:

> A ban on felling of trees at a time (in 1971) when wood was in very high demand for the rehabilitation of war damaged houses, coupled with the prevailing poor law and order situation, caused the most serious destruction of forest resources in the history of [Bangladesh].

Not only did indigenous people directly engage in illegal logging but they also colluded with outside timber merchants in the illegal business for financial gains (Rasul 2007). Hitherto, these indigenous people were known for the protection of these resources through the exclusion of outsiders (Rasul 2007).

Non-tenure related forest conflicts such as grievances can be devastating to the forest environment (Gerber 2010; Kroger 2013). Grievances have been linked to unsustainable behaviour among aggrieved forest dwellers (Kull 1999, 2004; Kroger 2013). In Cameroon for instance, disgruntled traditional chiefs engage in illegal logging due to conflicts with village-level forest elites appointed by the State (Oyono 2005). Also, strained relationships between forest villages and concessionaries due to unfulfilled CSR agreements have exacerbated the illegal logging problem in Cameroon (Alemagi and Kozak 2010).

It is discernible from the above discussion that forest conflicts, especially those relating to tenure, are very devastating to forests. The FAO's Global Forest Assessment Report in 2015 revealed that tropical countries are persistently experiencing forest loss and degradation despite slowed rate of deforestation (Keenan *et al.* 2015; Sloan and Sayer 2015; van Lierop *et al.* 2015).[4] Forest conflicts are part of the major underlying sources of this persistent degradation (Bekele and Ango 2015). Such conflicts usually erode people's moral sense of responsibility to protect forests and lead to the adoption of practices that usually degrade the environment (Gritten *et al.* 2013). This is an indication that tropical forests will continue to be degraded should such conflicts persist. Therefore, appropriate measures need to be put in place to address the underlying causes of forest conflicts and

[4] The global rate of deforestation was estimated to be 0.08% per annum in 2015 which is lower compared with the 0.18% per annum in the early to mid-1990s (FAO 2015).

induce sustainable behaviour. The following section will provide an overview of approaches available for inducing such conservation behaviour.

2.4 Approaches to Inducing Sustainable Forest Behaviour

Several categories of approaches can be used to influence individual forest behaviour or resolve forest conflicts in the developing world. Some of the well-known approaches applicable in developing countries include command-and-control, property rights, and incentive-based approaches. This section provides an overview of these approaches.

2.4.1 Command-and-control or centralised approaches

These types of approaches involve the regulating agency, usually the government, mandating a certain socially desirable behaviour or constraining certain behaviours using laws and regulations (commands) and then adopting necessary actions (controls) to ensure compliance with such laws and regulations (Hussen 2004; Kolstad 2011; Field and Field 2013). The most common command-and-control approach in forest management is the 'Fortress Approach': mainly through the designation of forests as Protected Areas (PAs), reserves or parks, and statist enforcement of exclusionary forest laws.

Statist conservation efforts are seen by proponents as a panacea for forest degradation (Terborgh 1999, 2000; Bruner *et al.* 2001; Chapman 2003; Struhsaker *et al.* 2005). This is because the government is thought to have the capacity to restrict access, monitor and enforce rules to preserve forests and the ecological services they provide. However, other scholars are of the view that command-and-control approaches have been ineffective in conserving forests in many situations (Gibson *et al.* 2005; Cole and Ostrom 2012). First, forest dependent communities have lower incentives to use forests sustainably when governments restrict use (Robinson and Lokina 2011; Roy *et al.* 2012; Singh 2013; Pfaff *et al.* 2014; Roy 2014). Statist approaches deprive forest people of their livelihoods. Thus, compliance with forest conservation rules is low since they are viewed as illegitimate (McCarthy 2000; Wilshusen *et al.* 2002). Second, governments have not shown full commitment to conservation goals since they permit large scale logging, mining and industrial activities in forests (Colchester *et al.* 2008; Beymer-Farris and Basset 2012; Kashwan 2013). Lastly, public forest administration in developing countries have been characterised by corruption and limited enforcement of forest rules (Alley 2011; Sunderlin *et al*. 2014). These have crippled statist conservation efforts. Many scholars have therefore called for alternative approaches to sustaining forests.

2.4.2 Property rights approaches

Assigning or clarifying enforceable property rights to resources have become one of the main approaches in inducing sustainable behaviour and settling disputes over resource use in most parts of the world. Economists view the assignment of clear property rights on environmental resources as one of the most efficient approaches to solving environmental problems (cf. Hardin 1968). This is because, the right-holder(s) can exclude others to ensure that the resource is preserved. When rights are not clearly defined, nobody will have the incentive to ensure that forest resources are not degraded. The allocation of these property rights could be individual or collective. Either way, it is thought that clearly defining rights over environmental resources will lead to their sustainability.

Private property approach

Property theorists have traditionally argued for the privatisation of forest resources as a 'silver bullet' for forest conservation (Demsetz 1967; Hardin 1968; Umbeck 1981; Anderson and Hill 1990; Larson and Bromley 1990; Pearse 1990). It is thought that assigning complete private property rights can achieve this at least in two ways. First, private ownership provides secure tenure. Tenure security has been defined differently by different authors (cf. Arnot *et al.* 2011). Secure tenure has been found to lead to sustainable behaviour since right-holders are assured that their investment in forest improvement will certainly accrue to them (Resosudarmo *et al.* 2014; Robinson *et al.* 2014b; Stickler *et al.* 2017). Individual users are thus willing to preserve forest for future use. Again, when forest individuals perceive their rights as secure, they are likely to invest in forest improvement (Broegaard 2005). However, if forest property rights are (perceived to be) insecure, individuals use forests unsustainably because they are uncertain about future benefits (Resosudarmo *et al.* 2014).

Second, regardless of who the right is assigned to, assigning property rights may initiate a negotiation process between parties of an environmental dispute to work out an efficient solution to degradation. This is known as the Coase theorem (Coase 1960). Here, Coase (1960) argues that assigning property rights over a particular environmental resource will lead to an efficient outcome whether the right was allocated to the damaging party or the victim. In this case, the damaging party may have to compensate the victim for a certain negotiated level of damage to the resource. Or the victim may have to pay the damaging party to reduce the amount of damage caused. Who pays matters little insofar as degradation is curtailed.

It should be pointed out that privatisation does not necessarily guarantee sustainable use of forests. There is ample evidence to show that private tenure has failed to conserve forest resources under many circumstances (Cole and Ostrom 2012; Liscow 2013). It has been found that secure rights (through privatisation) does not automatically translate into preservation, especially when the economic viability of clearing forests is higher (Naughton-Treves and Wendland 2014). Individuals are more likely to clear forests if the economic profits of clearance exceed preservation profits (Tacconi 2007; Cramb *et al.* 2009; Feintrenie *et al*. 2010). This is especially true in the absence of high external incentives such as social capital and conservation rewards (Naughton-Treves and Wendland 2014). Again, 'private individuals may overexploit the resource when they consider it more productive to do so' (Cole and Ostrom 2012, pp. 96-97). This shows that the relationship between privatisation and the decision to conserve may be very much dependent on other contextual factors.

Communal property approach

Another approach used in inducing sustainable behaviour among forest dwellers is the assignment of complete or quasi-complete property rights to user groups, usually forest villages. Privatisation and statist control had been advanced as conducive for better conservation outcomes because of a presumed inability of a group of individuals or communities to independently use and manage a forest (Olson 1965; Hardin 1968). However, this presumption has been challenged as misleading since Ostrom's (1990) influential publication on the commons. Communal property theorists, based on worldwide empirical case studies, have linked communal property regimes to better forest conditions (see for example, Agrawal and Ostrom 2001; Ostrom 2003; Lund and Treue 2008; Agrawal and Angelsen 2009; Chhatre and Agrawal 2009; Baland *et al*. 2010; Poteete *et al.* 2010; Porter-Bolland *et al.* 2012; Roy *et al.* 2013; Schroeder and Castillo 2013; Cardona *et al.* 2014; Saito-Jensen *et al.* 2015; Travers *et al.* 2015). These studies, among others, reveal that communities are able to craft rules, monitor them and apply 'graduated sanctions' to ensure better forest conditions. Based on this observed relationship between communal property rights and conservation, there have been indirect calls for granting at least proprietorship rights to forest dependent communities (Ostrom 2003). In fact, many countries in the developing world have or are adopting communal property approaches to manage their forest resources.

Despite the extant literature on the positive effects of communal property regimes on forest conditions, other scholars have made contrary findings (e.g., Campbell *et al*. 2001; Godoy *et al.* 2001). Communal property regimes in Africa have particularly become ineffective due to the lack of government support (Campbell *et al.* 2001; Hayes and Persha 2010; Kijazi and Kant 2011; Naughton-Treves and Wendland 2014). Also, Suh (2014) has found that granting of communal tenure in the Philippines and India may not automatically improve community forests if there is limited linkage with the broader forestry industry. This shows the insufficiency of communal tenure *alone* to trigger forest conservation (cf. Jagger 2014, p. 39).

The above analysis shows that the conventional property right approaches have offered varied outcomes across the world. This makes it difficult to conclude on a particular approach as the most effective in conserving forests. More importantly, an imposition of a particular conventional tenure will be impractical, socially unjustifiable, politically infeasible and ecologically disastrous because of the complexity of forest ownership and dependence in the world. It is estimated that about 75% of forests in the world are owned by governments whereas about 1.5 billion people are primarily dependent on forests for their livelihoods (Kashwan 2013, p. 613). Thus, attempts to promote communal property tenure will not be politically feasible since it may constrict the 'higher powers', who may oppose it indirectly. There are instances in Africa where governments have impeded smooth forest tenure reforms to protect their economic and political interests (cf. Oyono 2004; Bouda *et al.* 2011; Ezzine de Blas *et al*. 2011). However, a purely state or private tenure will also result in the displacement of about 1.5 billion people. This will likely face stiff local, national and international opposition. In a study to evaluate the acceptability of various forms of forest tenure in Tanzania, for example, Kijazi and Kant (2011) found that state and communal tenure are less favoured by forest actors. Instead, they found that forest actors favour a more participatory co-management. Thus, it is better to consider the rules and rights for forest management than prescribing a particular form of conventional tenure (cf. Cole and Ostrom 2012).

Alternative property rights approaches

In their framework, Schlager and Ostrom (1992) link the possession of 'bundles of rights' to people's decision to conserve forests. They indicate that owners have higher incentives to invest in the sustenance of forests. This is because they will be able to retrieve their investments in conservation. Proprietors are also theorised to have high incentives to conserve forest since they have the rights to exclude others from forest use—especially users whose activities would lead to degradation. Again, owners and proprietors have the incentives to conserve forests for longer periods because they are assured of the future benefit streams from the forest. They can therefore monitor resource use and enforce rules. Schlager and Ostrom (1992) indicate that though claimants also have incentives to conserve, their motivations are lower due to their lack of exclusion rights. However, the incentive for authorised users and entrants to invest or sustain forests is very low and is dependent on the enforcement of rules. They therefore 'engage in a game with rule enforcers, seeking to gain as much as possible' (Schlager and Ostrom 1992, p. 257).

Other studies affirm these theoretical assertions (e.g., Agrawal 2001, 2007; Ostrom 2001; Zhang and Owiredu 2007; Hayes and Persha 2010; Schroeder and Castillo 2013; Adhikari *et al.* 2014). These studies, among others, reveal that assigning some level of clearly defined property rights to forest dwellers is very crucial for forest management. Based on this, some scholars have called for the granting of at least proprietorship rights to local people to motivate them to conserve forests. However, these calls are far from being realistic considering the political economy of forest management in the world (Kashwan 2013). Kashwan (2013, p. 613) argues that the granting of an 'expansive set of rights' is not politically feasible. He recommends the granting of a 'minimal set of rights critical to the subsistence and well-being of forest people [such as use rights]' for effective forest conservation (Kashwan 2013, p. 613). Though originally thought to be associated with low incentives, the granting of use rights to forest-dependent communities have been found to be essential for better conservation outcomes (Chhatre and Agrawal 2009; Coleman 2009). Granting of use rights motivates forest dependent communities to monitor forest activities (Ghate and Nagendra 2005; Ostrom and Nagendra 2006; Coleman and Steed 2009).

The regularisation of *de facto* rights may also induce conservation. This strategy is thought to be associated with higher incentives to conserve forests (Duchelle *et al.* 2014). However, other scholars argue that granting of legal property rights does not necessarily translate into better forest outcomes (Agrawal *et al*. 2008). Rather, the effectiveness of property rights, be it *de facto* or *de jure*, is dependent on the context and the level of enforcement at the local level (Ostrom 1999; Meinzen-Dick *et al*. 2002; Gibson *et al.* 2005; Andersson and Gibson 2007).

2.4.3 Incentive-based approaches

Incentive-based approaches refer to mechanisms used to motivate the adoption of sustainable behaviour without necessarily changing the existing property regime. Some of these mechanisms are individual economic incentives, collective incentives and alternative livelihood activities. Individual and collective economic incentives can be used by conservation authorities to induce a change in behaviour. It is argued that where there are strong monetary incentives for conserving forests, individuals are more likely to conserve forests to obtain such monetary rewards (Mukul *et al.* 2014; Naughton-Treves and Wendland 2014). This has been the basis for the Payment for Environmental Services (PES) mechanisms and 'Reducing Emissions from Deforestation and Forest Degradation plus conservation, sustainable management of forests and enhancement of forest carbon stocks' (REDD+) initiatives that seek to reward forest communities for their environmental services (Muradian *et al.* 2010; Galik and Jagger 2015; Schomers *et al.* 2015).

Incentives could also induce sustainable behaviour through peer monitoring and local enforcement. If individuals are rewarded when they detect and report unsustainable actions of others, others will be compelled to comply with conservation rules. Such reward schemes will incentivise them to regularly monitor forest use, thereby deterring others from non-compliance (Hayes and Persha 2010). This type of local-level monitoring has been identified as the most effective way of enforcing forest conservation laws (Gibson *et al.* 2005; Singh *et al.* 2011; Chhatre and Agrawal 2008; Robinson *et al.* 2014a). It can be used to complement statist enforcement in most developing countries, where forestry departments are ill-equipped to carry out effective monitoring (Kaimowitz 2003). Such collaborative enforcement activities have been associated with good forest conditions even in the absence of social capital and livelihood projects (Gibson *et al.* 2005; Robinson *et al.* 2014a).

Another incentive-based approach that is used to induce sustainable behaviour is the implementation of alternative livelihood projects. It has been argued that forest dependent communities will be motivated to conserve forests when they are provided livelihood projects and basic infrastructural services, especially, with forest revenues (Irimie and Essmann 2009; Robinson and Lokina 2011). It is reported that individuals who directly benefit from alternative livelihood projects are more likely to desist from unsustainable practices and illegalities (Mackenzie *et al.* 2011; Mukul *et al.* 2014). Empirical studies reveal that livelihood projects bind individuals together to collectively monitor forest use

(Alemagi and Kozak 2010; Mukul *et al*. 2012, 2014). Such projects can erode perception of unfairness of exclusionary forest laws and promote reciprocity and interdependence among forest actors, thereby inducing individual compliance with forest laws (Alemagi and Kozak 2010; Robinson and Lokina 2011; Mukul *et al*. 2012). However, a game-theoretic analysis by Robinson *et al.* (2014a) in Tanzania revealed that the relationship between livelihood projects (bee keeping) and conservation is unclear. But the clarity of this relationship may well depend on the type of livelihood project and the mechanism through which it seeks to induce sustainable behaviour.

2.4.4 Other approaches to resolving forest conflicts

Other approaches for reducing forest conflicts and inducing sustainable behaviour are moral suasion (educational campaigns), community pressure, mediation, blockading and litigation. Public educational campaigns can be used to end forest conflicts and induce socially acceptable behaviour among forest actors. However, such educational campaigns are less likely to succeed if the underlying causes of disputes and unsustainable behaviour are not addressed. For instance, unsustainable forest practices caused by the deprivation of rights to forest resources in the developing world may not be easily changed through moral suasion if deprivation still persists.

Formal and informal community pressure can also be used to resolve conflicts and promote sustainable behaviour. In some cases, individuals, communities, environmental NGOs, donors and the media can voluntarily pressurise individuals, firms and governments whose activities degrade forests. Voluntary associations, public interest groups, local and international NGOs and global networks serve as watchdogs on forest issues and influence conservation decisions through the mobilisation of resources, provision of information, participation in debates, public commentaries and livelihood support (Cox 2006; Lu and Schuett 2012). Through such activities, these advocates are (sometimes) able to pressurise governments and firms, who do not want to lose reputation through bad publicity, to conform to particular socio-environmental ideals.

Mediation can also serve as a powerful tool for resolving forest conflicts in the developing world. This refers to the act of seeking the intervention of a third party to resolve conflicts through non-adjudicative means (Marfo and Schanz 2009). It has been found to be superior to the use of force in resolving conflicts in many settings (Landsman *et al.* 2003; Wall and Dunne 2012; Kressel 2014). However, its superiority may well depend on contextual factors such as the social-political environment, the characteristics of the conflicting parties, and the interests, neutrality and objectivity of mediators (cf. Bercovitch and Houston 1993; Wall and Lynn 1993; Isenhart and Spangle 2000; Mulcahy 2000; Evans 2001; Kay 2009; Jehn *et al.* 2010; Wall and Dunne 2012; Kressel 2014; Dhiaulhaq *et al.* 2015). The court system can also be used to settle forest conflicts. Litigation is a popular device for resolving environmental conflicts in advanced countries where people have the financial ability and are more informed about their rights (Field and Field 2013). It is less popular in most developing countries due to lack of information, poverty, and public mistrust of the judiciary system (cf. Marfo and Schanz 2009). Hence, litigation may not be very effective in resolving forest conflicts and inducing compliance with forest laws in the tropics. Blockading (forceful confrontations) may also be used by individuals and groups within communities to halt unsustainable forest practices such as destructive logging and mining activities. Actions such as embracing trees to prevent logging, road blocks, occupation of sites and other preventive actions are sometimes used by activists to halt logging activities of individuals and firms. A case in point is the Chipko movement for forest conservation in north India where forest dwellers used confrontational actions such as the hugging of trees to prevent the logging of those trees (Jain 1984; Burton 2004).

2.4.5 Policy mix approaches

In many circumstances, policy makers combine two or more approaches to resolve forest conflicts and induce sustainable behaviour among forest dwellers. This is usually known as the policy mix approach. As indicated earlier, many forest conflicts are complex in nature. Forest conflicts may be triggered by ill-defined property rights and exacerbated by poverty, lack of enforcement and other contextual factors. When confronted with such complex problems, it is argued that ‘the logical response is to work with a mix of the available options, and to choose policies that work well in a given situation’ (Cato 2011, p. 127). That is, it will be more efficient for a policy maker to combine property right approaches with increased enforcement of forest laws (command-and-control approach), incentive-based approaches or other relevant approaches to effectively resolve such conflicts than relying on the exclusive application of one of these approaches. In fact, some scholars (e.g., Poteete *et al.* 2010; Yin *et al.* 2016) maintain that such policy mix approaches are more likely to be practical and effective in resolving conflicts and promoting sustainable behaviour in developing countries because they combine the necessary elements of different approaches to address multifaceted problems (Poteete *et al.* 2010; Yin *et al.* 2016).

2.5 Conclusion

This chapter has reviewed the literature on property rights, forest conflicts, and approaches to resolving forest conflicts and inducing conservation behaviour. It became evident that ill-defined property rights are at the heart of almost all forest conflicts and shape forest use and management behaviour in developing countries. There are several categories of approaches to resolving forest conflicts and inducing sustainable forest behaviour. These include command-and-control approaches, property right approaches, incentive-based approaches and other approaches such as moral suasion, mediation, blockading and litigation. However, the causes of forest conflicts and degradation are complex and thus policy mix approaches that combine several policy devices are needed to induce sustainable behaviour.

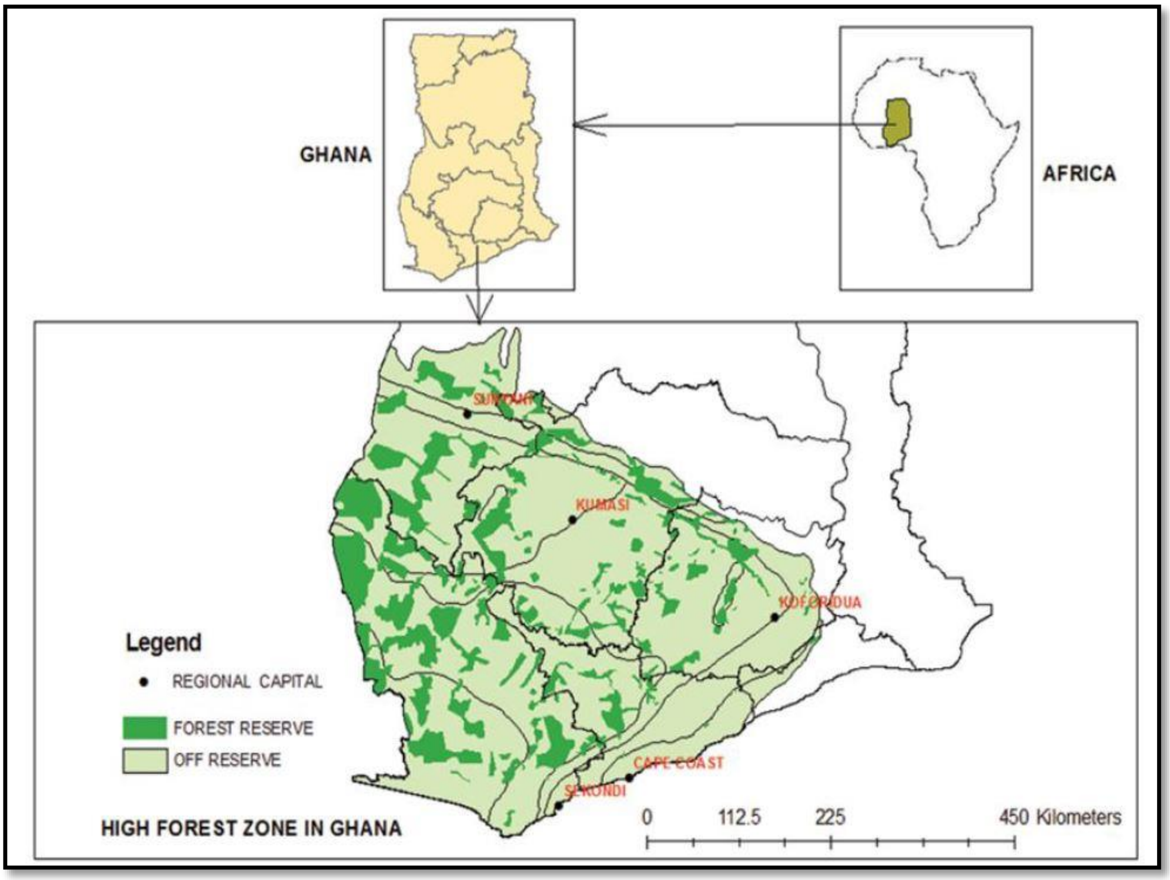
Chapter 3. Contextualising Property Rights, Forest Conflicts and Behaviour in the Off-reserve Forests of Ghana

This chapter aims to explore the context of the off-reserve forests in terms of property rights, conflicts and farmers' behaviour. The off-reserve forests in Ghana are a mosaic of natural forests, secondary forests, fallows and farms. They constitute about 65% of the High Forest Zone (see Figure 3.1). Farming (especially cocoa) and logging are the two main economic activities in the off-reserve forests. This chapter discusses agroforestry practices of (cocoa) farmers and the role of farmers in conserving the off-reserve forests. It also summarises the logging activities in the off-reserve forests and highlights the key actors involved in forestry. Further, the chapter utilises the concept of property rights to analyse the property rights of major stakeholders. It proceeds to discuss off-reserve forest conflicts and their underlying causes. It then discusses the effects of these conflicts on farmers' behaviour. Some attempts to resolving the off-reserve problem and the challenges militating against effective resolution of the conflicts are next discussed. A critical gap in the existing literature on the off-reserve situation is then highlighted.

3.1 Cocoa Agroforests in the Off-reserve Forests

The off-reserve forests provide fertile land and climate suitable for the cultivation of perennial crops (such as cocoa and oil palm) and food crops. Among these crops, cocoa farming has dominated the off-reserve landscape, producing cocoa beans to feed the world's cocoa market. Cocoa farming is the primary occupation of about 800,000 farming households in the country (Ghana Cocoa Board [Cocobod] 2015), representing about 33% of the total number of households in Ghana (see GSS 2013a). It is estimated that the livelihood of about 6.3 million people in Ghana is dependent on cocoa (Laven 2010).

Cocoa in Ghana is traditionally grown under shades. Farmers typically clear the undergrowth of trees, fell unwanted trees and retain or plant some trees to provide shades for the cocoa crops. This is called the 'extensive cocoa method' and is the most preferable practice for farmers (Gockowski *et al.* 2013). The extensive method is therefore a mixture of cocoa crops interspersed with plantain, cocoyam, yam and other crops as well as shade trees. Farmers retain mature trees, care for them and protect them from 'squatters'. They also retain naturally occurring saplings and coppices of shade trees, plant saplings of indigenous trees, nurture them and care for them to grow with the cocoa plants. The extensive cocoa farm is only abandoned after 30 to 40 years of cultivation (Gockowski *et al.* 2013). Thus, farmers may be able to protect these trees from illegal loggers until they are matured and ready for harvest.



Source: Boakye 2015

Figure 3.1 Map of Ghana showing the HFZ

Farmers retain on-farm trees for agricultural and economic purposes (Anglaaere *et al.* 2011; Akrofi *et al.* 2015). They retain and or plant trees on their farms to provide shading, improve soil fertility, improve soil moisture, regulate farm temperature, control pests and diseases and protect crops from bushfires and precarious weather (Anglaaere *et al.* 2011; Akrofi *et al.* 2015). Farmers are selective in shade tree retention (Asare 2005). There are three broad typologies of trees identified by farmers in their farming practices. These are *useful* trees, *neutral* trees and *aggressive* trees (Anglaaere *et al.* 2011). Useful trees have high values for timber, soil fertility and soil moisture improvement. Neutral trees have low commercial values but compatible with crops and provide shades, fruits and fuelwood. However, aggressive trees are hostile to cocoa seedlings and crops because they harbour pests and diseases, compete with crops for nutrients and soil moisture and reduce farm ventilation (Anglaaere *et al.* 2011). Thus, in the course of land clearing for cultivation, aggressive trees are felled but useful trees and some neutral trees are retained. In many cases, farmers plant saplings of indigenous timber trees at strategic locations in their farms to ensure maximum and uniform shading for crops.

Besides shading, farmers retain shade trees on farms for economic reasons. Trees are retained by farmers with the hope of earning income from the sale of these trees when they mature (Hansen and Treue 2009; Anglaaere *et al.* 2011; Akrofi *et al.* 2015). They also retain trees to provide wood for construction of personal or family buildings in the future, to save them money and to reduce the stress of buying them from markets located faraway from farming villages (Otutei 2012). Therefore, though shade trees are indispensably needed on farms, farmers tend to retain useful trees with high economic values than neutral trees (Gockowski *et al.* 2013). Apart from these economic and developmental purposes, farmers tend to retain and nurture fruit trees, trees with high medicinal values, trees that could easily be used as fuelwood and trees with spiritual values. These are not necessarily shade trees.

Cocoa agroforestry has been identified as a forest conservation strategy. It is viewed as contributing to biodiversity conservation and protecting forests against droughts and bushfires (Asare *et al.* 2014; Akrofi *et al.* 2015). Mature cocoa farms and fallows are the habitats of diverse tree species in both off-reserve and on-reserve forests in the HFZ (Anglaaere *et al.* 2011). Cocoa agroforests, especially mature farms and fallows, harbour and protect vulnerable and endangered tree species. For instance, Anglaaere *et al.* (2011) reveal that about a third of trees in mature farms in the Atwima district are classified by the UN as vulnerable species. Cocoa agroforests are also used as ‘buffer zones’ to protect forest reserves from bush fires and human encroachment in parts of the HFZ (Asare *et al.* 2014). It is estimated that about 21,000 km^2 of forests could have been saved had the intensification of cocoa agroforestry in West Africa been adopted in the 1960s (Gockowski and Sonwa 2011). This underscores the critical role cocoa agroforests play in forest conservation.

In the off-reserve landscape, particularly, it is estimated that fallow lands and farmlands form two-thirds of the forests. The off-reserve area is composed of natural forests (12%); secondary forests (3%); fallow lands (26%); farmlands (48%; consisting of mature cocoa, oil palm, food crops farms); grasslands (8%) and others (2%) (Hansen *et al.* 2009). In sum, fallow lands and farm lands constitute 74% of off-reserve forests in Ghana. Again, because of the tree-nurturing practices of cocoa farmers, farms and fallows harbour most of the timber trees in the off-reserve area (Dumenu 2010; Hansen and Treue 2009; Hansen *et al.* 2012). Logging in the off-reserve forests is thus concentrated on farms and fallows.

3.2 Off-reserve Logging in Ghana

Logging is one of the major contributors to Ghana's economy. In 2016, the forestry and logging subsector contributed 2.4% to Ghana's GDP (GSS 2017). In terms of foreign exchange, it is the fourth major export earner after gold, crude oil and cocoa. For instance, timber and timber products contributed about 2.28% of the total merchandise exports in 2016, amounting to US$254.3 million (Bank of Ghana [BoG] 2017). Logging also produces domestic lumber products used for infrastructural development in the country. With regards to contribution to livelihoods, the forestry subsector directly employed more than 100,000 people and indirectly provided 2.5 million jobs to Ghanaians in 2010 (Agyeman *et al.* 2012).

Logging is carried out in both forest reserves and off-reserve forests. It is governed by Acts and Regulations such as the *Timber Resource Management Act 547* (GoG 1998a); *Timber Resource Management (Amendment) Act 617* (GoG 2002); *L.I. 1649—Timber Resource Management Regulation* (GoG 1998b); and *L.I. 1721—Timber Resource Management (Amendment) Regulation* (GoG 2003). Annual estimates of total timber harvests vary due particularly to administrative lapses and methodological inconsistencies. However, it is estimated that the total annual harvest ranges between 3.7 million m^3 and 6 million m^3 of round wood equivalent (RWE) (Hansen *et al.* 2012). Out of the annual estimated harvests, illegal logging accounts for between 70% and 80% (Hansen and Treue 2008; Blay *et al.* 2009; Marfo 2010; Hansen *et al.* 2012).[5]

It is estimated that 30% to 40% of official timber production occurs in the off-reserve forests (Oduro *et al.* 2014). Most of the timber contracts granted in off-reserve forests have shorter durations of usually 5 years (Hansen and Treue 2008; Hansen *et al.* 2012). Before granting an off-reserve logging permit, the Forest Service Division (FSD) is legally mandated to carry out a pre-inspection exercise on the area to be logged with the concessionaire, landowners, the District Assembly (local government of the area) and the

[5] Illegal logging is used here to imply the harvesting of a timber tree without the permit of the Forestry Commission (GoG 1998a). Legal loggers are timber firms (concessionaires) who are permitted by the Forestry Commission to harvest particular timber trees within a concession.

farmers on whose farms the trees are found (FC 1998; GoG 1998a; 1998b). The FSD, the concessionaire and the District Assembly are legally required to seek and obtain the written consents of landowners and farmers before permits are issued (FC 1998; GoG 1998a, 1998b). Upon concluding necessary arrangements, concessionaires are granted permits and move into forest villages to commence logging. As already indicated, cocoa farms are usually replaced or abandoned after 30 to 40 years of cultivation. This implies that even nurtured trees mature for harvesting on active cocoa farms before farms are abandoned to fallow. Concessionaires therefore create access routes from adjoining roads into farms to log the timber trees (Otutei 2012). After this, logs are hauled from the farm using tractors and skidders, and transported to respective sawmills.

3.3 Stakeholders of the Off-reserve Forests in Ghana

Forest use and control in the off-reserve forests is characterised by numerous stakeholders. These include the Traditional Council, Chiefs (Stool landowners), the Forestry Commission (FC), the Office of the Administrator of Stool Lands (OASL), the District Assembly, concessionaires and farmers. The specific rights held by these stakeholders are illustrated in Figure 3.2.

Lands in Ghana are typically owned by chiefs who are the custodians of stool lands.[6] These are called Stool landowners and hold lands in trust for communities, clans and families. Chiefs in a particular paramount area come together as Traditional Council or Authority, headed by the Paramount Chief. Both the Traditional Council and chiefs play substantial roles in off-reserve logging. Concessionaires need the written consents and endorsements of landowners (chiefs) before permits can be granted by the FSD. A representative of the Traditional Council is required to chair a committee to be set up by the FSD should a landowner objects to a proposed logging activity (GoG 1998b, r. 5[3]). Stool landowners are also required to form part of the pre-inspection team for the logging area (FC 1998). Further, chiefs are to spearhead the negotiations for Social Responsibility Agreements (SRAs) between forest communities and concessionaires (FC 1998; Hansen and Treue 2009). They serve as mediators in resolving conflicts between communities and farmers on the one hand, and concessionaires on the other hand (Hansen and Treue 2009; Dumenu 2010). As landowners, chiefs and the Traditional Council receive rents and stumpage

[6] Stool lands are customary lands held in trust for the people by stools, skins, clans and families. Stools and skins are the seat of authority for traditional rulers in southern and northern Ghana, respectively.

revenue from commercial timber extraction (GoG 1992). They also lead concessionaires in performing forest rituals before logging commences (Ututei 2012).

The FC was established by the *Forestry Commission Act* (Act 571) in 1999 to carry out ‘the regulation and utilisation of forests and wildlife resources, the conservation and management of those resources and the co-ordination of policies related to them’ (GoG 1999, s. 2). The FC works through its Forest Service Division (FSD) in controlling forests. Unlike forest reserves, the FC only plays monitoring and advisory roles in the off-reserve forests (FC 1998, p. 1; Treue 2001). It is only concerned with the regulation of the commercial exploitation of timber resources in the off-reserve forests (Hansen and Lund 2011; Ututei 2012). The FC, in collaboration with the Ministry of Forestry, is the sole authority for granting timber rights to logging companies. It is also responsible for setting official management rules and carrying out the enforcement and monitoring of such rules using forest guards (Franck and Hansen 2014; GoG 1999). The FC also sanctions defectors of forest rules through seizure of illegal logs, confiscation of equipment and termination of contracts or ban from obtaining further timber rights, and prosecution of offenders (GoG 1998b; Hansen 2011; Derkyi 2012). It carries out inspections in concessions to ensure that lumber products meet specified diametric thresholds before lumbering could proceed. In addition, the FC determines the stumpage fees to be paid per timber log and collects the stumpage and rents on behalf of the OASL. On some rare occasions, FSD staff help resolve farmer-concessionaire conflicts in the off-reserve forests (Marfo and Schanz 2009).

The OASL is a public institution established in 1994 to manage revenue accruing from stool lands. Its major role is the establishment of a Stool Lands Account and collection and disbursement of all revenues (GoG 1992; Kasanga and Kotey 2001). Currently, the OASL only engages in the disbursement of revenues to the stool landowners since the collection of timber revenue has been ceded to the FC (Hansen and Treue 2009; Hansen and Lund 2011).

District Assemblies (local governments) of the area within which off-reserve forests are located are given a share of the stumpage revenue from timber (GoG 1992). This share constitutes a substantial proportion of their internally generated revenue (Hansen and Treue 2009; Hansen and Lund 2011). District Assemblies are required to incorporate planning of forest activities in their development plans. They are also required to endorse proposed timber contracts before they are granted (FC 1998). Further, they are legally required to assist the FSD to seek written consent from landowners for a timber contract and to assist in resolving disputes associated with the proposed logging activity (GoG 1998b). The District Assembly is also mandated to register chainsaws meant for the felling of trees under its jurisdiction (GoG 1998b). However, empirical studies reveal that the Assembly is not performing these legal obligations, partly because the FC has exclusively captured the control of the logging processes (Hansen and Treue 2009; Dumenu 2010; Otutei 2012). In fact, the District Assemblies do no play any visible roles with regards to the sustenance of the forests (Hansen and Treue 2009; Otutei 2012).

Concessionaires (logging companies) hold harvesting rights to timber in the off-reserve forests. The *Timber Resources Management Regulations* (GoG 1998) classifies logging firms according to the size of concessions. Small-scale firms have concession areas not exceeding 20 km^2, whereas medium-scale companies have concession sizes ranging between 20 km^2 and 125 km^2. Companies with concession sizes above 125 km^2 are classified as large-scale firms. By law, only small-scale companies can be granted concessions solely off-reserve (GoG 1998). However, medium-scale companies can be granted concessions both on-reserve and off-reserve whereas large scale companies can only be granted concessions on-reserve. Hansen *et al.* (2012) also categorise timber concessionaires into large firms and small firms according to processing capacities. Large firms are wood processing companies that usually process timber for exports (Hansen *et al.* 2012). The small companies do not have processing facilities and thus supply harvested logs to either the large firms or other sawmills without harvesting permits (Hansen *et al.* 2012).

Apart from the timber concessionaires, there are chainsaw operators who have been trained to use chainsaws to fell and saw logs into lumber. Chainsaw operators need to register their machines with both the District Assembly and the Forest Service Division (FSD) before they can be allowed to operate (GoG 1998b, rr. 28-29). Nonetheless, it is illegal to use chainsaws to convert timber logs into lumber, *in situ* (GoG 1998b, r. 32(1)). Further, anybody who buys or sells timber products converted by chainsaw commits an offence under the Timber Resource Management Regulation (GoG 1998b, r. 32(2)). It is also illegal for landowners to permit unregistered chainsaws or illegal logging on their lands (GoG 1998b, rr. 34 and 41(h)). This notwithstanding, illegal chainsaw logging is rampant in Ghana and accounts for about 74% of all illegal logging in the country (Lawson and MacFaul 2010).

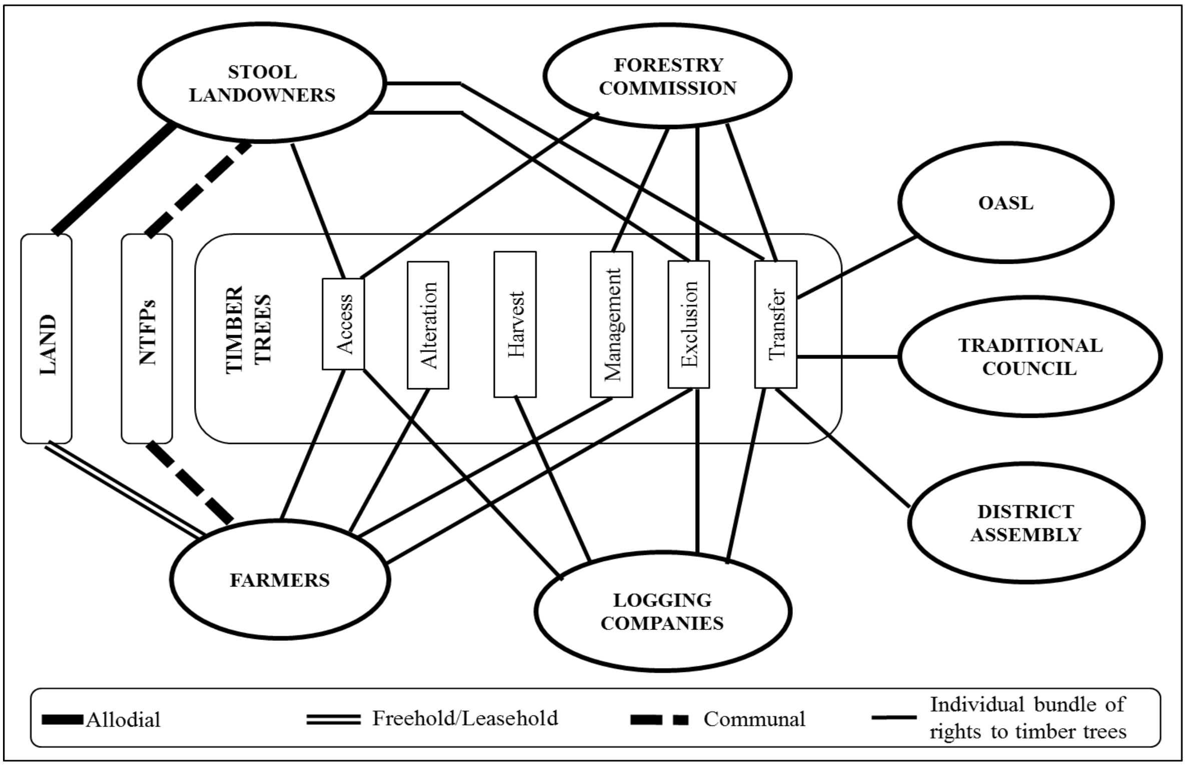
The most important stakeholders in the off-reserve landscape are farmers (Figure 3.2). Farmers are the conservators and protectors of the off-reserve forests. The important roles they play in the off-reserve forests have been discussed earlier under Section 3.1. It suffices to indicate here that the fates of most of the trees in the off-reserve forests largely rest with farmers. Farmers have the *de facto* right to decide on the level of shade tree density and diversity on their farms. They have the absolute right to dispose of young or mature trees at will during land preparation or in later stages of the farm. Also, they stay in the forests or are often in the forests and the decision to engage in, veto, detect or report illegal logging in the forests is largely at their discretion than any other stakeholder in the off-reserve landscape. As such, farmers play a critical role in either the sustenance or degradation of the off-reserve forests (cf. Owubah *et al*. 2001; Treue 2001; Amanor 2002; Dumenu 2010; Lambini *et al.* 2005; Hansen and Treue 2009). For this reason, farmers' forest behaviour forms the main focus of this study.

3.4 Property Rights in the Off-reserve Area

The off-reserve area in Ghana is characterised by multiple resources, multiple stakeholders, and multiple tenure. For the sake of specificity, the tenure arrangements for the three most important resources in the forestland are discussed here. These include the forestland, non-timber forests products (NTFPs) and on-farm timber resources. Figure 3.2 presents an overview of the existing off-reserve tenure.

3.4.1 Rights to the forestland

Ghana operates a pluralistic land regime. Both customary law and statutory law concurrently govern rights to land resources (Kasanga and Kotey 2001; Marfo 2009). Customary law is recognised in the Constitution of the Republic of Ghana (GoG 1992, a. 11) and land rights in Ghana are practically dictated by customary law (Boni 2005). There are four broad types of tenure to land in Ghana. These are allodial title, customary and common law freehold, leasehold and statutory land (Kasanga and Kotey 2001; Marfo 2009; Damnyag *et al.* 2012). Allodial title is an absolute freehold for indigenous communities with ownership held by stools, skins, clans and families. Lands held under allodial title are referred to as *stool lands* and are vested in the stools or skins in trust for the community. It estimated that about 78% of lands in Ghana are held by stools and skins through allodial titles (Arko-Adjei *et al.* 2009). Also, between 80% and 90% of undeveloped lands in Ghana belong to customary landowners (Kasanga and Kotey 2001; Marfo 2009).



Source: Author's Construct, 2015

Figure 3.2 Off-reserve stakeholders and property rights in Ghana

Lands held under allodial titles belong to communities. Individual native members of the community hold customary freehold to a fraction of the land collectively allotted to them for farming and other purposes (Marfo 2009; Damnyag *et al.* 2012). Non-indigenes who have been duly admitted into the community by the chiefs and people of the land hold common law freehold titles to the portion of land allotted to them. In the off-reserve area where the main land use is farming, holders of freehold titles have at least proprietorship rights to their portions of land. Customary freeholders also hold alienation rights to their portions of lands and can lease their portions or bequeath them to their descendants, *ad infinitum* (Marfo 2009). However, the alienation rights of settlers and migrants are limited and, in some instances, they cannot lease their portions of lands.

Another type of tenure arrangement is the leasehold. In Ghana, stool lands cannot be sold outright, but can be leased (GoG 1992, a. 267, s. 5). Here, a holder of an allodial or freehold title transfers the rights to the land to another person through a contractual agreement over a period of time (Marfo 2009; Damnyag *et al.* 2012). In most cases, a formal evidence of transfer is required by statutory law to signify possession (Marfo 2009; Damnyag *et al.* 2012). The leaseholder now possesses a proprietorship right over the land. Land held under statutory land tenure is owned by the government or its agencies. They are mostly found in urban areas (Damnyag *et al.* 2012). In some instances, the government co-owns the land with stools. It is estimated that about 20% of the land in Ghana is owned by the government whereas 2% is owned jointly by the government and stools (Arko-Adjei *et al.* 2009; Damnyag *et al.* 2012).

Migrant farmers who do not have freehold titles enter into agreement with freehold title holders in the form of sharecropping. Sharecropping is when a farmer cultivates a piece of land and shares the proceeds from the harvest with the freehold title holder. There are two main types of sharecropping – *abunu* and *abusa.* In the *abunu* system, the tenant farmer equally divides the proceeds with the title holder whereas the title holder receives only a third of the proceeds in the *abusa* system. It is reported that about 70% of cocoa farmers in the HFZ own the farms they work on whereas 20% are sharecroppers (Hainmueller *et al.* 2011).

3.4.2 Rights to non-timber forest products (NTFPs)

Non-timber forest products (NTFPs) in the off-reserve forests include bush-meat, mushrooms, fruits, herbal medicine, vegetables and firewood. Practically, these resources are communal (refer to Figure 3.2). That is, every individual member of the community has unrestricted rights to NTFPs in the off-reserve forests. Access, use and transfer of NTFPs are governed by normative communal rules. However, in situations where fruit trees, medicinal trees and firewood occur on farms, the farm-owner’s consent is sought before harvesting from the resource. Notwithstanding, it is sometimes practically impossible for farmers to monitor the use of NTFPs on their farms.

3.4.3 Rights to on-farm timber resources

Indigenous on-farm timber trees, whether retained or planted, are generally regarded as naturally occurring trees by the Forestry Commission. The bundles of rights associated with on-farm timber resources are, here, analysed using the Schlager-Ostrom (1992) framework as revised by Galik and Jagger (2015).[7]

[7] The analysis of property rights here focuses on only legal stakeholders. Therefore chainsaw operators are excluded.

Access or entry rights

There are no restrictions on who can enter the off-reserve forests (Figure 3.2). The chiefs are the owners of the forests and have unrestricted entry rights. Also, farmers have unrestricted access to the forests to cultivate cocoa, oil palm and food crops. This right is given through customary and contractual agreements, as discussed earlier. As the agency charged with the management of the forests, the FC has unrestricted access rights. It is an offence for anyone to restrict the FC from entering the forests (GoG 1998a, 1998b). Concessionaires also have unlimited entry rights into the forests for timber resource scouting purposes. They also have unrestricted access to their concession areas.

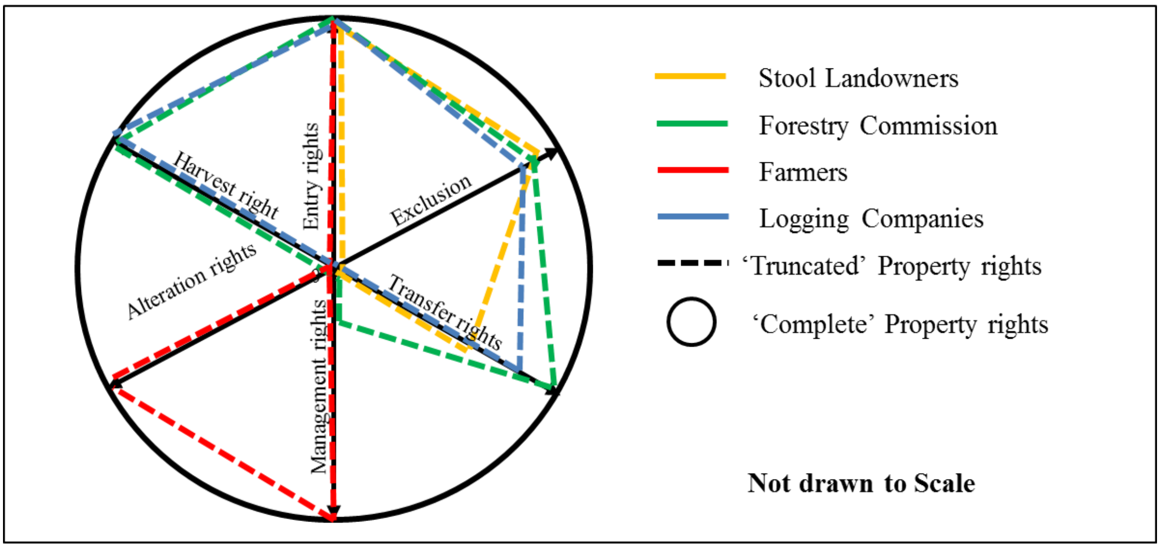
Withdrawal or harvest rights

Timber harvest rights are granted to only concessionaires who have been permitted by the FC to harvest timber (Figure 3.2). Timber permits are granted in three forms. These are Timber Utilisation Contracts (TUCs), Timber Utilisation Permits (TUPs) and Salvage Felling Permits (SFPs) (GoG 1998a, 1998b). The TUCs are granted to legally-registered logging companies, covering large tracts of lands in production zones for up to 40 years (FC 1998; GoG 2002). The TUPs are legally required to be granted to local governments, local communities, groups within communities and NGOs for community and development infrastructure (GoG 1998a, 1998b). They are to cover specified number of trees in a small area and logs harvested are not for sale, transfer or exchange (GoG 1998a, 1998b). Similarly, SFPs are granted for the clearance of trees on areas undergoing some form of infrastructural or agricultural development such as roads, buildings, and farming (GoG 1998a, 1998b).

It is illegal for anybody to harvest timber trees in the off-reserve forests without a permit from the FC (GoG 1998a, 1998b, 2002). Individuals cannot harvest timber trees (GoG 1998a, 1998b). Farmers cannot legally harvest timber trees on their farms for domestic or commercial purposes. Nonetheless, chainsaw operators connive with farmers to illegally harvest timber trees in the off-reserve forests (Hansen and Treue 2008; Marfo 2010; Hansen 2011; Hansen *et al*. 2012).

Management rights

Management rights are held by farmers and the Forestry Commission (FC). The FC has the *de jure* rights to manage the off-reserve forests (GoG 1999). In practice, however, the FC contributes little to the sustenance of the off-reserve forests. This is depicted in Figure 3.3, which shows the (qualitative) extent to which the various bundles of rights to timber trees are exercised by the four major stakeholders in the off-reserve forests. Farmers are the primary and *de facto* managers of the forests. They decide on the trees to be retained on farms. They also have the *de facto* rights to dispose of any tree which is incompatible with their farming activity, either during land preparation or at latter stages of farming (Owubah *et al*. 2001; Treue 2001; Hansen 2011). However, it is illegal for farmers to use felled timber trees for any commercial or developmental purposes.



Source: Author's Construct, 2015

Figure 3.3 Dimensions of off-reserve property rights to timber resources for major stakeholders

Rights of exclusion

Stool landowners, farmers, the FC and concessionaires have varying degrees of exclusion rights in off-reserve logging. Stool landowners have the 'absolute' right to veto timber harvesting activities on their lands (FC 1998). No harvesting permit can be granted without the written consent of the landowners (GoG 1998a, 1998b). Farmers whose farms fall within the proposed concession area have the right to veto any felling on their farms. The law demands that a written consent is sought from the farmer before a permit is granted (GoG 1998a). Thus 'any tree felled on a farm against the wishes of the farmer is illegal' (FC 1998, Section F 4.1, p. 2). Yet, studies reveal that farmers' rights to exclusion are seldom respected by the FC and concessionaires (Marfo *et al.* 2006; Hansen 2011; Otutei 2012). In fact, farmers do not have any *de facto* exclusion rights against concessionaires in the off-reserve landscape (see Figure 3.3). The FC has the absolute *de jure* right to exclude any concessionaire from timber extraction. Landowners are also permitted by law to prevent unlicensed chainsaws from logging off-reserve (GoG 1998b). Also, concessionaires have the right to exclude others from harvesting timber in their concessions (Figure 3.2). However, the illegal chainsaw logging phenomenon in the off-reserve area shows that though landowners, the FC and concessionaires may have the right to exclusion, this right is not fully enjoyed (Figure 3.3).

Alienation or transfer rights

The right to directly transfer timber resources in the off-reserve forests is held exclusively by the FC. Though the forest is owned by the stools, it is the FC that has the absolute right to sell the trees to timber concessionaires in the form of contracts and permits (GoG 1998a). The revenue from the sale of on-farm timber trees are shared among multiple actors (Figure 3.2). Benefits from the sale of timber in the off-reserve forests can be categorised into eight. These include concession rent, stumpage fee, timber rights fee, levies, corporate profit, corporate tax, social obligations and tree-tending fee (FC 1998; GoG 1998a, 1998b; Hansen and Lund 2011).

The concession rent is the amount per hectare paid to landowners by the concessionaire (Hansen and Land 2011). The stumpage fee is the specie-specific value of timber after deducting the cost of logging, transport and administration as well as an agreed working profit margin from the FOB price of the RWE of the air dried lumber (Richards and Asare 1999; Hansen and Lund 2011). Also, the timber rights fee is an annual lump-sum amount charged for the concession area (Hansen and Lund 2011). The levies consist of an export levy and air-dried lumber levy charged on the export of timber products (Hansen and Lund 2011). Corporate profit is the profit the concessionaire gains after the production and sale of timber products whereas the corporate tax is 30% tax charged on the corporate profit (Hansen and Lund 2011). Also, the tree tending fee is a negotiated amount concessionaires pay to farmers for tending timber trees, whereas the social obligations are the infrastructural benefits forest communities receive from concessionaires (FC 1998).

The stumpage fee and concession rent are treated as stool land revenue and are shared according to a formula enshrined in the *Constitution of the Republic of Ghana* (GoG 1992). Article 267, Section 6 of the constitution states that:

> Ten percent of the revenue accruing from stool lands shall be paid to the office of the Administrator of Stool Lands to cover administrative expenses; and the remaining revenue shall be disbursed in the following proportions – a) twenty-five percent to the stool through the traditional authority for the maintenance of the stool in keeping with its status; (b) twenty percent to the traditional authority; and (c) fifty-five percent to the District Assembly, within the area of authority of which the stool lands are situated.

The concession rent is thus shared accordingly. However, there is a variation in the distribution of the stumpage fee. The *Timber Resource Management Regulation* stipulates that:

> There shall be paid to the Forestry Department for timber management services, such amounts as shall be determined by the Minister in consultation with the Forestry Commission, Forestry Department and the Administrator of Stool Lands in respect of stool lands (GoG 1998b, r. 267 [1]).

In the off-reserve forests, this management fee is set at 50% of the stumpage fee (FC 2016). The FC collects both the stumpage and concession fee, deducts its 50% share of the stumpage fee and transfers the remainder to the OASL. The OASL then uses the constitutional formula to share the stool land revenue received from the FC. In sum, the exclusive beneficiaries of on-farm timber revenue are the stool landowners, the OASL, the respective District Assemblies and the FC.

The timber rights fees are charged during competitive bidding and kept by the FC (Hansen and Lund 2011). Likewise, the export levies are collected and kept by the FC. Here, the export levy becomes the revenue of the FC while the air-dried lumber levy forms part of the Forest Plantation Development Fund under the FC (Hansen and Lund 2011). The corporate tax is collected by the Ministry of Finance and Economic Planning. The Ministry then transfers it into the Consolidated Fund of the Government of Ghana (GoG) (Hansen and Lund 2011). Concessionaires also retain the profits from their logging activities after deducting taxes. The above indicates that though landowners, the FC, the OASL, the Traditional Council, and the District Assembly have transfer rights as depicted in Figure 3.2, only the FC may be said to exercise this right fully. The remaining stakeholders have very limited transfer rights in the form of access to timber revenue accruing from the sale of trees to logging companies by the FC (see Figure 3.3).

Farmers do not have any *de jure* rights to the benefits from timber resources on their farms (see Figure 3.3). The only benefit they (supposedly) enjoy from timber resources is the tree-tending fee. However, this is only recognised in the Manual for Procedures—the code of practice for timber utilisation contracts (FC 1998). No provision is made for tree tending fees in the Acts and Regulations governing timber extraction. As such, concessionaires seldom pay such fees (Hansen 2011). Thus in practice, farmers have no right to formal timber revenue from the off-reserve forests.

The concessionaire is legally required to sign a Social Responsibility Agreement (SRA) with forest communities (FC 1998; GoG 1998a, 1998b). The SRA consists of two components: the Code of Conduct and Social Obligations (FC 1998). The Code of Conduct particularly requires the concessionaire to 'respect the rights of farmers to receive payment for tree tending' (FC 1998, Section C 3.2, p. 2). The Social Obligations also require concessionaires to negotiate with communities and agree on the provision of infrastructural services to forest communities amounting to not less than 5% of the concession revenue (FC 1998; Ayine 2008; Agyei and Adjei 2017). The FSD is required to play the role of an arbiter in the SRA process. The SRA is to be signed by all parties involved and is to be included in the TUC (GoG 1998a, 1998b). Concessionaires also pay ritual fees to the landowners for forest rituals before commencing logging (Otutei 2012).

Alteration rights and farmers' right to compensation

Previous studies have considered farmers' conversion of natural and secondary forests to agroforests as part of their access rights (e.g., Hansen 2011; Dumenu *et al.* 2014; Lambini and Nguyen 2014; MLNR 2016b). Yet, access right is only concerned with the right to enter a particular property without altering the primary land use or harvesting the resource (refer to Chapter 2). The conversion of forests to cocoa agroforests cannot be regarded as part of farmers' access rights because it is beyond the entitlement conferred on them by this right. For this reason, farmers' entitlement to convert the off-reserve landscape from natural and secondary forests to cocoa agroforests is argued to be a distinct right in this study. Following from Galik and Jagger (2015), this right can be properly captured as an *alteration right*. Farmers hold the customary right to alter the land use from natural or secondary forests to agroforests (Figure 3.2). The granting of timber permits on farms further partially alters the land use, though temporary, from agroforestry to a mixed land-use: agroforestry and timber production. However, on-farm logging does not change the primary land-use (agroforestry) as does cocoa farming. Concessionaires only enter farms, log and leave. Arguably therefore, concessionaires cannot be said to hold alteration rights in the off-reserve area. This argument is consistent with the caution in the Manual of Procedures (MOP) to the FSD and concessionaires that 'agriculture is the primary land-use [*sic.*] off-reserve and it is forestry that has to fit into the farming system—not vice versa' (FC 1998, Section F 1.1, p. 1).

The logging and hauling processes on farms extensively damage young and mature crops (Marfo *et al.* 2006; Marfo and Schanz 2009; Hansen 2011). This is because concessionaires use heavy-duty machines in felling and skidding on-farm timber. In view of this, the concessionaire is required by the MOP to negotiate and agree with the farmer on 'good compensation' for any crop to be damaged before logging commences (FC 1998). Also, concessionaires are required to make prompt compensation payment to farmers after logging has been completed and the extent of crop damage ascertained (FC 1998). Legally, a provision for prompt and full payment of compensation should be part of the terms of timber contracts (GoG 1998a, s. 8 (e)). Thus, the law, grants farmers the *right to compensation* for damaged crops.

The FSD is required to ensure compliance with the compensation requirement before concessionaires can convey their logs to processing sites (FC 1998). Concessionaires cannot convey their felled logs away from the farms and communities without a Conveyance Certificate issued by the FSD (FC 1998). The Conveyance Certificate is the only document that authorises the transportation of logs from the farm to the processing centre [GoG 1998b, r 24(1)]. Before issuing such a certificate, the FSD is required to carry out a post-felling inspection to confirm that the concessionaire has complied with all requirements. These include payment of compensation and tree tending fees as well as the fulfilment of SRAs. The full payment of agreed compensation is therefore a major requirement for the successful application of a Conveyance Certificate (FC 1998). The MOP instructs District Forest Officers (DFOs) to withhold the issuance of the Conveyance Certificate from concessionaires if they do not fully compensate farmers (FC 1998).

3.5 Forest Conflicts in Off-reserve Forests in Ghana

The above tenure and compensation arrangements in the off-reserve landscape has bred numerous forest conflicts. These conflicts can be categorised as disputes over timber tree tenure (harvest rights and rights to on-farm timber revenue), and consent and compensation conflicts. These conflicts occur between farmers on the one hand and the government and concessionaires on the other hand.

As discussed earlier, the law bars farmers from harvesting or selling timber trees they have retained or planted on their farms. It is illegal for them to harvest trees even for the construction of their own buildings. Though, one of the major reasons behind tree tending by farmers is the use of their timber products for domestic buildings and future sales, the current tree-tenure regime prevents farmers from fulfilling this objective. Also, it is reported that farming communities are usually denied their rights to TUPs for community projects (Hansen and Lund 2011). Rather, TUPs are granted to concessionaires thereby excluding most farming communities from the utilisation of timber trees for developmental projects (Hansen and Lund 2011). These exclusionary tenure arrangements have generated disagreements between farmers and the FC.

Closely linked to the above is disagreement with the sharing of timber revenue. Farmers are excluded from the sharing of revenue from the sale of on-farm timber resources. The revenue is shared among landowners and government agencies who play little or no role in timber tree management (Ros-Tonen *et al.* 2010; Marfo *et al*. 2012). Again, farmers do not benefit from the use of timber revenue by these beneficiaries (Marfo 2004a; Ayine 2008; Hansen and Treue 2009; Hansen and Lund 2011). Hansen and Lund (2011) reveal that the District Assembly treats spends its share of the stumpage revenue on administrative activities. They do not use timber revenue for development projects which could benefit forest communities. Likewise, the Traditional Council uses its share on land litigations and building or renovation of palaces, whereas chiefs retain their share for personal use (Hansen and Treue 2009; Hansen and Lund 2011). Coupled with the non-payment of tree-tending fees, farmers derive little or no legal economic returns from conserving the off-reserve forests. This has generated disputes between farmers and the government.

Off-reserve logging is also replete with consent and compensation conflicts. Permits are often granted by the FC to concessionaires without prior consultation with farmers (Hansen 2011; Otutei 2012). In an extensive study on compliance with laws in on-farm logging in the HFZ, Hansen (2011) reveals that only 23% of farmers are contacted by concessionaires before commencing logging on their farms. Also, concessionaires proceed to log on-farm trees even when farmers veto logging (Hansen 2011). Besides lack of consultation before logging, there have been widespread compensation conflicts between farmers and concessionaires. Though the law requires 'prompt' payment of 'good' compensation, most often than not, concessionaires refuse to pay negotiated compensation (Lambini *et al.* 2005; Marfo and Schanz 2009; Hansen 2011; Otutei 2012). In cases where payments are made, they are unduly delayed or only made partially (Marfo and Schanz 2009; Hansen 2011). The above situations sometimes lead to confrontations, blockading by farmers and litigations between farmers and concessionaires.

The consent and compensation conflicts stem from lack of enforcement and corruption. First, the FC does not comply with timber regulations for political expediency. It is reported that contracts are granted to concessionaires without recourse to timber regulations (Hansen 2011; Hansen and Lund 2011; Carlsen and Hansen 2014). The TUCs seldom go through competitive tender bidding but are rather awarded administratively by the FC and the Ministry in charge of Forestry (Hansen and Lund 2011). Through such processes, the consent requirement is disregarded in most cases.

The FC is incapable of enforcing logging requirements, especially, those relating to compensation payments because of the widespread corruption of the system by economic and political elites. It is reported that FSD officials are compromised by concessionaires and other political elites through unofficial payments (Kantayel 2008; Hansen and Lund 2011; Ameyaw *et al.* 2016). Therefore, they are unable to enforce forest laws. In fact, it has been revealed that FSD officials particularly issue Conveyance Certificates to loggers without ascertaining whether they have satisfactorily compensated farmers (Hansen 2011). Those who try to enforce laws, such as those relating to farmer consent and compensation payment, are forcefully transferred or demoted (Amanor 2005).

Second, studies have revealed that concessionaires are able to make informal payments to other non-state actors such as traditional leaders to disregard compensation issues (Kantayel 2008; Marfo and Schanz 2009). Thus, attempts by farmers to seek mediation through chiefs, local government representatives and other village leaders have largely been unsuccessful (Marfo and Schanz 2009; Hansen 2011). Thirdly, farmers have limited financial capacities to pursue compensation payments through the court system (Marfo and Schanz 2009; Otutei 2012). In rare cases where farmers take legal actions against concessionaires, the latter always deploy their agencies to win compensation litigations (Marfo and Schanz 2009). Because of the above situation, Marfo and Schanz (2009) report in their case study that farmers end up accommodating non-payment of compensation without any action (35%), or withdraw later from conflicts (50%).

3.6 The Impacts of Off-reserve Conflicts on Farmers' Forest Behaviour

Though a number of stakeholders are involved in off-reserve forests, it is the actions of farmers that have more direct and long-term impacts on the sustainability of the forests. This section therefore discusses the impacts of the off-reserve forest conflicts on farmers' behaviour (tree retention and illegal logging) as reported in the current literature.

On-farm shade density and diversity have been found to be reducing over the years (Anglaaere *et al.* 2011; Acheampong *et al*. 2014; Dawoe *et al.* 2016). Farmers are disposing of some on-farm trees through cutting of saplings, felling of mature trees, ringing and burning of both young and mature trees (Amanor 1994, 1996, 2000, 2005; Owubah *et al.* 2001; Treue 2001; Lambini *et al.* 2005; Dumenu 2010; Otutei 2012). It is widely documented in the literature that farmers are adopting such strategies due to tenure and compensation conflicts (Amanor 1994, 2004; Owubah *et al.* 2001; Treue 2001; Lambini *et al.* 2005; Dumenu 2010; Otutei 2012; Armah *et al*. 2013). It has been revealed that;

> Farmers in their role as potential producers, perceive preservation of indigenous, economically valuable trees and conservation of forest as having a net cost to them, especially if compensation is not paid for damage to crops resulting from logging operations of concessionaires (Owubah et al. 2001, p. 253).

They therefore prefer to cut down some trees or kill some saplings on the farms as proactive measures to prevent future compensation conflicts. This is also to avoid unproductive investment in tree tending.

Illegal chainsaw logging (or chainsaw milling) is prevalent in Ghana and about 76% occurs on farms (Acheampong and Marfo 2011). The farmer is the gatekeeper of on-farm trees and therefore 'plays an important role in facilitating access to timber trees by 'illegal' chainsaw operators' (Acheampong and Marfo 2011, p. 82). Chainsaw logging in Ghana involves the logging of trees and conversion of logs to lumber *in situ* using chainsaws. This practice is unsustainable. Chainsaw logging does not follow scientifically sustainable methods, practices and regulations sanctioned by the FC (Marfo 2010). More importantly, chainsaw logging results in forest degradation and reduction in biodiversity and other environmental services provided by forests (Curran *et al.* 2004; Adam *et al.* 2007a; Adam and Duah-Gyamfi 2009; Marfo 2010; Hansen *et al.* 2012).

Scholars agree that the current tenure arrangement and compensation conflicts are the underlying causes of the illegal logging menace (Marfo 2004b, 2010; Damnyag *et al.* 2012; Amoah and Boateng 2014; Franck & Hansen 2014; Hajjar 2015a). Farmers prefer dealing with illegal loggers (chainsaw operators) because they make payments for on-farm trees and carry out more benign logging than concessionaires. Farmers do not get any rewards for tending trees when on-farm trees are logged by concessionaires. However, chainsaw loggers usually regard farmers as tree owners, seek their consents before logging, and negotiate and pay farmers for each on-farm tree they log (Acheampong and Marfo 2011; Hansen 2011). Farmers receive payments from operators in two main forms: tree payment and commission (Marfo 2010). Marfo (2010) reveal that farmers receive a greater proportion of the payments made by operators. Payments for trees and commission constitute about 38% of total payments made by operators in their logging activities (Marfo 2010). These payments are made promptly and are regarded as fair by farmers (Amoah and Boateng 2014). Also, operators tend to honour agreements they make with farmers (Hansen 2011).

Farmers also prefer dealing with operators because they consider their activities as less destructive to cocoa farms. Chainsaw operators fell on-farm trees and saw them *in situ*. The sawn lumber is transported through head porting. This reduces the extent of damage to crops and saplings as compared to concessionaires who use heavy machinery for felling and skidding on-farm trees with little or no compensation (Otutei 2012; Amoah and Boateng 2014). Further, chainsaw operators assist in felling unwanted trees, clean-up after logging and grant farmers access to logging residue as fuelwood (Amoah and Boateng 2014). Farmers also prefer operators to concessionaires because operators sometimes share lumber boards with them (Hansen 2011; Amoah and Boateng 2014). This gives farmers easy access to wood for domestic construction (Hansen 2011; Otutei 2012). Farmers lose all these payments and services when trees are logged by concessionaires. This preference, combined with the absence of tree tenure and non-payment of compensation, has induced widespread illegal logging in the off-reserve forests.

Another major factor influencing farmers' involvement in illegal logging is low enforcement of the tree harvesting rule. It has been revealed that when farmers perceive deterrence or risk of sanctions as low, they tend to fell timber trees for domestic use or sell them to chainsaw operators (Ramcilovic-Suominen and Esptein 2012, 2015). Unfortunately, forest law enforcement has been largely low and ineffective. The low levels of enforcement stem from limited capacity of the FSD, corruption and ambiguous legislations (Marfo 2010; Hansen 2011; Armah *et al.* 2013; Franck and Hansen 2014). The FSD monitors activities in the forests using forest guards and the Timber Task Force (Franck and Hansen 2014). However, most of the activities of farmers and operators go undetected. This is because the number of forest guards and personnel in the task force is inadequate (Hansen 2011). Also, trees are sparsely located on a vast area and forest guards are poorly resourced to reach remote areas of the forests (Armah *et al.* 2013). Some chainsaw operators also carry out their activities in the night thereby making it difficult for forest guards and the task force to detect illegal logging close to them (Marfo 2004b; Nutakor and Marfo 2009). With this low likelihood of detection in the off-reserve landscape, farmers can harvest timber for domestic use or sell on-farm trees to chainsaw operators without being arrested.

Closely linked to low detection is low risk of sanctioning when detected. This low risk of sanctioning is due primarily to corruption and the nature of sanctions. First, chainsaw operators and urban-based timber leaders make informal payments to forest officials, the police and military to pave way for their activities (Adam *et al.* 2007b; Damnyag and Darko-Obiri 2009a, 2009b; Darko-Obiri and Damnyag 2009, 2011; Marfo *et al.* 2009a, 2009b; Marfo 2010; Hansen 2011; Nutakor *et al*. 2011; Franck and Nelson 2014).[8] It is reported that about 50% of payments made by chainsaw operators go to the FSD, the forest task force and the police (Marfo 2010). The FSD, alone, receives about 28% of operator payments (Marfo 2010). The existence of these informal payments impels FSD officials to support and condone chainsaw activities for financial gains (Nutakor *et al*. 2011). Also, by making such informal payments, chainsaw operators are able to protect themselves and the farmers from potential sanctions. Additionally, in cases where chainsaw operators are arrested, the main sanction applied is seizure of lumber and chainsaw equipment. These are usually released when informal payments are made to the FSD (Hansen 2011). Further, the FSD seldom prosecutes chainsaw operators because prosecution of cases erodes the financial gains the FSD officials make from chainsaw operators (Nutakor *et al.* 2011). Also, it is reported that court prosecutions of chainsaw operations have largely not been

[8] Domestic timber dealers are urban-based cadres who invest substantial capital into financing chainsaw milling in rural areas through the provision of equipment and transport logistics. They also use part of their proceeds to make informal payments to FSD officials, the police and the military to protect operators and ease the transportation of sawn lumber to the urban markets.

successful due to external influences (Nutakor *et al*. 2011). Therefore, farmers perceive the risk of felling trees or dealing with illegal loggers as insignificant.

Furthermore, the sanctioning of illegal loggers has concentrated solely on operators. Farmers are seldom sanctioned for dealing with chainsaw operators or harvesting trees for domestic use. For instance, of the 179 farmer narratives of chainsaw dealings recorded by Hansen (2011), it was revealed that only in one case was the farmer sanctioned by the FC. The sanction was in the form of confiscation of lumber produce. Further, farmers are under no obligation (legally) to report illegal operations on their farms. Hence, they face no legal risk for failing to report illegal logging even if they are not directly involved in the act. This problem is compounded by the fact that the police and the FSD often disregard tip-off information on on-farm illegal operations given by farmers (Marfo 2010). This serves as disincentive for reporting. In sum, low risk of detection and sanctioning and lack of incentives for reporting provide more incentives for farmers to deal with chainsaw loggers. This underscores the major role low deterrence plays in influencing farmers' behaviour.

3.7. Efforts and Challenges to Resolving Tenure and Compensation Conflicts

This section discusses ongoing efforts by the Government of Ghana (GoG) to resolve the off-reserve problem (especially tree tenure conflicts) and the challenges faced by these efforts.

3.7.1 Ongoing efforts to resolve conflicts

Some efforts have been made by the government to resolve the tenure conflict and create the necessary incentives for farmers to retain and or plant more trees on their farms. The need for and intention to reform off-reserve tenure has featured prominently in government's policy documents. The 2012 Forest and Wildlife Policy (FWP) has explicitly recommended the enactment of the needed legislations to include farmers in timber benefit sharing and grant them rights to 'legally' dispose of on-farm trees (Ministry of Land and Natural Resources [MLNR] 2012a, policy strategy 4.1.1b). A Forest Development Master Plan (2016-2036) has been developed to implement the Policy. This plan reiterates the government's commitment to granting timber benefits to farmers (MLNR 2016a). More importantly, the GoG has recently commissioned at least three studies on the development of tree tenure and benefit-sharing framework; proposals for legislative reforms required for the proposed benefit-sharing framework; and legislative reforms required for the effective implementation of the 2012 Forest and Wildlife Policy (Akapame 2016a, 2016b; MLNR

2016b). Notable among these studies is a multi-stakeholder consultancy study on tree-tenure and benefit-sharing. The purpose of this study was to propose a timber benefit sharing framework based on the preferences of stakeholders (MLNR 2016b).[9]

The government has received enormous donor support geared towards sustainable forest management in the HFZ, including the off-reserve forests (MLNR 2016a). Recent donor-backed programs covering the whole of the HFZ include the Natural Resources and Environmental Governance Programme (NREG), the Voluntary Partnership Agreement (VPA) and REDD+-related programs. The NREG supported the natural resource sector to address issues relating to environmental governance. The Readiness Preparation Proposal (R-PP), Forest Investment Plan (FIP) and the Emissions Reduction Program Idea Note for the Cocoa Forest REDD+ Program (ER-PIN) are facilities under REDD+ to support Ghana's activities in reducing emissions from degradation and deforestation. Documents on these facilities have illuminated and reiterated the need for tenure reforms in Ghana to induce tree planting and retention in the off-reserve area. The documents have also hinted the intention of the government to reform on-farm tree tenure to incentivise farmers to conserve trees on their farms (Hajjar 2015b). In fact, the above-mentioned multi-stakeholder tree-tenure study was funded by the NREG. The tenure reform proposals by this study are intended to be piloted under the FIP and extended to a larger coverage area, if possible. On the whole, these programmes (REDD+ and NREG) have created the needed platform for nationwide discussion and debate on the need for and form of tree-tenure reform (Hajjar 2015b). This policy issue was, hitherto, neglected by the government (Hajjar 2015b).

The European Union has been supporting the Government of Ghana to intensify its forest law enforcement activities through its 'Forest Law Enforcement, Governance and Trade' (FLEGT) initiative. The aim of the Voluntary Partnership Agreement (VPA) signed under the FLEGT in 2010 is to help control illegal logging in the HFZ. The VPA seeks to push the GoG to enforce existing forest laws by rewarding legal timber producers with priority access to the EU market (Hajjar 2015b). Compensation payment by concessionaires has been included as a criterion for timber legality definition under the VPA (EU and GoG

[9] Stakeholders in the multi-stakeholder consultancy study preferred an off-reserve tenure regime where farmers have both *de jure* and *de facto* ownership and management rights to on-farm trees with regulatory authority vested in the State (MLNR 2016b). With regards to timber revenue, the consultants recommended that it is shared between farmers and landowners. However, it also recommended that part of it should be deducted as management fee for the Forestry Commission (not exceeding 10%); and as stool land revenue to be given to the OASL for onward disbursement according to the constitutional formula (MLNR 2016b).

2009). A Timber Task Force consisting of forest guards, police and military personnel is being used by the government to clamp down on illegal logging (Franck and Hansen 2014). To minimise the social costs of such enforcement activities, the FLEGT initiative in Ghana also aims at safeguarding illegal loggers and chainsaw operators whose sources of livelihoods may be displaced by law enforcement activities. The GoG is considering artisanal milling to provide alternative livelihood activities for chainsaw operators to motivate them to desist from illegal logging (Marfo and McKeown 2013; Hajjar 2015a; Hansen *et al.* 2015). Artisanal milling will involve milling of legal timber by licensed and qualified Ghanaian artisans using environmentally-friendly mobile sawmills that produce sustainable lumber to feed the domestic market without chainsaws (Marfo and McKeown 2013; Hajjar 2015a; Hansen *et al.* 2015). Artisanal millers are expected to use logs provided by concessionaires or obtain permit to fell less desirable tree species abandoned in concessions (Marfo 2010; Marfo and McKeown 2013).[10]

3.7.2 Challenges to resolving conflicts

The above efforts by the government have not achieved the desired outcomes. The tree tenure remains unchanged, the compensation law is frequently violated and illegal logging still persists in the off-reserve area. The enormous donor support has failed to bring the desired changes in the forest environment, as a whole, and forest tenure, in particular (Arhin 2015). The Ministry admits that 'there is a paradox in the forestry sector [because] the massive development assistance [….] have neither resulted in the desired change and growth, nor improved the forest resource integrity' (MLNR 2016a, p. xiii). More importantly, little has been done towards tree tenure reforms apart from the above consultancy reports on benefit sharing and legislative proposals. Though tenure reforms are explicitly articulated in the R-PP, FIP and ER-PIN documents, the issue has been sidestepped by the National REDD+ Strategy: the blueprint for the implementation of Ghana's REDD+ programme (FC 2015). The REDD+ Strategy only highlights farmers' tree tenure as an indirect cause of degradation. Also, the REDD+ documents have not proposed any concrete actions to reform tree tenure beyond the call for reviews, pilots and testing of available alternatives (Hajjar 2015b). On-going REDD+ projects and activities in the HFZ have by-passed piloting of alternative forms of off-reserve tree tenure and focused on halting agricultural expansion into forest reserves in the Brong Ahafo and Western Regions (Arhin 2015; Hajjar 2015a).

[10] See Hansen *et al.* 2015 and Hajjar (2015) for a critique of the artisanal milling policy option.

The issue of adequate and prompt compensation for crop damage is also missing in the 2012 Forest and Wildlife Policy and REDD+ discourses in Ghana. Ghana's REDD+ Strategy only lists the compensation problem as a challenge to achieving REDD+ objectives. It offers no solution to addressing it. Though the VPA appears to address the issue of compensation, there is little transparency in its legality assurance scheme (Lartey *et al.* 2012; Lesniewska and McDermott 2014). Surprisingly, 'Ghana is the only country not to include a transparency annex in its VPA' (Lesniewska and McDermott 2014, p. 21). The non-transparent nature of the VPA in Ghana provides law enforcers an easy avenue to ignore the compensation criterion during legality assessments without any serious repercussions or scrutiny from concerned activists. The continuous existence of the compensation problem in on-farm concession logging attests to this assertion.

A major challenge to equitable tree tenure reforms in Ghana is the lack of political will for reforms. It is still unclear whether the government will have the political will to follow through with the proposals made by the revised FWP and the 'expansive' tenure reform proposed in the multi-stakeholder consultancy report mentioned above. The government has not shown much commitment to addressing the issue of forest tenure as stipulated in the FWP. The report on the legislative proposals revealed that 'in general, the 2012 Forest and Wildlife Policy has at yet not been followed through with the requirements in the legislation to back the Policy legislative intentions' (Akapame 2016, p. 21).

Similar proposals for tree tenure reform in past policies have suffered the same fate. Research on forest policies in Ghana reveal that the government has failed to follow proposals for on-farm tree tenure reforms in forest policies due to the lack of political will (Amanor 2004; Armah *et al.* 2013; Hajjar 2015a). Policies on tenure reforms usually by-pass on-farm tree tenure (Hajjar 2015a) or when considered, they are deliberately made ambiguous to pave way for alternative and discretionary interpretations by political and economic elites. It is reported that economic and political elites have employed several strategies to oppose every previous effort to change the current tenure arrangement (Amanor 2004, 2005; Hansen and Treue 2008). They appeal to constitutional constraints to counter policies aimed at including farmers in the benefit sharing scheme (Amanor 2004). Amanor (2004) reveals that the need to incentivise local people to assist in controlling illegal logging has long been recognised by top public forestry officials. This, for example, led to the inclusion of issues of farmers' right to trees 'in the 1994 Forestry and Wildlife Policy and Interim Measures to Control Illegal Felling in 1995' (Amanor 2004, p. 14). The

Policy sought to ‘enhance land and tree tenure rights of farmers’ (Ministry of Land and Forestry 1994, policy strategy, 5.5.5). However, efforts towards recognising farmers’ rights to trees were resisted by vested interests who argued against tenure reforms using the national constitution (Amanor 2004). In the end, the State settled on the introduction of SRAs in forest villages instead of tenure reforms that will directly benefit farmers (Amanor 2004). It then proceeded to enact the *Timber Resource Management Act* and the *Timber Resource Management Regulation* to criminalise farmers’ use or sale of on-farm timber resources (a *de facto* right they, hitherto, enjoyed). The government then extended concession logging to off-reserve farmlands. These contradicted the 1994 Forestry and Wildlife Policy that necessitated the Act (Amanor 2004). The actions also contradicted the unrevoked *1979 Economic Plants Protection Act* which prohibited the granting of logging permits on farms (FC 2015). In short, there was no political will to implement the proposed reforms in the 1990s.

It, however, appears that the government’s lack of political will to follow through with proposals for tenure reforms may stem from the magnitude of reforms demanded by non-state actors. Advocates (especially CSOs) base on social justice to demand complete devolution of off-reserve timber resources to individual farmers and forest communities (Hajjar 2015b). Stakeholders in the multi-stakeholder consultancy study on benefit sharing demanded that the State stays off off-reserve timber revenue because it contributes nothing to the management of the forests. They preferred the revenue to be shared between the farmer and the stool landowner (MLNR 2016b). These demands are not feasible considering the fact that the State has a vested interest in off-reserve timber revenue. State agencies (the FC, DAs and OASL) currently retain about 80% of off-reserve timber revenue and these are treated as internally-generated revenue. Relinquishing such enormous revenue to farmers and landowners will mean a substantial loss to the State, thereby diminishing the feasibility of reforms. Also, the proposal for reforms in the consultancy report requires a change in the constitutional formula: a process that may prolong or stall the reform process. It is argued in this thesis that a more feasible demand for reform that is equitable but sensitive to the government’s vested interests in off-reserve timber revenue may generate the required political will for tree tenure reforms and catalyse the reform process (cf. Kashwan 2013).

3.8. Off-reserve Forest Conflicts and Farmers' Unsustainable Practices: A Critical Literature Gap

A number of gaps exist in the current academic literature on the off-reserve problem. The most critical of these is the lack of in-depth analyses of options to induce behavioural changes among farmers and concessionaires based on the identified link between the off-reserve conflicts and unsustainable forest practices. The literature is short of academic studies that provide formal theoretical analyses of actor behaviour and strategies for inducing sustainable or cooperative behaviour among farmers and concessionaires. Also, the current literature on the off-reserve forest conflicts is short of studies that undertake empirical analyses of the impacts of scholarly recommendations on the behaviour of farmers and concessionaires.

The literature on the conflict-degradation problem in the off-reserve forests is replete with policy recommendations. These recommendations have been summarised in Table 3.1. They have been categorised under the three major factors identified as the underlying cause of farmers' unsustainable behaviour. With regards to tree tenure conflicts, some studies have called for some unspecified recognition of farmers' right to timber trees. However, Table 3.1 shows that many studies have gone a step further to specifically call for either a complete devolution of on-farm timber trees to farmers or a revision of the current timber benefit sharing scheme to provide some competitive proportion of timber revenue to farmers.

Studies on compensation have recommended varied options for the resolution of compensation conflicts including mediation with actor empowerment; institutionalised bargaining; devolution of timber to farmers to prevent compensation conflicts; and the enforcement of the compensation law (Table 3.1). Also, studies on the enforcement of forest laws on illegal logging have recommended strict enforcement of the existing tree harvesting law and a focus on the domestic timber market to clamp down on domestic lumber merchants. Others include complementing strict enforcement with forest tenure reforms and other social interventions; and incentivising farmers and communities to assist the FSD in the enforcement of laws on forest illegalities.

Table 3.1 A summary of actions recommended in the existing literature for resolving off-reserve conflicts and inducing conservation behaviour from farmers

Cause of unsustainable behaviour	Prescribed policy action	Citations
Tree tenure conflict	Recognition of farmers rights to on-farm trees (unspecified)	Amanor (2004, 2005); Ramcilovic-Suominen and Hansen (2012); Ramcilovic-Suominen *et al.* (2013)
	Complete devolution of right to timber to the farmer	Odoom (2005); Boateng (2009); Hansen and Treue (2009); Hansen *et al.* (2009); Hansen (2011); Hansen and Lund (2011); Franck and Hansen (2014); Hansen *et al.* (2015); Oduro *et al.* (2015)
	Revision of the current benefit sharing arrangement to include farmers	Owubah *et al.* (2001); Kantayel (2008); Acheampong and Marfo (2009); Hansen and Treue (2009); Dumenu (2010); Marfo *et al.* (2010, 2012); Acheampong and Marfo (2011); Darko-Obiri and Damnyag (2011); Armah *et al.* (2013); Amoah and Boateng (2014); Boakye (2015); Oduro *et al.* (2015); Hajjar (2015a); Dawoe *et al.* (2016)
Compensation conflict	Mediation with four actor empowerment conditions	Marfo *et al.* (2006); Marfo and Schanz (2009)
	Institutionalised bargaining process	Marfo *et al.* (2006)
	Devolution of right to timber	Hansen (2011)
	Enforcement of compensation law	Owubah *et al.* (2001); Amoah and Boateng 2014
Lack of enforcement of tree harvesting law	Strict enforcement by FC alone	Odoom (2005); Boakye (2015)
	Focusing enforcement at domestic timber market.	Franck and Hansen (2014)
	Complementing law enforcement with tenure reforms and other social goals	Franck and Hansen (2014); Ramcilovic-Suominen and Epstein (2015); Ameyaw *et al.* (2016)
	Motivation of farmers and communities to assist in enforcement	Boakye (2015); Ramcilovic-Suominen and Epstein (2015)

Source: Author’s Construct, 2017

Yet, little evidence has been provided in the existing literature to demonstrate the efficiency, relative effectiveness and (where applicable) the distributive impacts of these recommended options. None of the numerous studies has provided a theoretical or empirical evaluation of its recommended policy action to observe how the behaviour of farmers and concessionaires will change accordingly. Only Boateng (2009) provides an overview of the expected economic, social and environmental outcomes of some proposed policy options (including complete devolution) to address the tree tenure problem. However, these outcomes are only hypothetical. Boateng (2009) neither provides any formal theoretical analysis of the options nor does he provide any empirical evidence to support his claims. Also, studies calling for a revision of the current timber benefit-sharing scheme have not been specific on the optimal proportion of the stumpage fee to be given to farmers in order to obtain the desired changes in behaviour. Likewise, studies calling for the combination of statist enforcement and local enforcement to combat illegal logging have not been specific on the form this should take. In short, the existing literature can be described as lacking in its analyses of policy options and additional studies are needed to address this gap.

3.9 Conclusion

This chapter has discussed the context within which farming and logging activities take place in the off-reserve forests of Ghana. The off-reserve forests are managed under a complex tenure system consisting of multiple resources, multiple stakeholders and a complex bundle of rights. Despite the multiplicity of stakeholders in the off-reserve area, farmers are the main stakeholders responsible for the management of the forests through their agroforestry practices. However, they do not have rights to harvest trees on their farms. They are also excluded from the sharing of timber revenues. Also, concessionaires seldom compensate farmers for crop damage caused by their logging activities. As a result, farmers have resorted to unsustainable practices as coping strategies. Subsequently, there seems to be a consensus in the literature that the illegal logging phenomenon and other unsustainable practices of farmers in the off-reserve landscape can be addressed only when issues related to tree tenure and compensation are resolved. This notwithstanding, there is no known study that theoretically and empirically evaluates policy options to resolve the off-reserve conundrum.

Chapter 4. Definitions, Concepts and Applications of Game Theory in Forest Management

Chapter 3 revealed that a number of stakeholders are involved in off-reserve forest management in Ghana. In relation to on-farm timber trees, farmers, concessionaires (logging companies) and the Forestry Commission (FC) are the key actors in the off-reserve landscape. These stakeholders are constantly involved in strategic interactions relating to on-farm logging. Each stakeholder has different objectives in the strategic interactions. They also adopt different and mostly conflicting strategies to pursue these interests. This battle of interests has resulted in the adoption of unsustainable practices by farmers. The overarching objective of this study is therefore to evaluate a range of options to induce sustainable practices among farmers. This demands a full and logical analysis of the strategies of these actors, the information they hold, their beliefs, the outcomes of the combination of their actions and their preferences over these outcomes. It also demands a realistic simplification of the complex interaction existing among them. Game theory is an appropriate approach for this purpose.

This chapter therefore provides a brief exposition of game theory. The chapter begins with a brief summary of the suitability of game theory to the current study. It then proceeds to give an overview of relevant terminologies and assumptions in game theory such as strategies, payoffs, rationality and common knowledge. Following this, relevant solution concepts such as dominant strategy equilibrium, Nash equilibrium and others are discussed. Next, the three major strategic tensions in games are discussed together with the concept of Pareto efficiency. The major criticisms and counter-criticisms of game-theoretic analysis are discussed next. Studies applying game-theoretic modelling to forest management problems in developing countries are then reviewed and some gaps identified.

4.1 Rationale for using Game Theory

Game theory provides better and more realistic simulation of the behaviour of self-interested decision makers (Kreps 1990; Watson 2013; Dixit *et al.* 2015). It has been noted that '[w]hen the situation involves interaction of decision makers with different aims, game theory often supplies the key to understanding the situation' (Dixit and Skeath 1999, p. 34). This is a major advantage of the approach over alternative approaches for optimising multi-stakeholder multi-objective situations such as goal programming and multi-criteria analyses (MCA) (Madani 2010; Soltani *et al.* 2016). These alternative approaches ultimately convert a multi-actor multi-objective situation to a single composite objective function with a single decision maker in which it is assumed that all stakeholders perfectly cooperate to maximise the composite objective with no regard for the maximisation of their self-interested objectives (Madani 2010). However, this is usually not the case in many real world situations such as forest management problems in developing countries. Such problems are often characterised by multiple stakeholders, competing interests and non-cooperative pursuit of individual interests. Therefore, the use of optimisation methods that assume perfect cooperation and contribution towards the maximisation of an ultimate objective function may not be suitable for forest management situations such as those of the off-reserve forests. They may conceal the self-optimising attitudes of stakeholders and reduce the ability to analyse and understand individual behaviour in the off-reserve landscape and how they can be modified for better forest outcomes.

Game theory does not strictly require the use of pecuniary incentives and values in analysing human behaviour. It is able to simulate strategic interactions without the use of the monetary payoffs of players (Madani 2010). The payoffs of players can be described in qualitative terms. Non-market preferences and incentives can also be incorporated in models to simulate conflicts. This is particularly important for the current study because some of the essential benefits and costs accruing to stakeholders from the off-reserve forests are not easily quantifiable in monetary terms. That is, some essential socio-political factors critically influence the decisions of actors in the off-reserve area in Ghana and game theory permits the inclusion of these factors in the parameters underlying the analyses of behaviour. It also permits the analysis of human behaviour under uncertainties. As such, the approach can be used to understand compensation interactions between farmers and concessionaires in which farmers barely know concessionaires. This provides a unique theoretical avenue to understand and predict compensation outcomes in on-farm logging.

In addition to the above, the approach allows for the analyses of different variants of a particular strategic situation. The assumptions in the analyses of a particular game can be varied to observe behavioural changes. This will, especially, enable formal analyses of the likely impacts of different policy scenarios on the behaviour of farmers and concessionaires in the off-reserve forests in Ghana. The existence of strategic moves, such as leadership by *commitments*, provides the opportunity for the modeller to observe how other players will behave in response to some commitments by others to alter outcomes of games to their advantage (Dixit *et al.* 2015). Through the use of devices such as commitments, game theory can suggest policy options for altering behaviour and this serves the purpose of the study.

4.2 An Overview of Concepts in Game Theory

Game theory is a rational choice approach that mathematically analyses the behaviour of individuals and their outcomes in a given situation to offer deeper understanding of behaviour. It is a methodological tool for understanding and predicting the outcomes of strategic interactions of rational individuals within particular economic, social and political contexts (Kreps 1990; Gibbons 1992; Madani 2010). There are two broad categories of game theory. These are cooperative and non-cooperative game theory. Cooperative game theory analyses strategic interactions among rational individuals who jointly coordinate their actions to achieve a collective outcome. Players in a corporative game make binding commitments to jointly undertake particular courses of action (Rasmusen 1994). By contrast, non-cooperative game theory looks at the interaction of self-interested individuals (Dixit *et al.* 2015). In real-life settings, however, there appears to be an overlap between competition and cooperation (Watson 2013). This makes non-cooperative games rare in real-life situations.

A game describes a strategic situation where players compete or cooperate with strategies to achieve outcomes. At the barest minimum, a strategic game consists of a set of *players*, their sets of *strategies* and their *utility* or *payoff functions* for each combination of strategies of these players (Rasmusen 1994; Osborne 2004; Watson 2013; Elsner *et al.* 2015). In a more advanced form, the strategic elements of a game consist of a set of players, a set of actions, information sets, sets of strategies, payoffs or utilities and outcomes (Rasmusen 1994; Watson 2013). Games are generally classified as static or dynamic with regards to the order of moves. Static games are one-shot games in which the moves of players are made simultaneously. After such simultaneous moves, players receive payoffs based on the combination of their selected strategies (Gibbons 1992). Static games are usually represented using the normal form. The normal form consists of a set of players, their sets of strategies and payoffs associated with the combination of these strategies.

Dynamic games have players taking turns to make moves. This does not preclude situations of simultaneous actions from dynamic games. However, it is imperative that one of the players moves first before such simultaneous moves occur. Dynamic games are usually represented using the extensive form. The extensive form depicts games as directed graphs (or game trees) consisting of nodes and branches. There are decision nodes and terminal nodes. Players make decisions at the decision nodes whereas the game ends at the terminal nodes.

4.3 Relevant Terminologies and Assumptions in Game Theory

Some terminologies and assumptions in game theory need to be defined. A *strategy,* in game theory is a 'complete contingent plan' of action for a player in the game (Watson 2013). For a player *i,* the set S_i is the strategy space (or set of strategies) in a given game and $s_i \in S_i$ is player *i*'s strategy. The strategy space of other players except *i* is given by S_{-i} and $s_{-i} \in S_{-i}$ is the strategy of all other players except *i*. Strategies can be *pure, mixed* or *behavioural*. Pure strategy is when a player chooses a particular strategy with certainty. However, in mixed strategies, players randomise their strategies based on a belief or the assessment of the moves of the other players. That is, a mixed strategy is when player *i* randomises among strategies with a probability distribution p_i given the belief that the opponent (player *j*) is playing according to a probability distribution q_j. A behavioural strategy is a mapping from each information set of a player to a distribution over the actions available at that particular information set. [11] Behavioural strategies used in dynamic games. *Strategy profiles* are the vectors of the strategies of players at any point in the game. Thus, the strategy profile s = (s_i, s_j), where s_i and s_j are the strategies of players *i* and *j*, respectively.

Payoffs or *utilities* are the numerical representation of the preference rankings of players over the outcomes of the game with respect to each strategy profile (Dixit *et al.* 2015). That is, the payoff $\pi_i(s)$ = (s_i,s_j) is the payoff of player *i* when the strategy profile *s* is chosen by the players. These could be ordinal or cardinal utility. In many economic outcomes, however, pecuniary payoffs are mostly used since players seek to maximise their monetary profit or minimise their cost in strategic interactions. However, pecuniary payoffs fail to accurately capture the utilities of players who care more than the monetary worth of outcomes (Watson 2013). When player *i* plays a mixed strategy based on player

[11] An information set refers to the information held by a player at a particular node (Watson 2013).

i's beliefs, then player i's expected payoff or utility is the probability-weighted average of the payoff player i would have obtained by playing a pure strategy s_i. Suppose that in a 2-player game, the strategy space of player i is given by $S_i = \{s_1, s_2, \dots, s_n\}$ and that player i plays a mixed strategy with probability distribution $p_i = \{p_1, p_2, \dots, p_n\}$. Suppose also that player i believes that player j, with a strategy space $S_j = \{s_1, s_2, \dots, s_m\}$, will choose strategies with a probability distribution of $q_j = \{q_1, q_2, \dots, q_m\}$, then the *expected utility* of player i is given as:

$$\pi_i(p_i, q_j) = \sum_{i=1}^{m}\sum_{j=1}^{n} p_i \pi_{ij} q_j. \tag{4.1}$$

One important assumption underlying game theory is *rationality* of players. That is, individual players choose their strategies to maximise their payoffs in the game. This rationality extends to situations of uncertainty. In uncertainty, players select strategies that maximise their expected utilities (von Neumann and Morgenstern 1944). Following from this, it is further assumed that the rationality of each player is known to all the players and each player knows that everyone knows everyone is rational, *ad infinitum*. Again, the rules of the game (players, strategies and outcomes) are known to all and each player knows that everyone knows that everyone knows the rules, *ad infinitum*. Thus, the rules of the game and rationality of each player are said to be *common knowledge*.

Another terminology that needs mention here is *information*. The information structure of a game consists of what players know and when they know it (Rasmusen 1994). There are two basic elements that are used to specify the type of information a player has. These are the payoffs of the game and the history of play. When players cannot tell exactly where they are on a game tree, they are said to have imperfect information. When players can tell exactly where they are on the game tree, then those players have perfect information. Incomplete information in games implies that at least one of the players does not know the payoff functions of the other players. The payoff functions of all players are common knowledge in games of complete information (Gibbons 1992).

4.4 Relevant Solution Concepts and Techniques in Game Theory

Much of game-theoretic analyses is geared towards arriving at an equilibrium or equilibria. The equilibrium of a game consists of a strategy profile such that each player's strategy is a best response to that of the others. The methodology or rule for arriving at a behavioural prediction for the game based on equilibrium analysis is called *solution concept* (Rasmusen 1994; Bierman and Fernandez 1998). The commonly used solution concepts for normal form games considered here are dominant-strategy equilibrium and Nash equilibrium. In addition, the section discusses Backward Induction and Subgame Perfect Equilibrium—solution concepts used for the analyses of extensive games (Selten 1975; Kreps and Wilson 1982; Fudenberg and Tirole 1991; Battigalli 1996; Rasmusen 1994; Watson 2013).

4.4.1 Dominance

Dominant strategy equilibrium occurs when all players in a game play their dominant strategies. A strategy s_i is dominant for player i when it yields a strictly higher payoff against any strategy chosen by the other player: that is

$$\pi_i(s_i, s_{-i}) > \pi_i(s_i', s_{-i}) \forall s_{-i} \forall s_i' \neq s_i. \tag{4.2}$$

The other strategies are called dominated strategies and rational players do not play them. However, there are games where there are no strictly dominant strategies. In such games, there may be weak dominance where a strategy s_i yields a higher payoff than s_i' in some strategy profiles and never does worse in all other strategy profiles. That is:

$$\pi_i(s_i, s_{-i}) \geq \pi_i(s_i', s_{-i}) \forall s_{-i}, \tag{4.3}$$

and

$$\pi_i(s_i, s_{-i}) > \pi_i(s_i', s_{-i}) \text{ for some } s_{-i}. \tag{4.4}$$

Analysis based on weak dominance is problematic since it cannot offer a solid solution to a game (Watson 2013). In such cases, *iterated dominance* may be used. This technique relies on iterated elimination of weakly dominated strategies to arrive at strategies that can no longer be eliminated. These strategies are *rationalisable* strategies. Despite the promise of the iterated dominance strategy, it cannot provide precise predictions for most games. This is because in some real life situations, players play weakly dominated strategies (Rasmusen 1994; Watson 2013). Further, iterated dominance may prove difficult in games with larger numbers of players and strategies (Bierman and Fernandez 1998). Again, it usually results in multiple rationalisable strategy profiles without a unique solution to the game. In such cases, other solution concepts are needed to select among the multiple equilibria (Gibbons 1992).

4.4.2 Nash equilibrium

Before proceeding to Nash equilibrium, it will be useful to define a *best response* for a player. The strategy s_i^* of player i is said to be best response to the strategy s_{-i} of the other players when it yields the greatest payoff to player *i*. That is:

$$\pi_i(s_i^*, s_{-i}) \geq \pi_i(\, s_i', s_{-i})\; \forall s_{-i}, \forall s_i' \neq s_i^*. \tag{4.5}$$

Therefore, a strategy profile $s = (s_i^*, s_{-i}^*)$ is said to be a Nash Equilibrium when each player's strategy is a best response to the belief that the other players are playing their best response. That is,

$$\forall i\; \pi_i(s_i^*, s_{-i}) \geq \pi_i(\, s_i', s_{-i})\; \forall s_{-i}. \tag{4.6}$$

One important characteristic of Nash equilibrium is that, given the condition, each player has no incentive to deviate from the equilibrium strategy (Kreps 1990; Rasmusen 1994).

Nash Equilibrium is fundamental to the analyses of static games. In fact, an underlying theorem in game theory is that every game that has a finite number of players and sets of strategies has 'at least' one Nash equilibrium (Nash 1951, p. 288). However, the solution concept sometimes yields multiple equilibria without offering a unique solution to the game. In this situation, it becomes difficult to select among any of these pure strategy Nash equilibria. Moreover, some games do not have pure strategy Nash equilibrium. In such instances, a mixed strategy equilibrium may be found. A mixed strategy Nash equilibrium is when, for each player, player i's mixed strategy is the best response to the mixed strategy of the other players.

4.4.3 Backward induction

Dominance and Nash equilibrium are usually used to predict solutions to static games (in normal form) with complete and perfect information. In analysing dynamic games, however, different solution concepts are used. Players are assumed to choose their strategies at the beginning of the game and are sequentially rational. Sequential rationality implies that players seek to maximize their expected utility any time they are on the move in the game (Watson 2013). Sequential rationality is also assumed to be common knowledge among all the players in the game (Watson 2013).

Dynamic games with complete and perfect information have three main characteristics: the players move sequentially; the moves are observed by each player; and the payoff structure of the game is common knowledge (Gibbons 1992). A game with such characteristics can be solved by *backward induction*. The solution concept of backward induction involves the analysis of the game from the terminal nodes to the initial node. Here, the dominated actions of the player on the move at the predecessor of the terminal node are pruned from the tree. This goes on for each player and for every node till the initial node is reached. The strategy profile corresponding to the unpruned branches becomes the unique Nash Equilibrium of the game. Consider a two player sequential move game involving player *i* and *j*, where player i chooses an action $a_i \in A_i$ and player j observes a_i and selects an action $a_j \in A_j$ and the game ends with payoffs $\pi_i(a_i, a_j)$ and $\pi_j(a_i, a_j)$. Using backward induction, player *j* will select the action that solves:

$$\max_{a_j \in A_j} \pi_j(a_i, a_j) \tag{4.7}$$

when given the move at the second node. Now suppose that $BR_j(a_i)$ is the action that solves the above problem. That is:

$$BR_j(a_i) = \max_{a_j \in A_j} \pi_j(a_i, a_j) \; \forall a_i \tag{4.8}$$

then player *i*, being sequentially rational, would seek to solve the problem:

$$\max_{a_i \in A_i} \pi_i\left(a_i, BR_j(a_i)\right). \tag{4.9}$$

Supposing again that a_i^* solves the above problem for player *i*, then the backward induction equilibrium of the game is the strategy profile $s^* = \left(a_i^*, BR_j(a_i)\right)$ [Gibbons 1992]. In fact, backward induction always predicts a unique Nash equilibrium for any dynamic game with complete and perfect information (Peters 2015).

Backward induction provides one of the simplest techniques for solving dynamic games of this nature and does not rely on cheap talks, incredible threats or promises from players (Kreps 1990; Myerson 1991; Watson 2013).[12] However, backward induction has some limitations. For instance, it provides little help when analysing games with payoff ties (Watson 2013). Payoff ties make players indifferent and the analyst would have no basis to prune any of the branches associated with the payoffs under consideration (Kreps 1990).

[12] Incredible threats or promises are those that are not in players' own interests to implement when given the move and, as such, rational players will ignore such threats and promises (Dixit *et al.* 2015).

Another limitation linked to payoff ties is that backward induction eliminates other equilibria based on incredible threats (Barron 2013). Also, the technique becomes too difficult in complex games with large numbers of players and strategies (Dixit *et al.* 2015). More importantly, backward induction cannot be used to analyse infinite dynamic games and is not suitable for dynamic games with complete but imperfect information (Gibbons 1992; Watson 2013). When players move simultaneously at a particular point in a dynamic game with complete information, the solution prescribed by backward induction may be imprecise.

4.4.4 Subgame perfect equilibrium

In an extensive form representation, a subgame consists of a singleton node *y* and all its successors together with their payoffs (Rasmusen 1994). This subgame can be analysed as a game on its own, and once such a subgame is reached, players are assumed to play it till the game ends (Bierman and Fernandez 1998). The equilibrium that is reached after analysing the subgame is called a subgame Nash equilibrium. There may be several subgame Nash equilibria in an entire game. However, a strategy profile is called a subgame perfect equilibrium (SPE) if it is a Nash equilibrium for every subgame (Selten 1965). This means the action profile prescribed by the SPE should be played by sequentially rational players at any point in the game, conditional on the node being reached. This helps to eliminate implausible equilibria associated with imperfect information in dynamic games with complete information.

4.5 Strategic Tensions and Pareto Efficiency

The rationality assumption in game theory reveals three major strategic tensions in strategic interactions. First, since players are self-interested and seek to maximise their expected utilities, there emerges a conflict between individual and group interests (Watson 2013). The second tension has to do with strategic uncertainties (Kreps 1990; Watson 2013). Though each player forms a belief over the strategies of the other players, these may not necessarily be accurate. This leads to uncoordinated actions. Thirdly, even where there are no strategic uncertainties, the coordination of the actions could lead to inefficient outcomes (Myerson 1991; Watson 2013). An outcome is Pareto efficient (or optimal) if it makes at least some players better off without making any other player worse off (Myerson 1991). In a game consisting of *n* players, let $N = \{1, 2, \ldots, n\}$ be the set of players, S =

$\{s_1, s_2, \ldots\ldots, s_n\}$ be the set of strategy profiles and $\pi_i(s)$ be the utility function of player i. A strategy profile s^* is Pareto efficient if there exist no other strategy profile s' such that:

$$\pi_i(s') \geq \pi_i(\, s^*)\ \forall i, \tag{4.11}$$

and

$$\pi_i(s') > \pi_i(\, s^*)\ \exists i, \tag{4.10}$$

(Myerson 1991; Watson 2013). The concept of efficiency is a welfare criterion to evaluate a particular game, usually from the perspective of an outsider.

Players with welfare motives can employ devices known as *strategic moves* to alter the behaviour of other players to achieve socially optimal outcomes (Dixit *et al.* 2015). Some of the strategic moves discussed in the extant literature for addressing inefficient coordination include *reputation* and *trigger strategies*; *penalties* and *rewards* through enforceable *contracts*; and *leadership* (Watson 2013; Dixit *et al.* 2015). In repeated (or stage) games, the actions of players affect future beliefs and behaviour. Players with good track records have good reputation and vice versa. Such reputations attract rewards or punishment, respectively. The need to protect ones good reputation may incentivise players to cooperate, thereby foregoing short-term gains for a better future (Watson 2013). This is because there may be an internal threat for retribution.

A *trigger strategy* is a contingent strategy that is used to either punish or reward a player. In stage games, a trigger strategy prescribes two main action profiles for players. These are the *cooperation profile* and the *punishment profile*, with the latter being the Nash equilibrium of the stage game (Watson 2013). Players are expected to play the cooperative profile so long as both cooperate. However, they should play the punishment strategy the moment one or both deviate(s) from the cooperative strategy (Watson 2013). Insights from game-theoretic analysis indicates that such trigger strategies motivate players to cooperate, especially those with high discount factors in infinitely repeated games (Watson 2013). This is because payoffs in repeated games are discounted and summed up for the entire stage game (Watson 2013). The stage game is then analysed to arrive at a subgame perfect equilibrium. It must be stated, however, that trigger strategies are not very effective in stages close to the end of a finite repeated game (Dixit *et al.* 2015).

Trigger strategies are mostly implemented by the players themselves and are applicable to only repeated games. To prevent non-cooperative behaviour in other settings, a reward and penalty scheme can be implemented by a third party such as a court or a regulatory body (Watson 2013). The players in the game can write an enforceable contract to ensure that they cooperate even in a one-stage game. If any of them deviates from cooperation, the court can impose a penalty on the defector and reward the cooperating player(s). Further, a regulatory body can punish any player who deviates from playing the socially optimal strategy in the game. Even in a stricter sense, the regulatory body could punish all defecting players in case all of them deviate (Dixit *et al.* 2015). A way of modelling this is by incorporating punishment and rewards into the payoff functions of the players at the start of the game. The new game becomes a *modified* or an *induced game* (Watson 2013). The modified game is then analysed to predict the behaviour of the players.

Another strategic move proposed by Dixit *et al.* (2015) is leadership. In games of asymmetry, a particular player performs worse or better than the other in the Pareto-inferior Nash equilibrium. Such a player could take up a leadership role in the game and make a *commitment* to cooperate. As noted by Dixit *et al.* (2015, p. 289), such a strategic move should be verifiable, observable and irreversible. Contenders will be motivated to cooperate once they observe strategic moves by other players. However, cooperation is not guaranteed to be automatic for players who are motivated by schadenfreude or other non-cooperative motives (Watson 2013).

4.6 Criticisms of Game Theory

Game theory, like any other theoretical framework, has been criticised as being deficient and imprecise in predicting real-life behaviour.[13] First and most importantly, game theory is criticised for failing to accurately predict strategic behaviour in some real-life settings. In some cases, agents in real-world experiments do not play the actions predicted by game-theoretic modelling. A typical example frequently cited in the literature is the solution to the *centipede game* (cf. Dixit *et al.* 2015). Experimental evidence indicates that players usually fail to play the solution proposed by backward induction. Second, game theory has been criticised as being deficient in forecasting decisions in real-life conflict situations (Armstrong 2002; Goodwin 2002; Green 2002, 2005; Wright 2002). These authors argue that role-playing outperforms game theory in forecasting decisions in conflict situations. It

[13] See Dixit *et al.* (2015) and Kreps (1990) for a detailed discussion of these critiques and counter-critiques.

must be noted, however, that game theory relies on accurate and precise definition of the rules of the game. Thus, any misspecification of the rules of the game, especially concerning the payoff functions of players, is a recipe for imprecision. Moreover, role-playing is not independent of game theory since the players act in a game-setting to be able to forecast the behaviour of the opponent (Bolton 2002; Erev *et al.* 2002). Therefore, modellers should endeavour to achieve higher degrees of accuracy and precision in specifying the rules of the game.

Linked to the above is a critique of the assumption of rationality and common knowledge. These assumptions are regarded as not consistent with practical behaviour (Rubinstein 1999). It has been argued that real players are not as rational as assumed by game theory and other rational choice models (Zey 1992, 1998; Halpern and Stern 1998; Thaler 2015). Critics posit that individual decision making is much more influenced by social factors than the information individuals possess. To respond to this critique, the concepts of bounded rationality and retrospection have been incorporated into game-theoretic modelling (Kreps 1990; Rubinstein 1998). The concept of bounded rationality recognises that rationality is limited, but players act rationally within this limit (Kreps 1990). Also, individuals act rationally within the opportunities and constraints imposed by social factors. On retrospection, the past experiences of players may inform their current decisions (Kreps 1990). As players play the game over a repeated number of times, the rules of the game become common knowledge as they are able to act based on the history of the repeated play. Also, the fact that players do not play equilibrium strategies does not necessarily mean that rationality is flawed. Observations from players' moves and history could alter players' actions in the game. Players can intentionally play counter-equilibrium actions in early stages of a game to maximise their payoffs in future stages (Watson 2013). This does not mean the players are irrational, but rather *rationally irrational*. In such cases, alternative solution concepts such as *forward induction* could be deployed to predict behaviour. However, the conditions under which forward induction are used are not concretely specified in game theory and more research is needed in this direction (Watson 2013). It is also important to note that players do make mistakes in the course of play, and this should not be regarded as irrational. This is usually a slip and does not mean the player or other players will continue making mistakes: something called the *trembling-hand perfection* (Selten 1975; Kreps 1990). Even so, players guard against making mistakes that may cost them a great fortune (Myerson 1978).

Another critique is the problem with multiple equilibria. Game theory has been criticised as offering ambiguous solutions to strategic situations. Some of the analyses do not have equilibrium, whereas others predict two or more equilibria (Kreps 1990; Dixit *et al.* 2015). In such cases, the theory is criticised as not being helpful in selecting a unique solution to a problem. Fortunately, advances in the theory have developed refinements to the Nash equilibrium concept. Refinements such as subgame perfect equilibrium, forward induction and perfect Bayesian equilibrium could be used to eliminate implausible equilibria from the analysis. Another important refinement is the *focal point equilibrium* advanced by Schelling (1960). Here, something intrinsic to the game environment converges the expectations of players on a particular Nash equilibrium. This could be the nature of payoffs or outcomes associated with the equilibria, a social convention, cultural setting, history and so on (Schelling 1960; Watson 2013; Dixit *et al.* 2015). Despite the disagreements on the efficacy and justifications of these refinements in equilibrium selection, they still offer improved ways for modelling strategic behaviour (Dixit *et al.* 2015).

The above criticisms notwithstanding, game theory is seen as a powerful tool for analysing strategic behaviour. Although it has its shortcomings (as does every analytical tool), it offers a logical and precise way of analysing conflicts. Insofar as there is a precise protocol for the game, game-theoretic modelling can be a good predictive tool. With cautious application and adaptability, game-theoretic modelling remains a very useful tool for explaining, predicting and prescribing behaviour (Dixit *et al.* 2015). It has been observed that the theory has improved scholars' understanding of many conflict and non-conflict situations (Camerer 2003; Osborne 2004; McCain 2014; Dixit *et al.* 2015). It has been used to successfully analyse many conflict situations including conflicts over the use and control of forest resources in developing countries.

4.7 Applications of Game Theory to Forest Management Problems

Game theory has been widely applied to forest management situations in the developing world. This section provides a brief review of these studies to identify some of the existing gaps in the current literature.

4.7.1 Overview of key studies applying game theory in forest management

Game theory has been extensively applied to the analyses of the conditions under which forests are conserved in different forest regimes and varied strategic settings. Many game-theoretic studies have concentrated on communal property or collective action problems (Chopra *et al.* 1990; Ostrom *et al.* 1994; Angelsen 2001; Apesteguia 2001, 2006; Cárdenas and Ostrom 2004; Lee *et al.* 2015; Liu *et al.* 2018). Using a bargaining model, Chopra *et al.* (1990) discussed possible contracts between governments and local communities to successfully manage a forest. Ostrom *et al.* (1994) have used repeated game models to test the behaviour of appropriators in common property regimes (communal forests in India) using laboratory and field data. The results from the experimental and filed data often falsified the hypotheses generated from the game-theoretic analyses. Angelsen (2001) looked at the effect of appropriation interactions between the State and local communities and how these affect tropical deforestation. Cárdenas (2004) studied the different types of mechanisms to avert the tragedy of the commons and found that social norms and individual subjective valuation of net-benefit of regulations are more effective than external regulation.

Cárdenas and Ostrom (2004) looked at how different levels of information affect incentives to cooperate in the commons and found that a participant's decision to cooperate or defect is affected by the participant's prior experience, the participant's perception of external regulations and the group's composition. Apesteguia (2001, 2006) used game-theoretic modelling to examine how the behaviour of people in a communal property regime is affected by information on the payoff structure of the game. Lee *et al.* (2015) applied evolutionary game-theoretic modelling to analyse the measures for reducing corruption to suppress illegal logging in a collective action situation. Finally, Liu *et al.* (2018) used game-theoretic modelling to analyse how two payment for ecosystem services (PES) in China affect tenure security. They concluded that different types of PES have different implications for land tenure, which have further implications for conservation.

Game-theoretic models have also been used to study the incentives to participate in forest conservation under collaborative and community-based forest management (Kant and Nautiyal 1994; Ligon and Narain 1999; Lise 2001, 2005, 2007; Burton 2004; Shahi and Kant 2005, 2007, 2011; Engel *et al.* 2006, 2013; Atmis *et al.* 2007, 2009; Engel and Lopez 2008). Kant and Nautiyal (1994) used game theory to develop a mechanism for sharing proceeds from timber harvest between the government and communities under Joint Forest Management in India. Ligon and Narain (1999) considered the effect of different scenarios of governance policies on the management of communal forests in India. They concluded that Joint Forest Management may be less effective in promoting local-level enforcement if institutions are weak and vice versa. Through a series of studies, Lise (2001, 2005, 2007) estimated a game model to investigate the kind of games villagers play in managing forests in Northern India. He found that people's willingness to participate varies among villages. Again, Burton (2004) considered a war of attrition between logging companies and environmentalists over the conservation of a tree. He discovered that under complete information, blockading by environmentalists is efficient in conserving forests.

By adopting a framework similar to that of Burton (2004), Engel and Lopez (2008) also looked at a bargaining problem between a community and a logging firm with third party intervention. The authors discovered that the efficacy of third-party interventions is dependent on initial conditions and that such interventions may sometimes be counterproductive. Earlier, Engel *et al*. (2006) analysed the bargaining situation between a logging company and a community with weak property rights in Indonesia. They revealed that without proper third-party intervention on the side of the community, such contracting problems could lead to degradation. Engel *et al.* (2013) examined when collaborative management emerges between the State and forest-fringed communities in situations when they are in conflict over the use of a protected area in Indonesia. The authors found that co-management is less likely to emerge under low enforcement costs, high conservation benefits and low community benefits from resource extraction.

Shahi and Kant (2005, 2011) used an evolutionary game-theoretic approach to model the interaction between public agencies and communities in Joint Forest Management in India and to explain the variations in outcomes across villages. Shahi and Kant (2007) extended their earlier model (Shahi and Kant 2005) to study the interactions among groups in heterogeneous communities. It was discovered in this study that the success of Joint Forest Management is dependent on policy prescriptions and local conditions. Atmis *et al.* (2007) have also used game-theoretic modelling to analyse the factors influencing the participation of women in forest management in Bartin Province, Turkey. They reported that both the perception of forest dependence and of the quality of forest promote cooperation among women. Further, Atmis *et al.* (2009) used game theory to identify the factors affecting the participation of forest cooperatives in forestry in Turkey. The study revealed that the higher the wood production level of a cooperative, the higher the level of participation.

Some authors have also applied game theory to the management of State forests (especially, protected areas) in developing countries. For example, Muller and Albers (2004) modelled household extractive decisions under different market settings to observe how these settings influence the optimal management plan of the managers of protected areas in developing countries. The authors revealed that managers will be more likely to induce sustainable behaviour among households if they adopt an optimal mix of various policies such as enforcement, agricultural development and conservation compensation payments. Further, Robinson *et al.* (2014a) developed a game model to investigate how motivating local forest dwellers could lead to better management of the Kibaha state forests in Tanzania. They found that when public forest managers legalise NTFP collection by forest users close to the state forests ('insiders'), they will be motivated to monitor and restrict the access of 'outsider' charcoal producers to the forests, thereby helping to enforce forest laws. Similarly, Soltani *et al.* (2016) used non-cooperative and bargaining models together with goal programming to analyse the strategic interactions between the Iranian government and villagers in northern Zagros, Iran. The study revealed that villagers are cooperative with the government even without formal agreements. They concluded that the State can achieve higher levels of forest protection if agreements are formalised with communities.

4.7.2 Some research gaps in the literature on game-theoretic application in forest management problems in the developing world

Despite the wide application of game theory to forest management problems, much remains unexplored. First, studies have overly concentrated on pecuniary incentives and payoffs to the neglect of non-pecuniary incentives such as the socio-political and cultural preferences of players (refer to Table 4.1). It has long been recognised that preferences and interests in forest interactions are, to a greater extent, influenced by the social-cultural and political contexts within which these interactions occur (Gjertsen and Barrett 2004; Cárdenas and Ostrom 2004). The influence of these contextual factors is even more pronounced in developing countries (Cárdenas and Ostrom 2004; Henrich 2000; Henrich *et al.* 2001). They essentially shape the everyday economic decisions people make. The actual values individuals place on their interests in such interactions go beyond pecuniary costs and benefits to include the social and political costs and benefits of their choices.

For this reason, Cárdenas (2004, p. 239) has long called for the need to 'pay more careful attention to the role that preferences play in human [behaviour]' when modelling and designing institutions for sustainable forest management in developing countries. These sociol-cultural and political preferences need to be taken into consideration in theoretical models to make models more reflective of the real-life situation they are depicting. Neglecting such non-pecuniary values in the analysis may likely result in less realistic theoretical predictions. It has been noticed that 'discrepancy between results obtained from the model and reality may be due to our inability to grasp what is essential' in the phenomenon under consideration (Forgó *et al.* 1999, p. xii). Arguably therefore, theoretical models in forest management decision-making in the developing world may be more reified if they are made flexible enough to incorporate essential *assumptions* about the socio-political costs and benefits of stakeholders.

Yet, assumptions incorporating the socio-political preferences and incentives of players are largely ignored in the analyses of game models in the existing literature (see Table 4.1). Studies have focused more on the pecuniary values of individual or communal incomes from forests and or the quantities of wood harvested in the design of game models. This is partly because the need for simplicity in game theory sometimes entails the isolation of few elements of decision-making for analysis (Osborne 2004; Watson 2013). However, the role of socio-political preferences in forest interactions in developing countries is too essential to ignore in models. In addition, the nature of the modelling process adopted by most researchers leaves little room for the consideration of these socio-political preferences. For instance, Shahi and Kant (2007) bemoaned the fact that though social and political preferences are commonly observed in India, the nature of the current evolutionary game-theoretic specifications could not allow their incorporation in their models. They therefore called for an extension of the current game-theoretic formulation in forest management to incorporate such preferences. However, such studies are still rare in the current literature.

Further, the existing game-theoretic formulations on State-Community forest interactions have mostly assumed that the State's management objective is either to maximise the welfare of its constituents, the benefits of conservation or both. This assumption is based on normative perceptions about the role of the State. It overlooks the fact that State actors in many developing countries are also interested in the rent-seeking opportunities generated by forest management (cf. Contreras-Hermosilla 2002; Smith *et al.* 2003; Siebert and Elwert 2004; Palmer 2005; Alley 2011; Amacher *et al.* 2012). This indisputable fact demands that current game models go beyond how State actors ought to behave in forest management decision-making in developing countries to how State actors actually behave. This implies, where possible, carefully identifying realistic interests and preferences of the State in forest management interactions and incorporating these in model specifications. However, the current literature on game-theoretic modelling in forest management is short of studies that incorporate such rent-seeking and other interests of the State. The consideration of these 'other preferences' of the State in game-theoretic studies is crucial if models are to make more reliable predictions that reflect current realities in developing countries.

Several of the studies in Table 4.1 have tested their theoretical predictions with experimental or empirical data on past or current behaviour. However, using data on current or past behaviour to test predictions about future behaviour may not be useful when models evaluate hypothetical policy scenarios. Such hypothetical policy scenarios present opportunities or constraints that were or are absent from past or current situations, respectively. Thus, empirical data on expected future behaviour under the policy scenarios is needed to verify theoretical predictions. This, in most cases, may require the use of empirical data on proximate antecedents such as behavioural intentions, willingness and expectations (Mitchell and Carson 1989; Armitage and Conner 2001; Ajzen and Fisbein 2005; Pomery *et al.* 2009). However, the current game-theoretic studies on tropical forest management problems are yet to utilise data on these proximate antecedents in testing predictions about future behaviour.

Table 4.1 A summary of past studies using game-theoretic modelling on forest management problems in the developing world

Citation	Objective	Type of forest regime	Country of study	Empirical testing with field data	Socio-political preferences in model parameters
Chopra *et al.* (1990)	Possible state-community contracts to successfully manage a forest	Collaborative Management	India	Yes	No
Ostrom *et al.* (1994)	Behaviour of appropriators in common property regimes	Communal property	India	Yes	No
Kant and Nautiyal (1994)	Mechanisms for sharing timber proceeds between the government and community	Collaborative Management	India	Yes	No
Ligon and Narain (1999)	Effects of different scenarios of government policies on the local management of communal forests	Collaborative management	India	No	No
Angelsen (2001)	Effect of different types of games between State and local community on tropical deforestation	Communal property	General	No	No
Lise (2001, 2005, 2007)	The kind of games individual villagers play in collaborative management	Collaborative Management	India	N/A^	No
Muller and Albers (2004)	Effects of different market settings on the optimal management plans of protected area managers in developing countries	State forest	General	No	No
Cárdenas (2004)	Evaluation of different types of mechanisms for averting the tragedy of the commons	Communal property	Columbia	Yes	No
Cárdenas and Ostrom (2004)	Effect of different levels of information incentives to cooperate	Communal property	Columbia	Yes	No
Shahi and Kant (2005, 2011)	Interactions between public agencies and homogenous local communities and how they affect forest outcomes	State Forest and Collaborative Management	India	No	No
Apesteguia (2001, 2006)	Effect of information on payoff structure on individual behaviour in a communal property	Communal property	General	No	No

Engel *et al.* (2006)	Strategic interactions between logging firms and local communities with weak property rights.	Collaborative Management	Indonesia	No	No
Atmis *et al.* (2007)	Factors influencing women's participation in forest management	Collaborative Management	Turkey	N/A^	No
Shahi and Kant (2007)	Interactions between public agencies and heterogeneous local communities and how they affect forest outcomes	State Forest and Collaborative Management	India	No	No
Engel and Lopez (2008)	Bargaining interactions between local communities and logging firm with interventions from third-party agents	Collaborative Management	General	No	No
Atmis *et al.* (2009)	Factors affecting the participation of forest cooperatives in forestry	Collaborative Management	Turkey	N/A^	No
Engel *et al.* (2013)	Emergence of co-management between the State and forest communities in the context of conflict over a protected area	State forest	Indonesia	Yes	No
Robinson *et al.* (2014a)	Effect of State-led motivation of villagers on forest law enforcement and conservation	State forest	Tanzania	No	No
Lee *et al.* (2015)	Measures to reduce corruption in rule enforcement to suppress illegal logging	Communal property	General	No	No
Soltani *et al.* (2016)	Strategic interactions between government and villagers	State forest	Iran	N/A^	No
Liu *et al.* (2018)	The effect of payment for ecosystem services (PES) policies on tenure security	Private and communal property	China	Yes	No*

^ These studies did not derive theoretical predictions from their models. They only used primary data to derive payoff matrices and estimate the game being played by stakeholders.

*Considered the political benefits in the payoff structure of only the village leader in the model.

Further, game-theoretic studies in forest management in the developing world have overly concentrated on communal property, collaborative forest management regimes and, to some extent, protected areas. Little attention has been paid to equally important but different regimes. For instance, game theory is yet to be applied to problems in off-reserve forest management in Ghana: a regime distinct from communal property and collaborative forest management. Under communal property forest regime, the user group (usually forest villages) has at least proprietorship rights to the forest resource and directly determines their benefits in the use of the resource (Ostrom 1990; Ostrom *et al.* 1994). Also, in collaborative forest management, state agencies enter into agreements with communities to manage forests resources in return for a share in the proceeds from timber and access to NTFPs from the forest (Shahi and Kant 2007). Off-reserve forests are neither communal nor collaborative because only the government has the sole legal right to grant harvesting rights to timber resources (but not to farmers). Farmers do not have any share in the economic rents accruing from logging though they are the *de facto* managers and conservators of the forest. Apart from off-reserve forests, little attention has also been paid to the management of sacred groves in Africa. Therefore, the application of game theory to such unexplored regimes, especially in Africa, is warranted to contribute to game-theoretic understanding of human behaviour in forest management in diverse settings.

4.8 Conclusion

This chapter has given an overview of the various terminologies and assumptions in game theory relevant to understanding strategic interactions in the off-reserve landscape. Based on its usefulness in understanding and predicting human behaviour, game theory has been widely applied to the analysis of forest management problems in developing countries. A review of these applications identified a few critical research gaps in the current literature. These include the lack of empirical testing of game-theoretic predictions using proximal antecedents to behaviour and limited incorporation of assumptions on the socio-political preferences of players in game models. Others include the limited consideration of the rent-seeking interests of state actors in game-theoretic studies on forest management in the developing world. Also, game theory is yet to be applied to forest management interactions in unique forest settings such as sacred groves in Africa and the off-reserve forests in Ghana. This thesis attempts to address these gaps by focusing on tenure and compensation conflicts in the off-reserve forests in Ghana.

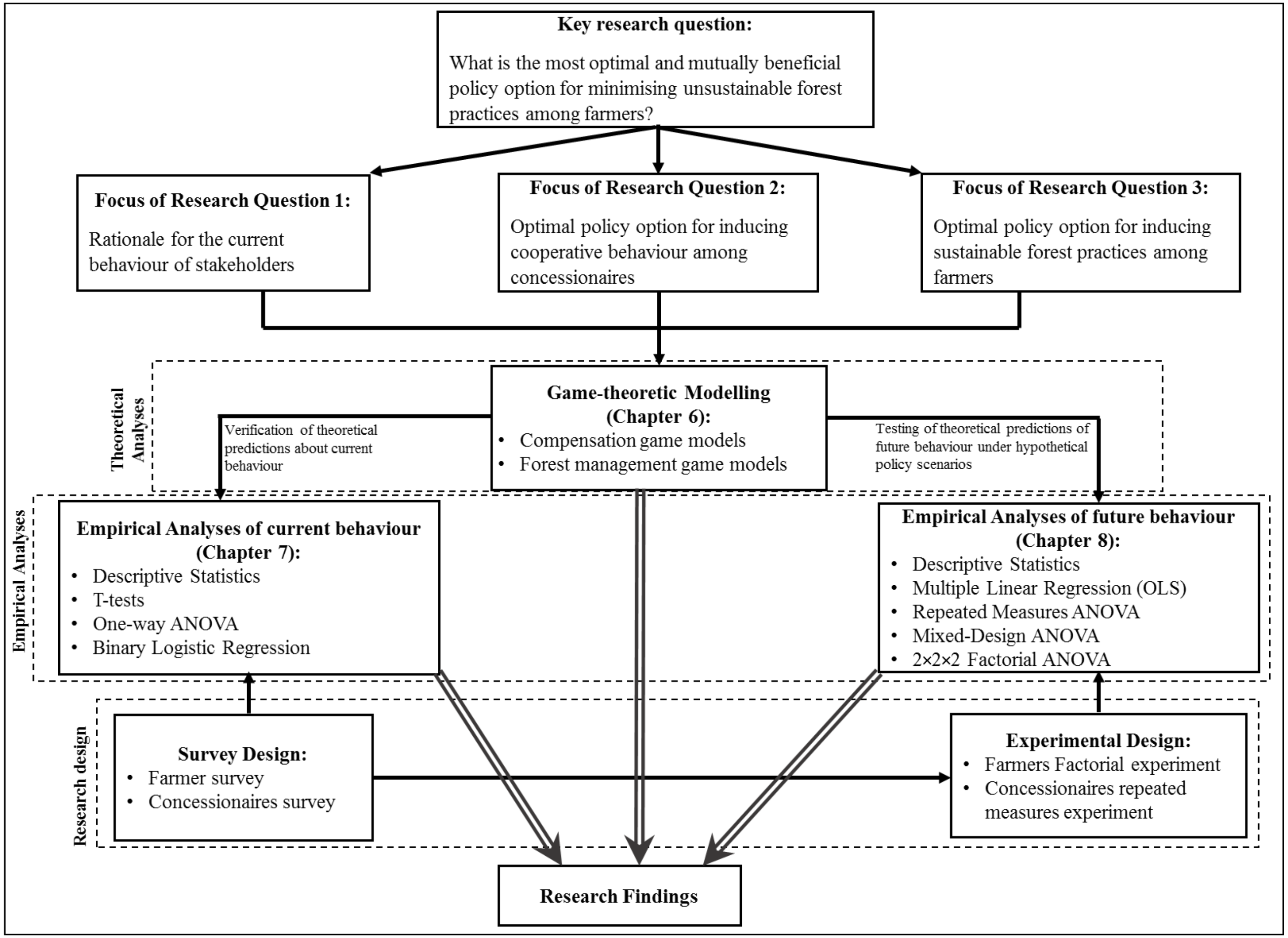
Chapter 5. Research Methodology

The overarching objective of the study is to examine how certain scenarios could induce behavioural changes among farmers and concessionaires. It employs game-theoretic modelling to analyse, explain, predict and prescribe strategic behaviour among the stakeholders in the off-reserve landscape. Some of the predictions of the game-theoretic models are formulated as hypotheses and tested with field data. These deductive and theory-verification processes require more structured techniques (Neuman 2014; Punch 2014). These techniques are effectively offered by the quantitative approach. The quantitative approach provides ‘highly systematic procedures’ which are considered suitable and appropriate to meet the demands of game-theoretic modelling, deductive analyses and theory-verification (Creswell 2011). The approach is also considered preferable when a study aims at identifying factors that influence particular outcomes and examining the usefulness of a particular intervention (Creswell 2011).

This chapter therefore provides a detailed account of the quantitative methodology used to answer the research questions posed by the study. The chapter begins with a brief overview of the methodological framework adopted in addressing the research questions. This is followed by a brief overview of the game-theoretic modelling procedure used to analyse the off-reserve interactions of stakeholders under varied scenarios. Following this, the chapter describes the survey design used in the study, including the study population and sampling techniques, research instruments and the face-to-face survey. The chapter then proceeds to outline the methods and steps used in the experimental designs to test the predictions (hypotheses) of the game-theoretic modelling. It also provides a description of the data analyses techniques used.

5.1 An Overview of the Methodological Framework

This study addresses three specific research questions. Figure 5.1 is a flow chart of the procedure followed to respond to these questions. The thesis follows the general procedure adopted in most of the studies applying game theory to forest management problems in the developing world (e.g., Chopra *et al.* 1990; Kant and Nautiyal 1994; Ostrom *et al.* 1994; Cárdenas 2004; Cárdenas and Ostrom 2004; Engel *et al.* 2013; Liu *et al.* 2018).



Source: Author’s Construct, 2017

Figure 5.1 A flow chart of the procedures and methods used in the study

These studies usually undertake formal theoretical analyses of the situation and formulate hypotheses from the predictions of the model. The hypotheses are then tested with empirical data and field or laboratory experiments. In line with these studies, both formal theoretical analyses and empirical data analyses are used in this thesis. Game-theoretic modelling is used to provide a further insights into the current behaviour of stakeholders from a rational choice perspective. It is also used to analyse and predict the future behaviour of farmers and concessionaires under policy scenarios. The game-theoretic insights into the current behaviour and predictions of future behaviour are verified and tested through empirical analyses of data obtained from a combination of the survey and experimental designs. The study findings are drawn from both the theoretical and empirical analyses.

5.2 A Brief Overview of the Game-theoretic Modelling Procedure

The study develops game-theoretic models to explain and predict the behaviour of farmers, concessionaires and the government (State) in their off-reserve logging interactions in Ghana. It uses the extensive form to depict these games and relies on backward induction, subgame perfect equilibrium and Bayesian perfect equilibrium for the analyses. It starts with a two-player compensation game to analyse the current compensation conflict between a farmer and a concessionaire in the off-reserve forests. This game aims at predicting compensation outcomes when farmers independently pursue compensation for crop damage within the prevailing socio-legal environment. The analyses begin with models of complete information between a typical concessionaire and three different *types* of farmers. These are followed by two models of incomplete information to explain and predict how the *types* of concessionaires may influence the outcomes of compensation interactions.

Following this, variants of a three-player forest management game are developed to evaluate policy options for resolving the off-reserve conflicts and inducing sustainable behaviour among farmers. The analyses begin with a model that explains the current behaviour of the State, concessionaires and farmers in their on-farm logging interactions. The study then proceeds to use hypothetical *commitments* by the State to observe how certain hypothetical policy actions by the government can alter the behaviour of farmers and concessionaires. This is called a *modified forest management model*. A third-party litigation scenario is then incorporated into the modified forest management model to observe how this will affect the behaviour of the State and the concessionaire in logging compensation payments.

5.3 Policy Scenarios Evaluated in the Game Models

It was found in Chapter 3 that the major causes of unsustainable practices among farmers are the absence of tree tenure, non-payment of compensation and lack of enforcement of the tree harvesting law. Established policy approaches discussed in Chapter 2 include command-and-control, property rights, and incentive-based approaches. This study designed policy scenarios based on some of these policy approaches to observe how they can influence behaviour either separately or jointly. These scenarios are presented below.

5.3.1 Command-and-control approaches (CAC)

Chapter 3 revealed that farmers engage in illegal logging due to low enforcement of the tree harvesting law. The government can undertake to strictly enforce the tree harvesting law to control illegal logging among farmers. This is very important because the enforcement of conservation laws is considered to be the most important factor in ensuring sustainable behaviour (Kaimowitz 2003; Gibson *et al.* 2005; Chhatre and Agrawal 2008; Singh *et al.* 2011; Bouriaud *et al.* 2014; Coleman and Liebertz 2014; Robinson *et al*. 2014b). Several proposals for overcoming the enforcement problem have been made in the literature (Table 3.1). These include focusing enforcement at the domestic lumber market, strict enforcement by the Forestry Commission alone, and partnership with local farmers and communities to enforce the tree harvesting law. To focus on the domestic market is to miss the source of illegality (the cocoa farm) and this precludes it from being a viable option in this study.

Likewise, it is generally agreed in the literature that the government of Ghana cannot effectively monitor the off-reserve forests alone because it has limited human and logistic capacity and trees are dispersed on individual farms (see Chapter 3). Thus, collaboration with some community members at the village level to monitor the forest appears to be the only viable option. This is also regarded as the most effective approach to forest law enforcement in the extant literature (Gibson *et al.* 2005; Chhatre and Agrawal 2008; Singh *et al.* 2011; Robinson *et al.* 2014a). Community members (mostly farmers) stay in the forests and can easily detect non-compliance by other villagers at any time of the day. Yet the State will need to incentive these local-level enforcers to effectively monitor the forests (cf. Hayes and Persha 2010). Hence, the policy scenario considered in the forest management game to overcome the enforcement problem is the provision of monetary incentives to some community members by the State to collaborate with the Forest Service Division (FSD) to monitor forests in each community, and the sanctioning of culprits in strict accordance with the law. This is called the *Strict Enforcement* scenario.

Enforcement of the compensation law can be adopted as a CAC strategy by the government to address non-compliance with the compensation law among concessionaires. This scenario is called the *enforcement of the compensation law* by the State in the forest management game. It connotes the FSD refusing to issue Conveyance Certificates to concessionaires if they fail to fully compensate farmers for crop damage.

5.3.2 Property rights approaches

Two competing property rights options for resolving the off-reserve tenure problem are recommended in the existing literature. These are the complete devolution of tree rights to farmers and the revision of the current timber revenue sharing arrangement to provide a competitive proportion of on-farm timber revenue to farmers (refer to Table 3.1). In summary, the proponents of complete devolution demand that the government stays off the off-reserve forests; decriminalises sale of on-farm trees by farmers; discontinues granting of timber concessions on farms; removes the ban on chainsaw milling; and allows farmers to deal with any logger of choice. Complete devolution is less feasible in Ghana considering, first, that the off-reserve forests provide about 40% of timber revenue to the government (Oduro *et al.* 2014). Currently, 80% of off-reserve stumpage revenue is shared among State institutions such as the Forestry Commission, District Assemblies and the Office of the Administrator of Stool Lands (OASL). The government stands to lose substantial revenue from the off-reserve forests should trees be devolved to farmers. As noted by Kashwan (2013), such a call for devolution is not realistic because the State has a vested interest in the forest.

Second, complete devolution is not mutually beneficial because it will exclude the FC, OALS, the Traditional Council and District Assemblies from the off-reserve logging industry. Also, off-reserve concessionaires are more likely to be put out of business because farmers are more likely to deal with chainsaw millers due to reasons outlined in Chapter 3. Third, current REDD+ documents in Ghana view a complete devolution of tree tenure as unlikely. In fact, the government's Forest Investment Plan for REDD+ states that:

> Major aspects of tree tenure, including detailed formulas for benefit sharing, are expressed in the Constitution and are likely to be difficult to change in the short-term. The challenge is to devise mechanisms within the available policy, legal and administrative framework, and to revise the policies and the regulatory framework that can be addressed, including institutional arrangements and mandates, to review regimes and the rights to manage, decide and to benefits from trees on farm (MLNR 2012b, p. 37).

Thus, complete devolution may not be politically feasible and equitable (Hajjar 2015b). Based on the above, Kashwan's (2013, p. 613) recommendation of a 'minimal set of rights critical to the subsistence and well-being of forest people' holds true for the off-reserve forests in Ghana. To be consistent with this recommendation, the study aims to explore a mutually beneficial policy scenario based on the call for the provision of a competitive proportion of timber revenue to farmers. But, what proportion of the stumpage revenue will be competitive enough to induce sustainable behaviour among farmers?

Studies have shown that chainsaw loggers provide about a third of the stumpage fee of the tree to the farmer as tree payment (Richards and Asare 1999; Amanor 2004; Marfo 2010). Chainsaw loggers also provide lumber boards and sanitise farms after logging (Hansen 2011; Amoah and Boateng 2014). Therefore, any Statist provision of timber revenue that seeks to motivate farmers to stop dealing with illegal loggers should, of a necessity, exceed a third of the stumpage value in order to partly cover the non-monetary benefits farmers gain from chainsaw logging. Besides this minimal value, any recommendation regarding the proportion of revenue to be given to the farmer must consider the ability and willingness of the State to pay. According to Marfo (2010, p. 50), 'it has often been proposed in forestry meetings that 40 percent of timber revenue collected by the FC from off-reserve areas be distributed to communities or farmers as a way to compensate them for tending and managing the trees on their lands and farms'. This 40% proposal seems to be plausible both in rivalling the payment made by chainsaw loggers and in its feasibility. The government is currently implementing the Modified Taungya System (MTS) in forest reserves where farmers are given support to interplant trees with their crops in degraded reserves and nurture them to canopy level. The government then pays 40% of the stumpage value of each tree to the farmer when the tree is logged by a concessionaire (Kalame *et al.* 2011; Ros-Tonen *et al.* 2013; Dumenu *et al.* 2014). With the needed political will and support, the government can easily roll out this system to the off-reserve forests. The study therefore adopts the provision of 40% of stumpage revenue to the farmer as a hypothetical policy action to resolve the off-reserve tenure problem. This is called the *Right to trees* scenario in the forest management game. Here, right to timber trees connotes recognising farmers as one of the owners of on-farm trees and granting them 40% of stumpage revenue.

5.3.3 Other approaches: independent actions by farmers and community pressure

Farmers have been using various actions to pursue compensation, though they are oftentimes unsuccessful (Marfo and Schanz 2009). These include persuasion, mediation, litigation and blockading (force). These actions are considered as independent actions by farmers to pursue compensation within the confines of the prevailing socio-political environment of on-farm logging compensation. Scenarios on these actions are designed and analysed in the compensation game to examine their expected impacts on concessionaires' likelihood to pay full compensation.

It was further established in Chapter 3 that compensation conflicts partly exist due to the incapability of farmers to independently pursue compensation in a compromised socio-political system. To address the issue of farmers' incapability, this study evaluates the likely impact of a *third-party litigation* (community pressure) on concessionaires' likelihood to fully and promptly pay negotiated compensation to farmers in the forest management game. Third-party litigation refers to the pursuit of farmers' rights to compensation in the court system by a third party on behalf of farmers anytime the farmer is not compensated. The third party could be an individual advocate or an advocacy group (farmer-based or NGO) that has the capacity to match a concessionaire in the legal system.

The ultimate results of the scenarios on compensation payment for the farmer are either receipt of full compensation or not. Hence, they were presented as one scenario (*Full Compensation Scenario*) in the farmers' experiment. Each of the scenarios for concessionaires were analysed separately. However, the scenarios for farmers were analysed both separately and jointly in the forest management games. Details of the presentation of these policy scenarios in the questionnaires for farmers and concessionaires are given in the section on the experimental designs. The predictions from the models are proposed as hypotheses and tested with empirical data gathered through a combination of the survey and experimental designs.

5.4 Survey Design

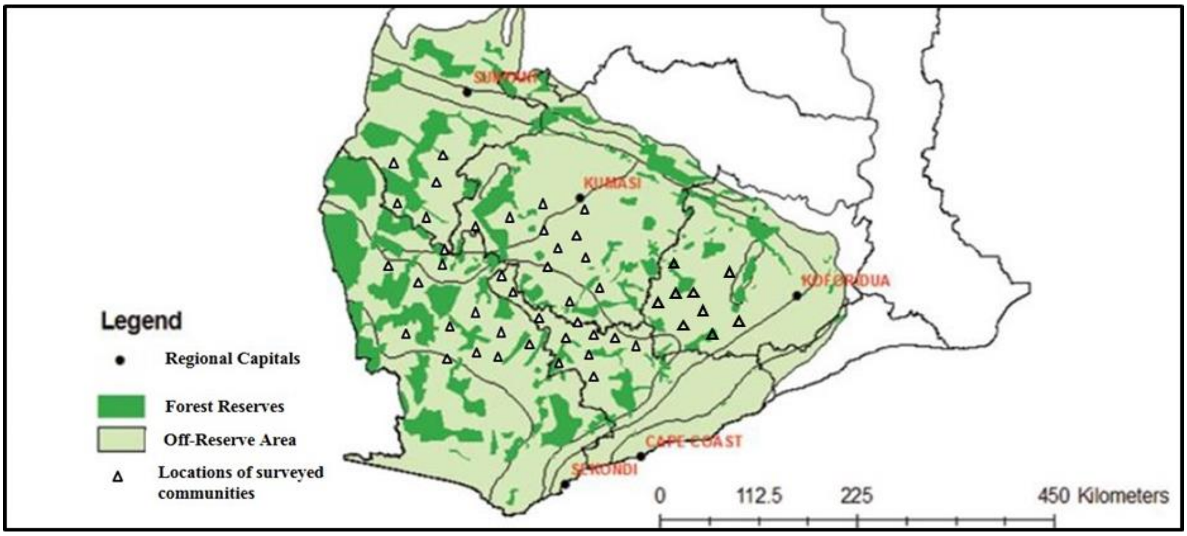
The study uses the survey design for data collection, analyses and interpretation. The survey design is considered suitable for this study since it allows the findings from a sample to be generalised to the population (Fink 2002; Creswell 2011; Fowler 2014). Survey research is recognised by some scholars as the most appropriate strategy for gathering empirical data to describe and explain the characteristics, attitude, intentions and behaviour of a large population that cannot be directly observed (Babbie 2013).

5.4.1 Sampling technique

The populations for the study are farmers and concessionaires in the off-reserve landscape in the High Forest Zone (HFZ) of Ghana. Ghana is divided into ten administrative regions and the HFZ is made up of six of these regions. These include the Western, Central, Eastern, Ashanti, Brong-Ahafo and Volta Regions. The Forestry Commission has divided the ten regions into Forest Districts. Five forest districts with off-reserve logging were randomly selected from the first five regions enumerated above. The Volta Region was excluded from the survey since it has little off-reserve logging activities.

Two probability sampling designs were used to select concessionaires and farmers respectively. The simple random sampling design was used in the selection of concessionaires. A list of all registered concessionaires actively involved in off-reserve logging in the five regions was compiled from the district offices of the Forest Service Division and 30 concessionaires selected at random from the list. A multistage area probability sampling design was used to select cocoa farmers. The choice of the sampling design is based on three main reasons. First, the study generalises to the whole population of cocoa farmers and concessionaires which is generally problematic when a non-probability sample is used (Creswell 2011; Fowler 2014). Second, the study sought to reach remotely located farmers in the forest districts. Lastly, the multistage sampling design was selected because an aggregate list of farmers is not readily available in Ghana (cf. Chadwick *et al*. 1984; Babbie 2013).

A three-stage cluster sampling was used to select farmers. The primary sampling units was the forest districts. Five of the forest districts in the five regions, one from each region, were randomly selected using the probability proportionate to size (PPS) technique (cf. Babbie 2013). This was to obtain a more representative sample of cocoa farmers (Barnett 1991; Babbie 2013; Fowler 2014). Following this, 40 villages involved in off-reserve logging (8 from each district) were randomly selected from the five districts through the PPS technique. The locations of the sampled communities are indicated in Figure 5.2. The study then proceeded to the selected communities to compile a list of cocoa farmers from which 10 farmers were randomly selected from each of the 40 selected communities for a face-to-face survey. Equal numbers of cocoa farmers were selected from each community to increase the precision of estimates from the sample (Fowler 2014).



Source: refer to Figure 3.1

Figure 5.2 Map of the HFZ of Ghana showing the locations of study communities

5.4.2 Survey questionnaires

The study used two sets of questionnaires, one for farmers and one for concessionaires, to gather empirical data for analyses. Due to the peculiarity of the research problem, the researcher could not locate any pre-existing instrument for subsequent adaptation. Therefore, new questionnaires were developed by the researcher. Samples of the two sets of questionnaires are attached in Appendices F and G.

Extensive literature review and focus group discussion are widely recommended in the literature as some of the first steps in improving the reliability and validity of a questionnaire (Chadwick *et al*. 1984; Mitchell and Carson 1989; Fowler 2014; Punch 2014). Following from this recommendation, an extensive literature review was carried out to conceptualise the study variables and identify the common measures of the study concepts that are most suitable to farmers. Further, a focused group discussion was used to enhance the reliability of the farmers' questionnaire.[14]

The researcher followed the advice from relevant literature to design reliable and valid instruments (e.g., Chadwick *et al*. 1984; Mitchell and Carson 1989; Neuman 2014; Rea and Parker 2014). First, there were screening questions in the farmers' questionnaire to filter respondents in order to obtain accurate responses from farmers. Second, the language was simplified and tailored to the specific vocabulary of the respondents (e.g., 'contractor' for concessionaires; 'operator' for chainsaw loggers). This was purposely done to enhance communication. Further, sensitive questions such as those on illegal timber harvesting were carefully and appropriately worded to obtain valid responses from farmers.

The questionnaires mixed both closed-ended and open-ended questions. However, the instruments made use of more close-ended questions to promote 'recognition' instead of 'recall', increase response rate to sensitive questions and ensure uniformity in response (cf. Chadwick *et al*. 1984; Fowler 2014; Nardi 2014; Neuman 2014; Rea and Parker 2014). This also offered more opportunities to, and lessened the cognitive burdens of farmers, who form the majority of the non-literate population in Ghana (GSS 2013a). One of the common criticisms of close-ended questions is that they force respondents to answer questions that they would not (Neuman 2014; Rea and Parker 2014). To overcome this problem, most of the closed-ended questions had a 'Don't know' option. This ensured that the questionnaires collect valid responses from respondents who were willing to respond to questions (cf. Mitchell and Carson 1989; Nardi 2014). Where the options given for a particular question were deemed to be non-exhaustive, 'Other: please specify' was added to the options in the farmers' questionnaire. This was to enable respondents to provide answers that exactly represent their opinions (cf. Rea and Parker 2014).

The questions in the questionnaire were carefully ordered to avoid biased responses. The questionnaire begins with interesting questions, such as those on farming experience, to develop rapport and trust for answering subsequent and sensitive questions (cf. Chadwick *et al*. 1984; Nardi 2014). Further, the directions of scaled questions were varied to prevent strategic behaviour and compliance bias (cf. Nardi 2014; Vogt *et al.* 2014). More importantly, multiple question items were used to measure the same variable(s) about

[14] The FGD and pilot survey were done for only the farmers' questionnaire due to time and financial constraints.

farmers such as the economic status of the farmer, illegal harvesting of on-farm trees, favourability of chainsaw operators and so on. These questions were purposefully and strategically placed in the questionnaires to check the reliability of responses, check strategic behaviour, reduce non-response to key study variables and test inter-item reliability (cf. Chadwick *et al*. 1984; Babbie 2013; Nardi 2014; Nuno and St. John 2015).

Apart from careful design, the farmers' questionnaire was pretested to test and enhance reliability and validity and subsequently improve upon the design of the questions (cf. Mitchell and Carson 1989; Frankfort-Nachmias and Nachmias 1996; Babbie 2013; Fowler 2014; Nardi 2014; Neuman 2014). The pretest involved 10 farmers. The result of the pre-test was used to test the construct and criterion validity of the instrument. Subsequent revisions of the questionnaires were made where necessary.

5.4.3 Face-to-face survey

The study conducted face-to-face surveys by interviewing sampled farmers and concessionaires. The face-to-face survey was the most appropriate and feasible data collection technique for the current study. Face-to-face surveys have several advantages over other survey techniques including higher response rate (due to probing) and reduction in strategic behaviour (through personal contacts) (Mitchell and Carson 1989; Fink 2002; Fowler 2014; Neuman 2014). Factors such as high illiteracy among farmers, poor telephone and cellular network in Ghana, lack of computer skills and poor internet connections precluded self-administration, telephone interviews, and web-based surveys.

Major issues confronting face-to-face surveys are interviewer biases, compliance behaviour by respondents, and involuntary errors. Interviewers can influence the result of an interview through misreading of questions, wrong explanations of questions, recording responses wrongly, intentionally recording their preferred option and failure to properly probe (Chadwick *et al.* 1984; Babbie 2013; Neuman 2014). Also, the perception of the respondent regarding the social class, expectations, and the demeanour and reactions of the interviewer may bias the respondent's responses to particular questions in the survey (Chadwick *et al.* 1984; Babbie 2013; Neuman 2014). The researcher followed the advice in relevant literature to overcome these issues (e.g., Chadwick *et al.* 1984; Babbie 2013; Neuman 2014). For instance, the explanations to each question were standardised by reading the question exactly as it appears in the questionnaire. As a native of Ghana, the interviewer was aware of the cultural perceptions with regards to appearance and took these into consideration during the fieldwork.

It has also been found that respondents tend to provide answers to please interviewers depending on the social desirability of the question (Chadwick *et al.* 1984; Mitchell and Carson 1989; Nardi 2014). To address this, the interviewer clearly explained to respondents that there is no right or wrong answers to the question and that it is only candid opinions that are required. Also, respondents were informed about the anonymity and confidentiality of responses and how the study will aggregate responses from other respondents for analyses. Ample time was provided to respondents to think through the questions (Chadwick *et al.* 1984; Mitchell and Carson 1989). These measures, together with others, helped to reduce compliance and involuntary errors.

5.5 Experimental Design

The study tested the predictions (hypotheses) of the game-theoretic models to observe how some policy scenarios will affect the behaviour of farmers and loggers. The experimental design is thus the most suitable and appropriate technique to evaluate such causal variables (cf. Webster and Sell 2007; Willer and Walker 2007a, 2007b; Babbie 2013; Neuman 2014). Two experimental designs were used to address the last two research questions of the study. These are the factorial experiment and the repeated measures design.

5.5.1 The factorial experiment on farmers

The factorial design is used to simultaneously examine the individual and combined effects of two or more independent variables (called factors) on a particular outcome (Vogt and Johnson 2011; Freund *et al.* 2010; Keppel and Wickens 2013; Neuman 2014). A 2×2×2 factorial experiment was conducted on farmers. The factors were the policy scenarios discussed in Section 5.1.2. They include *strict enforcement*, *full compensation* and *Right to trees*. The levels were the presence or absence of each of these factors.

Participants

The participants in the factorial experiment were the 400 farmers randomly selected for the survey. The 2×2×2 factorial design required eight treatment groups with each receiving varied combinations of the three factors (policy scenarios). One of these groups was a control group and received none of the stimuli. Table 5.1 shows the treatment groups and the type of stimuli administered to each of them. The 'Yes' indicates the presence of a factor whereas 'No' indicates the absence of a factor.

Table 5.1 Treatment groups and the type of treatment given

Groups / Factors	A	B	C	D	E	F	G	H
Strict enforcement	Yes	No	No	Yes	No	Yes	Yes	No
Full compensation	No	Yes	No	Yes	Yes	No	Yes	No
Right to trees	No	No	Yes	No	Yes	Yes	Yes	No

As advised in the literature (e.g., Freund *et al.* 2010; Creswell 2011; Neuman 2014), the 400 farmers were randomly assigned to these groups to avoid systematic biases. Each of the treatment groups consisted of 50 participants to achieve a balanced design.

Instrumentation

The survey questionnaire contained the experimental questions in the form of policy scenarios (Section D). The scenarios were described in the referendum format for participants to answer a series of questions regarding the scenario. The details of the scenarios as presented to farmers are captured in Table 5.2.

Table 5.2 Details of the three main scenarios in the factorial experiment

Scenario	**As presented in the questionnaire**
Status quo (for control group)	*Currently, you are not allowed to harvest trees on your farm and loggers seldom compensate farmers for crop damage. If the current tree tenure and compensation situation continues to persist, how willing or unwilling are you to do each of the following activities in the table below?*
Strict enforcement of the tree harvesting law	*Currently, you are not allowed to harvest trees on your farm. Suppose that the government wants to tighten the monitoring of forest activities in the off-reserve forests. As such, the government intends to contract some people from your community to actively monitor logging activities in the community. Anybody found felling a timber tree without the permit of the Forestry Commission will be immediately prosecuted. Suppose that you are uncertain of receiving compensation from loggers for crop damage but the government contracts some people from your community to monitor logging activities in your community as described above. In such a scenario, how willing or unwilling are you to do each of the following activities in the table below?*

Table 5.2 Details of the three main scenarios in the factorial experiment (continued)

Scenario	As presented in the questionnaire
Full compensation	*Currently, you are not allowed to harvest trees on your farm and loggers seldom compensate farmers for crop damage. Suppose that you are certain that loggers will fully compensate you for crop damages after logging on your farm, how willing or unwilling are you to do each of the following activities in the table below. In such a scenario, how willing or unwilling are you to do each of the following activities in the table below?*
Right to trees (Modified Taungya System)	*Currently, you are not allowed to harvest trees on your farm and loggers seldom compensate farmers for crop damage. The government is implementing the Modified Taungya System (MTS) where farmers who interplant trees with their crops in forest reserves and tend them to canopy level are paid 40% of the stumpage value of each tree. Suppose that you are uncertain of receiving compensation from loggers for crop damage but the government rolls out this MTS to the off-reserve forests when a logger permitted by the Forestry Commission (FC) fells any tree on your farm. In such a scenario, how willing or unwilling are you to do each of the following activities in the table below?*
Strict enforcement and full Compensation	*Currently, you are not allowed to harvest trees on your farm. Suppose that the government wants to tighten the monitoring of forest activities in the off-reserve forest. As such, the government intends to contract some people from your community to actively monitor logging activities in the community. Anybody found felling a timber tree without the permit of the Forestry Commission will be immediately prosecuted. Suppose that you are certain that loggers will fully compensate you for crop damages after logging on your farm and the government contracts some people from your community to monitor logging activities in your community as described above, how willing or unwilling are you to do each of the following activities in the table below?*
Strict enforcement and right to trees (MTS)	*Currently, you are not allowed to harvest trees on your farm. Suppose that the government wants to tighten the monitoring of forest activities in the off-reserve forest. As such, the government intends to contract two people from your community to actively monitor logging activities in the community. Anybody found felling a timber tree without the permit of the Forestry Commission will be immediately prosecuted.* *The government is implementing the Modified Taungya System (MTS) where farmers who interplant trees with their crops in forest reserves and tend them to canopy level are paid 40% of the stumpage value of each tree. Suppose that you are uncertain of receiving compensation from loggers for crop damage but the government rolls out this MTS to the off-reserve forest when a logger permitted by the Forestry Commission (FC) fells any tree on your farm. Suppose also that in addition to rolling out the MTS, the government contracts some people from your community to monitor logging activities in your community as described above, how willing or unwilling are you to do each of the following activities in the table below*

Table 5.2 Details of the three main scenarios in the factorial experiment (continued)

Scenario	As presented in the questionnaire
Full compensation and right to trees (MTS)	*Currently, you are not allowed to harvest trees on your farm and loggers seldom compensate farmers for crop damage. The government is implementing the Modified Taungya System (MTS) where farmers who interplant trees with their crops in forest reserves and tend them to canopy level are paid 40% of the stumpage value of each tree. Suppose that the government rolls out this MTS to the off-reserve forest when a logger permitted by the Forestry Commission (FC) fells any tree on your farm. Suppose also that you are certain of receiving compensation from loggers for crop damage, how willing or unwilling are you to do each of the following activities in the table below?*
Strict enforcement, right to trees (MTS) and full compensation	*Currently, you are not allowed to harvest trees on your farm. Suppose that the government wants to tighten the monitoring of forest activities in the off-reserve forest. As such, the government intends to contract two people from your community to actively monitor logging activities in the community. Anybody found felling a timber tree without the permit of the Forestry Commission will be immediately prosecuted.* *The government is implementing the Modified Taungya System (MTS) where farmers who interplant trees with their crops in forest reserves and tend them to canopy level are paid 40% of the stumpage value of each tree. Suppose that the government rolls out this MTS to the off-reserve forest when a logger permitted by the Forestry Commission (FC) fells any tree on your farm. In addition, the government contracts some people from your community to monitor logging activities in your community as described above. Suppose also that you are certain of receiving compensation from loggers for crop damage, how willing or unwilling are you to do each of the following activities in the table below?*

The use of a questionnaire as an instrument for the experiment raises questions of reliability, validity and interviewer-related biases. The measures discussed under Section 5.2 to improve reliability and validity and to reduce interviewer biases equally applied to the scenarios. In addition to these measures, specific steps relating to the reliability and validity of the scenarios were taken into account.

It is crucial to write a realistic scenario to prevent or minimise the occurrence of biased responses (Mitchell and Carson 1989). A realistic scenario is one that is familiar to participants and presents the key elements appropriately and clearly (Mitchell and Carson 1989). In addition, a realistic scenario is one that appears plausible to participants and is morally compatible (Mitchell and Carson 1989). Farmers were familiar with all three factors making up the scenarios. There are community members who sometimes detect and report illegal logging in their communities to the FSD without any economic incentives (Marfo 2010). Therefore, a scenario involving the monitoring of activities by state-recruited community members was not unfamiliar to participants. Further, a scenario concerning full compensation payment was very familiar to farmers since there are some farmers who are fully compensated for crop damage (Hansen 2011). Farmers were also familiar with the Modified Taungya System (MTS) in the forest reserves.

Further, the existence of these scenarios in different forms in the High Forest Zone made them plausible to participants. These scenarios were morally compatible since they exude the principles of equity in forest management in Ghana. Lastly, the key elements of the scenarios were presented to enable participants to clearly understand the scenarios to avoid misspecifications. The scenarios were explained clearly to improve their validity and enhance communication. Following from Mitchell and Carson (1989), the contexts within which participants answered the questions were well stimulated. Participants were asked to make the necessary hypothetical assumptions in order to standardise assumptions among participants and obtain reliable and valid responses. More sentences were used to explain the scenarios to allow participants to think through the questions. This was aimed at enhancing communication and reducing random errors (cf. Chadwick *et al.* 1984; Mitchell and Carson 1989). The use of the face-to-face survey also provided the opportunity to further explain the scenarios to the participants to increase their understanding.

Experimental procedure

The experiment was carried out as part of the face-to-face survey. Participants responded to a series of questions relating to on-farm tree retention and illegal harvesting of trees after being exposed to some stimuli. Thus, there was no pretest. Apart from the participants in the control group, each of the other participants was presented with a scenario different from the current off-reserve tenure and compensation situation. Participants in the control group responded to the same questions based on a scenario that assumes that the current situation remains unchanged.

Internal and external validity

Many factors affect the internal and external validity of experimental designs. Factors that affect internal validity include history, maturation, selection biases, testing effects, instrumentation, experimental mortality, statistical regression, diffusion of treatment, compensatory behaviour, compensatory rivalry, demoralisation and experimenter biases

(Campbell and Stanley 1963; Cook and Campbell 1979; Chadwick *et al*. 1984; Shadish *et al.* 2001; Creswell 2012; Babbie 2013; Neuman 2014). History, maturation and mortality did not affect the study because the experiment did not continue over a long period of time (Babbie 2013; Neuman 2014). It is a one short experiment that lasted for about 10 minutes. There was no testing effect because the experiment did not administer any pretest to participants. Further, diffusion was not a threat to the experiment since participants did not know each other. Participants were randomly assigned to groups to curtail selection biases (Creswell 2011; Charness *et al.* 2012; Babbie 2013; Neuman 2014). Also, the experiments used only scenarios without providing any form of physical stimuli that could serve as a source of compensatory behaviour, rivalry or demoralisation among participants.

Factors known to affect the external validity of experiments include the peculiar characteristics of participants, the experimental setting and the experimental circumstances. These factors interact with the experimental stimuli thereby affecting the generalizability of the research findings (Campbell and Stanley 1963). To ensure the external validity of the results, generalisation was restricted to farmers in the off-reserve forests of the HFZ of Ghana where necessary (cf. Creswell 2011, 2012). More importantly, the study strategically used the *posttest-only control group design* through randomisation to control threats to both internal and external validity (Campbell and Stanley 1963; Babbie 2013). Through randomisation and equivalent groups, it has been demonstrated that this design has the advantage of improving the validity of an experiment (Campbell and Stanley 1963; Babbie 2013).

5.5.2 Repeated-measures experiment on concessionaires

The repeated-measures design involves exposing the same experimental participants to multiple stimuli to observe how they respond to each of these treatments (Charness *et al.* 2012). This design is deemed suitable when the researcher has few participants and little time (Charness *et al.* 2012; van Peer *et al.* 2012). The repeated measures design was therefore chosen for the experiment on concessionaires because of their scarcity in the off-reserve landscape (cf. Dumenu 2010; Hansen 2011).

Participants

The participants in this experiment were the concessionaires operating in the off-reserve landscape. A sample of 30 concessionaires was recruited and exposed to all the scenarios. Apart from the two main scenarios discussed earlier, the experiment also included concessionaires' likelihood to pay compensation should farmers continue to use existing actions in the *status quo* without any external intervention.

Instrumentation

A survey questionnaire was used to administer the experiment. The questionnaire consisted of a set of scenarios described in the referendum format for participants to answer three questions relating to the compensation of farmers for crop damage. There were two sets of scenarios in the concessionaires' questionnaire. The first set consists of scenarios of external intervention in the compensation conundrum. Table 5.3 captures the details of these scenarios.

Table 5.3 Details of scenarios on external intervention in the repeated-measures experiment

Scenario	**As presented in the questionnaire**
Enforcement of the compensation law	*Currently, farmers are complaining that they seldom receive compensation from concessionaires for damages to crops during logging. Suppose that the Forest Service Division (FSD) restrains you from conveying your logs to the sawmill until you have fully paid farmers their due compensation. In such a scenario, how likely or unlikely are you to take each of the following actions in the table below?*
Third-party litigation	*Suppose that a third party private agency takes charge of the compensation negotiation and payment process on behalf of farmers. This agency has the ability to pursue compensation payment through persuasion and the legal system. The affected farmers will bear 10% of their entitlements as service fee of the private agency. However, if the logging company fails to pay compensation before conveying its logs, every cost associated with the pursuit of payment by the private agency will be borne by the logging company. In such a scenario, how likely or unlikely are you to take each of the following actions in the table below?*

The second set of scenarios consists of scenarios relating to farmers' use of individual actions to pursue compensation without the external interventions captured in Table 5.3. Details of these scenarios are captured in Table 5.4

Issues relating to the reliability and validity of the questionnaire have been discussed under the survey design section. In addition to that, two of the three questions following the scenarios were redundant questions aimed at checking the reliability of responses to the main question.

Table 5.4 Details of scenarios on farmers' independent actions in the repeated-measures experiment

Scenario	As presented in the questionnaire
Preamble: *Suppose that you have not paid full compensation to farmers, but farmers are determined to pursue their compensation. Please answer the following questions relating to each of the strategies of farmers*	
Persuasion	*How likely or unlikely are you to do each the following if a farmer uses persuasion to convince you to settle the compensation?*
Mediation	*How likely or unlikely are you to do each of the following if a farmer seeks the assistance of a chief, forest official or a local government official (DCE, Assemblyman) to pursue compensation for crop damage?*
Litigation	*How likely or unlikely are you to do each of the following if a court of law orders you to pay the compensation due a farmer within a specified time period?*
Blockading	*How likely or unlikely are you to do each of the following if a group of aggrieved farmers blockade your attempts to convey your logs because you have not paid them the full compensation due them?*

In terms of realism, the scenarios were familiar, plausible, morally compatible and well presented. The scenarios relating to enforcement and third-party litigation were familiar to concessionaires in Ghana. It is a legal requirement that concessionaires pay compensation before Conveyance Certificates are issued (FC 1998). It is the implementation of this requirement that is lacking. Thus, it was not strange for loggers to encounter such a scenario in the experiment. Third-party litigation is common in the mining sector in Ghana and this is well known to Ghanaians, including concessionaires. Concessionaires were very familiar with the *status quo* strategies used by farmers to pursue compensation (Marfo and Schanz 2009). The fact that these scenarios have been implemented in Ghana (some in the logging sector) makes them plausible. The scenarios were also morally compatible because they aimed at settling compensation disputes in the off-reserve landscape. Finally, the elements in the scenario were clearly presented and explained in the questionnaire to enhance communication.

Experimental procedure

The experiment was carried out as part of the face-to-face survey using Sections C and D of the loggers' questionnaire. After each scenario had been presented, participants responded to three separate questions regarding their likelihood to pay compensation for crop damage. These include questions on likelihood not to pay any form of compensation, pay part of the compensation and pay full compensation before conveyance of logs.

Internal and external validity

The numerous factors that affect the validity of experimental designs in general have been outlined under the factorial design. Apart from selection biases, the measures to mitigate these threats to validity also hold for the repeated-measures design. Selection biases do not affect the validity of repeated-measures design because participants are their own control (Charness *et al.* 2012; van Peer *et al.* 2012; Vogt *et al.* 2014). However, the validity of the repeated-measures design is threatened by order effects (carry-over and learning effects) and demand effects (Freund *et al.* 2010; Charness *et al.* 2012; van Peer *et al.* 2012). A mechanism for mitigating order and demand effects is complete *counterbalancing*. Counterbalancing is randomising the order of questions to mitigate the effect of the sequence of questions on responses (Freund *et al.* 2010; van Peer *et al.* 2012). Each sequence of the questions or stimuli was used on at least one of the participants. The study used different question orders to counterbalance order and demand effects. Each participant was randomly assigned to one of these sequences. Though some scholars do not see counterbalancing as a complete solution to confounding (cf. Charness *et al.* 2012), it nonetheless, helps to mitigate threats to validity caused by question order (Freund *et al.* 2010; van Peer *et al.* 2012). Through proper design, ordering, counterbalancing and interviewing, repeated-measures design can prove to be more statistically and theoretically robust (Charness *et al.* 2012; Vogt *et al.* 2014).

5.6 Variables used in the Empirical Analyses

The study used several variables in addressing the research questions. Details of these variables are provided under their respective analysis chapters (Chapters 6 and 8). The dependent variables for the ANOVA (from the experimental designs) were based on behavioural willingness and expectations (likelihood). The experiments aimed at predicting the behaviour of participants if opportunities or constraints in the scenarios are present. In circumstances such as this, ‘proximal antecedents to behaviour’ are used to predict actual behaviour (Pomery *et al.* 2009, pp. 894-895). These proximate predictors include behavioural intentions, expectations and willingness (Fishbein and Ajzen 1975; Warshaw and Davis 1985; Ajzen 1991; Pomery *et al.* 2009). Intentions are seen as the closest predictors of planned behaviour or reasoned actions (Ajzen and Fishbein 2005). These are premeditated actions that are the goal state of the decision-maker (Pomery *et al.* 2009). Behavioural expectation connotes 'individual's estimation of the likelihood that he or she will perform some specified future [behaviour]' (Warshaw and Davis 1985, p. 215). However, behavioural willingness refers to an individual's 'willingness to perform a certain [behaviour] in situations that are conducive to that [behaviour]' (Pomery *et al.* 2009, pp. 896). It does not involve much premeditation like behavioural intention (Pomery *et al.* 2009).

Research has demonstrated that these antecedents have high correlation with actual behaviour (Gibbons and Gerrard 1997; Armitage and Conner 2001; Ajzen and Fishbein 2005; Pomery *et al.* 2009). Due to this, they have been widely applied in several fields of study (e.g., Mitchell and Carson 1989; Gibbons and Gerrard 1995; Gerrard *et al.* 2005; Krysan *et al*. 2009; Pomery *et al.* 2009; Heckman *et al*. 2011; Armstrong *et al*. 2012). However, the use of any of these three behavioural predictors depends on the purpose of the study and the parameters of the scenario. When the study deals with a goal state, such as in the theory of planned behaviour, behavioural intention is a better predictor of behaviour (Fishbein and Ajzen 1975; Ajzen 1991; Ajzen and Fishbein 2005). When the scenario involves both premeditation and an assessment of some influential factors (personal and situational), behavioural expectation is seen as a better predictor of behaviour than intentions (Gibbons and Gerrard 1997; Pomery *et al.* 2009). Behavioural willingness is, however, a preferred predictor when a scenario presents an opportunity that, hitherto, will not be available. Therefore, behavioural willingness was more suitable for the experiment on farmers in this study since it sought to observe farmers' willingness to undertake certain actions provided circumstances conducive to (or constraining) certain types of behaviour in the off-reserve landscape were present. In contrast, behavioural expectation (likelihood) was used for the concessionaires' experiment since the study sought to examine their likelihood to fully and promptly compensate farmers when certain constraining measures are put in place.

5.7 Data Analysis Methods

Data from the surveys were entered into SPSS version 22 for analyses. The database was thoroughly checked and edited to make sure the exact responses for each case was entered correctly. The survey achieved 100% response rate for the farmers survey. However, some questions relating to the profile of logging firms were not answered by some concessionaires since they felt these are confidential. Non-response to individual questions were represented as missing data in the SPSS. Missing values were removed case-wise in respective analyses. An overview of the techniques used for the empirical analyses is given below.

5.7.1 Descriptive analyses, *t*-tests and one-way ANOVA

The characteristics and current behaviour of farmers and concessionaires were presented using descriptive statistics, *t*-tests and one-way ANOVA, where applicable. Frequencies, percentages, median, mean and standard deviation were used to report the characteristics and current behaviour of farmers and concessionaires. One-way ANOVA was used to test whether there are significant differences in shade tree density among the three main varieties of cocoa cultivated by farmers in the off-reserve forests. A paired-sample *t*-test was also used to test whether there is a significant difference between the types of shade trees (non-timber and timber trees) retained by farmers. An independent-sample *t*-test was used to test the difference in shade tree density between farmers with illegal logging intentions and those who did not have illegal logging intentions for retaining shade trees. Levene's test was used to check the assumption of homogeneity in the *t*-tests and the ANOVA. The one-way ANOVA and the independent *t*-test violated the assumption of homogeneity. Subsequently, the Welch *F*-ratio was used to correct the ANOVA. Also, the results corresponding to 'equal variance not assumed' were reported for the independent *t*-test. Statistical significance for all empirical models in this study was set at a *p*-value of 0.05.

5.7.2 Binary logistic regression and ordinary least squares (OLS) analyses

Two binary logit models were fitted to examine the factors that influence farmers' receipt of compensation from concessionaires and their involvement in illegal logging. The logit model estimates the probability π of an event Y_i occurring as a function of predictor variables, $X_1, X_2 \ldots\ldots X_n$ (Chatterjee and Hadi 2006). This relationship is basically represented as:

$$\pi = \frac{e^{b_0+b_1X_1+b_2X_2+b_3X_3+\ldots+b_nX_n}}{1+e^{b_0+b_1X_1+b_2X_2+b_3X_3+\ldots+b_nX_n}} \tag{5.1}$$

where b_0 is the 'intercept' and b_1 to b_n are the regression coefficients. Using logarithmic transformation, this probability function can be expressed as:

$$ln\left(\frac{\pi}{1-\pi}\right) = b_0 + b_1X_1 + b_2X_2 + bX_3 + \ldots + b_nX_n \quad (5.2)$$

The marginal effect for each of the independent variables in the logit models were computed for the discrete change in each variable (from 0 to 1) while holding the other variables constant at their means.

Likewise, multiple linear regression was used to analyse the factors influencing farmers' choice of blockading and mediation in compensation conflicts. The OLS models for each of the two dependent variables were in the form:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \ldots + \beta_nX_n + \varepsilon \quad (5.3)$$

where Y is the dependent variable, β_0 is the intercept; β_1 to β_n are the coefficients of the corresponding predictors (X_1 to X_n) in the model and ε is the error term. The full description of the models including their variables are given in Chapters 7 and 8.

The study used standard diagnostic tests to check for any violations of assumptions such as multicollinearity, homoscedasticity, linearity, normality and independence of errors in the OLS and logit models (cf. Chatterjee and Hadi 2006; Freund *et al.* 2010; Field 2013; van Peer *et al.* 2012). The models were found to have satisfactorily met these assumptions. Bias-corrected and accelerated (bca) bootstrapping was used to further enhance the robustness of all the regression models.

5.7.3 Repeated-measures ANOVA

A repeated-measures ANOVA was used to test hypotheses on concessionaires' likelihood to pay compensation to farmers. *Omega squared* (ω^2) was computed manually to estimate the overall effect size of the model using the formulae below:

$$\omega^2 = \frac{\left[\frac{k-1}{nk}(\mathrm{MS_M} - \mathrm{MS_R})\right]}{\mathrm{MS_R} + \frac{\mathrm{MS_B} - \mathrm{MS_R}}{k} + \left[\frac{k-1}{nk}(\mathrm{MS_M} - \mathrm{MS_R})\right]} \quad (5.4)$$

where; $\mathrm{SS_B} = \mathrm{SS_T} - \mathrm{SS_M} - \mathrm{SS_R}$;

(5.5)

$$\mathrm{SS_T} = s^2_{\mathrm{grand}}(N-1); \quad (5.6)$$

$$\mathrm{MS_B} = \frac{\mathrm{SS_B}}{N-1}\,. \tag{5.7}$$

Also, *k* is the number of conditions; *n* (= *N*) is the number of participants in each condition; MS_M is the model mean squares; MS_R is the residual mean squares; MS_B is the between-subjects mean squares; SS_B is the between-subjects sum of squares; SS_T is the total sum of squares; SS_M is the model sum of squares; SS_R is the residual sum of squares; and s^2_{grand} is the grand variance (Field 2013, p. 566).

The effects sizes of the individual factors in the model were manually computed using:

$$r = \sqrt{\frac{F(1, df_R)}{F(1, df_R) + \ df_R}} \tag{5.8}$$

where, *F* is the *F*-statistic and df_R is the degree of freedom for residuals (Field 2013). Mauchly's test was used to test for the assumption of sphericity in the repeated-measures ANOVA (Freund *et al.* 2010).

5.7.4 Mixed-design ANOVA and factorial ANOVA

A mixed-design ANOVA (with data from the factorial experiment) was used to test a hypothesis on farmers' tree retention behaviour under the hypothetical scenarios. Post-hoc tests (multiple pairwise comparison) were conducted to examine the differences in farmers' willingness among the eight treatment groups in the factorial experiment. Significance levels of the Post-hoc tests were adjusted using the Šidák correction to control the familywise error rate and circumvent the loss of statistical power associated with the Bonferroni correction.

Hypotheses on farmers' willingness to engage in illegal logging under the policy scenarios were tested using a 2× 2×2 factorial ANOVA. The linear model fitted was in the form:

$$\begin{aligned} WIL = \beta_0 + \beta_1(Enf) + \beta_2(Comp) + \beta_3(Right) + \ \beta_4(Enf \times Comp) \\ + \beta_5(Enf \times Right) + \beta_6(Comp \times Right) \\ + \beta_7(Enf \times Comp \times Right) \\ + \varepsilon \end{aligned} \tag{5.9}$$

where *WIL* is willingness to engage in illegal logging; β_0 is the intercept; β_1 to β_7 are effect sizes; ε is the error term; *Enf* is Enforcement; *Comp* is Full compensation; and *Right* is Right to trees. *Omega squared* (ω^2) was computed manually to estimate the effect size of each of the main and interaction effects (Field 2013; Vogt *et al.* 2014) using the formulae below:

$$\omega^2_{\text{effect}} = \frac{\hat{\sigma}^2_{\text{effect}}}{\hat{\sigma}^2_{\text{total}}} \tag{5.10}$$

where;

$$\hat{\sigma}^2_{total} = \hat{\sigma}^2_{enf} + \hat{\sigma}^2_{comp} + \hat{\sigma}^2_{right} + \hat{\sigma}^2_{enf\times comp} + \hat{\sigma}^2_{enf\times right} + \hat{\sigma}^2_{comp\times right} + \hat{\sigma}^2_{enf\times comp\times right} + MS_R; \tag{5.11}$$

$$\hat{\sigma}^2_{enf} = \frac{(a-1)(MS_{enf} - MS_R)}{nabc}; \tag{5.12}$$

$$\hat{\sigma}^2_{comp} = \frac{(b-1)(MS_{comp} - MS_R)}{nabc}; \tag{5.13}$$

$$\hat{\sigma}^2_{right} = \frac{(c-1)(MS_{right} - MS_R)}{nabc}; \tag{5.14}$$

$$\hat{\sigma}^2_{enf\times comp} = \frac{(a-1)(b-1)(MS_{enf\times comp} - MS_R)}{nabc}; \tag{5.15}$$

$$\hat{\sigma}^2_{enf\times right} = \frac{(a-1)(c-1)(MS_{enf\times right} - MS_R)}{nabc}; \tag{5.16}$$

$$\hat{\sigma}^2_{comp\times right} = \frac{(b-1)(c-1)(MS_{comp\times right} - MS_R)}{nabc}; \tag{5.17}$$

$$\hat{\sigma}^2_{enf\times comp\times right} = \frac{(a-1)(b-1)(c-1)(MS_{enf\times comp\times right} - MS_R)}{nabc}. \tag{5.18}$$

Also, $\hat{\sigma}^2$ is the estimated variance component; *MS* is the mean square; *R* is the residual; *a* is the number of levels of enforcement; *b* is the number of levels of full compensation; *c* is the number of levels of right to trees; and *n* is the number of participants per treatment group (cf. Field 2013, p. 537).

Simple effects analyses were conducted on the significant higher-order interaction to examine the effects of the individual scenarios in the interactions. Interaction plots were used to assist in the interpretation of the effect of each scenario at the factor level combination of the other scenarios in the significant higher-order interaction (cf. Freund *et al.* 2010; Field 2013). Equation 5.8 was used to manually compute effect sizes in the contrasts obtained from the simple effect analyses. The study checked for the assumptions of homogeneity of variance of the factorial ANOVA using Levene's test. Both the Levene's and Mauchly's tests were used to check for homogeneity of variance and sphericity in the mixed-design ANOVA. The mixed design ANOVA, however, violated the sphericity assumption, and the Huynh-Feldt value was used to correct the *F*-statistic (Field 2013).

5.8 Justification for Analysing Likert data with Parametric Tests

The experimental data obtained from the survey were 5-point Likert data. These were used as dependent variables and analysed using ANOVA and OLS in Chapter 8. However, the use of such parametric tests in analysing Likert data has received some criticisms in the literature. Critics argue that analysing Likert data with parametric tests is inappropriate and results lack robustness because such data usually have non-normal distributions, unequal variances and non-linearity (Kuzon *et al.* 1996; Jamieson 2004; Bishop and Herron 2015). They therefore suggest the use of non-parametric tests for the analysis of Likert data. However, such criticisms have been found to be more theoretical than evidential (Carifio and Perla 2008; Wadgave and Khairnar 2016). Scholars have long provided compelling evidence to demonstrate the robustness and appropriateness of analysing Likert data with parametric tests (e.g., Dunlap 1931; Pearson 1931, 1932a, 1932b; Havlicek and Peterson 1976; Norman 2010). Moreover, existing evidence demonstrates that parametric tests are more suitable for Likert scale data than non-parametric tests (Sullivan and Artino 2013).

ANOVA relies on the assumption of the normal distribution of means and according to the Central Limit Theorem (CLT), the means of sample sizes of more than 5 to 10 per group are approximately normal irrespective of the distribution of the data (Norman 2010). Each of the eight groups in the farmers' experiment in the current study had 50 farmers and there were 30 concessionaires in the repeated-measures experiment. These sample sizes, respectively, exceed the minimal sample size required by the CLT for normal distribution of means. With such large sample sizes, the results of the ANOVA on the 5-point Likert data obtained from the experiments are expected to be robust regardless of violations in the assumption of normal and symmetric distributions (cf. Norman 2010).

The above argument from the CLT cannot justify the use of OLS on the 5-point Likert data, though. This is because OLS deals with variations rather than central tendency (Cronbach 1957). Nevertheless, there is compelling evidence outside the CLT to justify the use of OLS on the Likert data in this study. Havlicek and Peterson (1976) and Norman (2010) have, respectively, used simulated and real data to demonstrate that regression results are robust even when assumptions of normality and non-linearity are grossly violated. The results are also insensitive to the type of scale used. For instance, Norman (2010) created 10-point, 5-point and 4-point scales from the same data set and calculated and compared the Pearson correlation (r) for each of these scales. He found identical values for the different scales. He concluded that 'parametric statistics can be used with Likert data, with small sample sizes, with unequal variances, and with non-normal distributions, with no fear of ''coming to the wrong conclusion''' (Norman 2010, p. 631).

5.9 Ethical Considerations

The study obtained ethics approval from the Human Research Ethics Committee at the University of Adelaide (refer to letter in Appendix A). This was after it had been reviewed and judged to have met the requirements of the Australian Code for Responsible Conduct of Research. The researcher sought the consent of all participants in the survey before administering questionnaires. Participants were informed of the purpose of the study. They were also assured of the confidentiality of their responses. To ensure anonymity, the names of the respondents were not collected during the survey. Also, the study aggregated the responses from participants. Therefore, individual responses are non-identifiable. As a condition for ethics approval, the names of the 40 communities sampled for the survey have been withheld. This is to further protect the identity of the survey respondents.

5.10 Conclusion

This chapter has detailed out the methodological framework for this study. A game-theoretic approach is adopted to theoretically respond to the research questions. The survey and the experimental designs are combined in the study to collect empirical data for analyses. Further, the policy scenarios examined in the game-theoretic models have been presented. The simple random sampling and the area probability sampling techniques were used to randomly select 400 farmers and 30 logging companies for a face-to-face survey using a questionnaire. Issues relating to the reliability and validity of the questionnaires and the face-to-face survey method have been discussed. Factors that may affect the internal and external validity of the experimental designs have been highlighted and the measures used to mitigate such threats discussed. Also, the statistical techniques used to draw inferences from the empirical data are highlighted. The chapter has therefore presented and justified the methods, steps and processes used to conduct theoretical and empirical analyses to achieve the aims of the research.

Chapter 6. Game-theoretic Analyses of Behaviour in the Off-reserve Forests

This chapter presents formal theoretical analyses of the behaviour of the major actors in off-reserve conflicts and how they can be changed from a *rational choice perspective*. It provides a game-theoretic analyses of the behaviour of the actors in the off-reserve setting and provides a theoretical explanation for such non-cooperative behaviour. It also presents a game-theoretic analyses of several policy options to influence the behaviour of farmers and concessionaires. This provides the theoretical basis for the policy options tested and discussed in Chapters 8 and 9, respectively.

The chapter is divided into three main parts. The first part (Section 6.2) presents and analyses compensation games to explain why some farmers receive part or full compensation whereas others receive nothing. It also aims at investigating the most rational actions to be adopted by different *types* of farmers to independently pursue compensation should the *status quo* prevail; and whether concessionaires will pay full compensation should farmers continue adopting these actions. The second part (Section 6.3) presents a forest management game to explain the current uncooperative behaviour of farmers, concessionaires and the State in the off-reserve forests. Part three (Section 6.4) presents two variants of the forest management game introduced in Section 6.3 with the aim of identifying the most optimal option(s) to effectively induce sustainable forest practices among farmers and ensure that concessionaires fully compensate farmers for crop damage.

6.1 Categories of Games Analysed

Two categories of game models are analysed in this chapter (Table 6.1). The first category consists of two-player compensation games and are used to analyse the behaviour of concessionaires and farmers when farmers independently pursue compensation within the prevailing off-reserve social environment without external interventions. Five variants of the compensation game are presented. These include three models of complete information corresponding to the *types* of farmers considered in the game. There are also two models of incomplete information which analyse the compensation interactions between farmers and different *types* of concessionaires. The independent actions of farmers considered in the compensation game models include:

- Persuasion;
- Mediation;
- Litigation; and
- Blockading

Table 6.1 Types of models analysed

Categories of Games	Types of models	Focus
Compensation games	Compensation game for unconnected non-leader with complete information	Compensation interactions between the unconnected non-leader and a typical concessionaire
	Compensation game for connected non-leader with complete information	Compensation interactions between the connected non-leader and a typical concessionaire
	Compensation game for leaders with complete information	Compensation interactions between the leader and a typical concessionaire
	Compensation game for unconnected non-leader with incomplete information	Farmer-concessionaire compensation interactions when the type of concessionaire is not known to the unconnected non-leader
	Compensation game for connected non-leader with incomplete information	Farmer-concessionaire compensation interactions when the type of concessionaire is not known to the unconnected non-leader
Forest management games	Original forest management game	Rationale behind current behaviour of State, farmers and concessionaires
	Modified forest management game	Effect of State's commitment (policy scenarios) on behaviour of farmers and concessionaires
	Modified forest management game with third-party litigation	Addressing concerns of legality in the modified forest management game through a credible threat of third-party litigation

The second category of games are three-player forest management models involving the government (State), a farmer and a concessionaire. These are games of complete information and are used to evaluate policy options to resolve tenure and compensation conflicts and induce sustainable behaviour among farmers. Unlike the compensation games, the forest management games have three players, considered both the tenure and compensation conflicts, and involved external interventions in on-farm logging compensation. Further, they did not consider independent actions by farmers to pursue compensation because the compensation games revealed that the average farmer is less likely to be fully compensated by concessionaires without any external interventions.

Three main forest management models are analysed in this chapter, namely the original forest management model, the modified forest management model and the modified forest management model with third-party litigation. The modified forest management model is a variant of the original forest management game with some hypothetical *commitments* (policy scenarios) from the State. The modified forest management model with third-party litigation is an extension of the modified game with a credible threat of compensation litigation from a capable third-party advocate. The hypothetical policy scenarios considered in the forest management games include:

- Strict enforcement of the tree harvesting law only
- Full compensation only
- Rights to trees (Modified Taungya System) only
- Strict enforcement and full compensation only
- Strict enforcement and right to trees only
- Full compensation and right to trees only
- Strict enforcement, right to trees and full compensation
- Enforcement of the compensation law by the State (FSD)
- Third-party compensation litigation

6.2 Pursuing Compensation Independently: The Compensation Games

The literature reports that most farmers do not receive full compensation for crop damage from concessionaires. The compensation models provide a theoretical explanation for this situation. They also theoretically address the question of whether farmers will receive full compensation if they continue to independently pursue compensation within the prevailing social and legal system. Following are variants of a compensation game model between the farmer and the concessionaire within the *status quo*.

6.2.1 Structure of the game

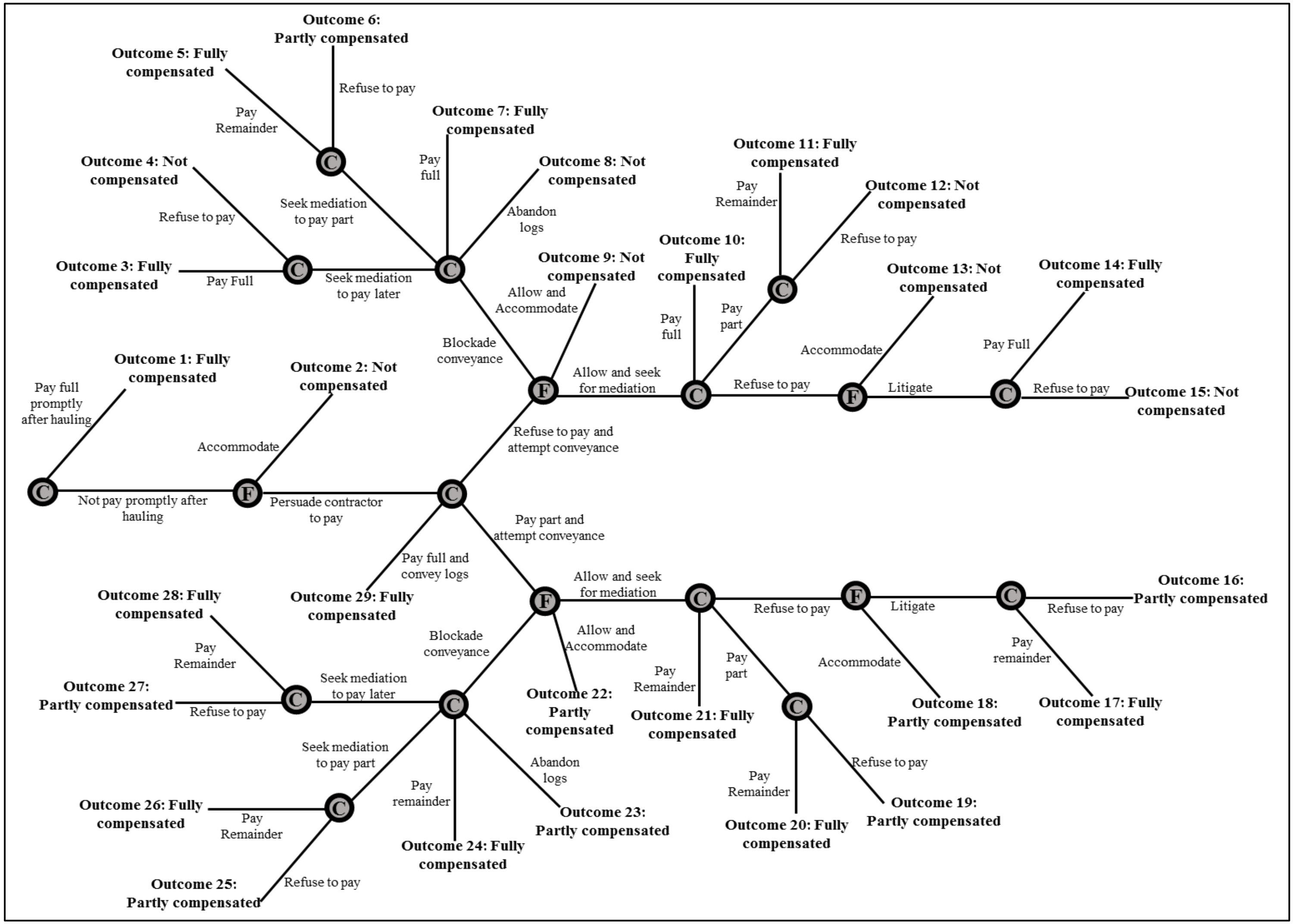
The game, as depicted in Figure 6.1, starts after felling and hauling when the extent of damage is assessed and compensation amount negotiated. The concessionaire (C) moves first to decide whether to promptly pay the full compensation or not. If the concessionaire pays fully, the game ends. If the concessionaire does not pay fully after hauling and negotiation, the farmer (F) moves to either accommodate or persuade the concessionaire to pay the compensation before conveyance.[15] The game ends if the farmer chooses to accommodate. However, if the farmer uses persuasion, the concessionaire now moves to either pay the full amount and convey the logs; pay part of the amount and attempt conveyance; or decline to pay and attempt conveyance. The game ends if the concessionaire chooses to pay the full compensation. However, the farmer is called on to make a move if the concessionaire either chooses to pay part of the compensation and attempts conveyance or declines to pay and attempts conveyance.[16] At this step, the farmer either allows conveyance and accommodates, allows conveyance and seeks for mediation from higher authority or blockades conveyance.[17] Note that the same set of actions are available to the farmer irrespective of the concessionaire's action leading to this step.

The game ends if the farmer accommodates. However, if the farmer uses mediation, the concessionaire is called upon to decide whether to pay the full amount owed, pay part or refuse to pay through the mediation process. If the concessionaire chooses to pay part of the amount during mediation with a promise to pay the remainder later, the concessionaire is called upon again to fulfil or break the promise. Nonetheless, if the concessionaire refuses to pay any amount after the mediation process, the farmer decides whether to accommodate or litigate through the court system. If the farmer litigates, the concessionaire makes the final move to pay the amount owed or not and the game ends. For simplicity, it is assumed that concessionaires will pay the full compensation if they lose the court cases and vice versa. If the farmer blockades the conveyance of logs, the concessionaire will have four options to choose from. The concessionaire will have to choose either to seek for mediation to pay the full amount later; seek mediation to pay part of the amount owed with a promise to pay the remainder later; pay the full amount owed; or abandon the logs. The game ends if the concessionaire chooses either to pay the full amount owed or abandon the logs.

[15] Accommodation is when the farmer ceases to pursue compensation further whereas persuasion refers to the act of verbally trying to convince the concessionaire to pay the compensation. Also, conveyance is the transportation of logs from the forest area to faraway sawmills.

[16] For simplicity, part payment is used here to refer to half of the amount owed. This is in accordance with the rural Ghanaian practice, where part payment usually corresponds to half of the amount owed.

[17] Third-party mediating agents are people in leadership positions in the village. In contrast, blockading refers to any forceful action to physically impede the conveyance of logs. These actions include, but are not limited to, blocking of access roads, deflation of tyres of conveyance vehicles and violent attacks.



Source: Author’s construct, 2017

Figure 6.1 Underlying compensation game model

However, if the concessionaire chooses to use mediation, the concessionaire will have to choose whether to fulfil or break the promise and the game ends.[18] Admittedly, the game can continue if the concessionaire refuses to honour promises after mediation or refuses to pay after litigation. However, this is not the case in the real world because farmers give up pursuing compensation after litigation or blockading (Marfo and Schanz 2009).

6.2.2 Payoffs of the game

The farmer's expected value of full compensation is α_F. This value is affected by delayed payment. Delayed payment refers to any payment received after conveyance. Thus, α_F reduces by $\mathfrak{f}_F$ if the concessionaire does not pay any amount before conveying the logs but pays the full amount during the mediation interaction. However, this reduction doubles if the concessionaire pays the full amount after litigation because there has been a further delay. Also, if the concessionaire pays part of the amount before conveyance, delayed payment will only affect the value of the amount paid later. Therefore, the cost of delay will only be proportional to the outstanding compensation amount. For instance, the delay cost becomes $\frac{1}{2}(\mathfrak{f}_F)$ if the concessionaire pays half of the compensation and pays the remainder during mediation. Again, if the farmer chooses to use persuasion, the farmer bears a persuasion cost of $\varkappa$. If the farmer accommodates without persuading, the farmer bears the cost of accommodation which is the social reproach suffered for chickening out so easily. This cost is valued at γ.[19] A blockading cost, φ_F, is incurred by the farmer for choosing to use blockading. Also, the farmer incurs η_F for choosing to use mediation to pursue compensation. However, the farmer incurs θ_F for choosing to use litigation.

The payoff parameters of the concessionaires are similar to that of the farmer. The cost of full compensation to the concessionaire is α_C. Also, the concessionaire gains from delaying the payment of compensation. For instance, the concessionaire gains $\mathfrak{f}_C$ if the full amount is paid after mediation and this doubles if the full amount is paid after litigation.[20] The concessionaire obtains a compensation reputation valued at $\jmath$ if full compensation is paid promptly after hauling. On the contrary, the concessionaire suffers a loss of compensation

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[18] It is assumed that the farmer will accede to the intervention of the mediating agent when blockading occurs. This is consistent with the Ghanaian norm (especially in rural areas) which demands that the plea of an 'elder' be accepted irrespective of the circumstances.

[19] Further variations of this cost will be introduced later in the analysis, depending on the *type* of farmer involved in the game.

[20] The value, $\mathfrak{f}_C$, represents the satisfaction the concessionaire obtains by keeping the compensation amount for some time before paying or the luxury of time to raise the compensation amount. It can also represent the value of expected interest the concessionaire obtains for investing the compensation amount within the period of delay.

reputation if the full compensation is not paid before conveyance of logs.[21] Also, a defiance cost, $\hbar$, is incurred by the concessionaire for defying mediating authorities by not cooperating or by breaking a mediated promise. Again, the concessionaire bears a litigation cost of θ_C if the farmer chooses to litigate. Blockading delays conveyance of logs. Subsequently, the concessionaire bears the cost of delayed conveyance, φ_C, if the farmer blockades.[22] A mediation cost, η_C, is incurred by the concessionaire for choosing to seek for mediation during blockading. However, the cost of abandonment, σ, is borne by the concessionaire for abandoning the timber logs during blockading.[23] The payoff functions for each player are shown in Figures 6.2 to 6.4 in the order of appearance of the players.

Both concessionaires and farmers can consist of several *types*. However, the models and analyses presented in this section assume that the concessionaire is a 'typical' concessionaire—a non-altruistic concessionaire. Only the farmer's type will be varied in the equilibrium analyses with complete information. A farmer can be one of several types based on several characteristics. However, of much importance to compensation interactions with concessionaires is the social status of the farmer (Marfo *et al.* 2006; Otutei 2012). Based on social status, a farmer can either be a 'top-level leader', 'lower-level leader', a 'connected non-leader', or an 'unconnected non-leader' within the forest community.[24] The top-level leader is either a traditional ruler (chief/regent), an Assembly member (head of the Area Council and representative of the area in the District Assembly) or a spiritual leader (priest, priestess or pastor). Lower-level leaders occupy any other leadership positions within the community apart from the aforementioned. The 'connected non-leader' has no leadership position but has some socio-political connections within the community. However, the 'unconnected non-leader' has neither position nor connections. Figures 6.2, 6.3, 6.4 and 6.5 are the game models for the 'unconnected non-leader', 'connected non-leader', 'lower-level leader' and the 'top-level leader' respectively.[25] The payoff functions are the same except those of the cost of social reproach for accommodation.

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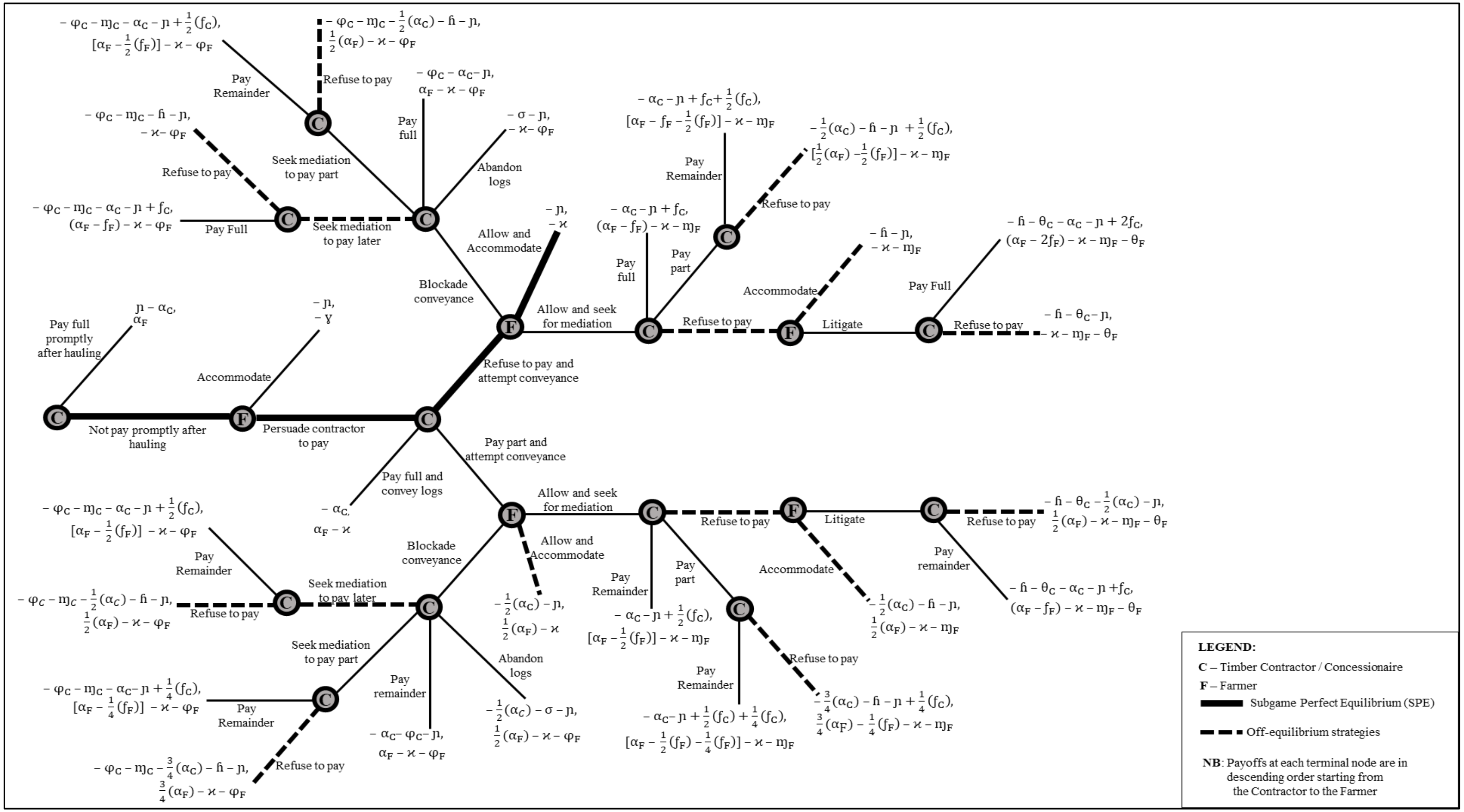
[21] The concessionaire does not gain or lose compensation reputation when the compensation is paid at the time of conveyance.

[22] Timely conveyance is very important to concessionaires since logs are needed for immediate processing or sale. Also, a substantial proportion of off-reserve concessionaires hire conveyance vehicles for transporting logs and thus any delay increases the cost of conveyance.

[23] Note that though the concessionaire abandons the logs, the farmer has no right to use or sell these abandoned logs. Only the Forestry Commission can decide what to do with these abandoned logs (FC 1998; GoG 1998b).

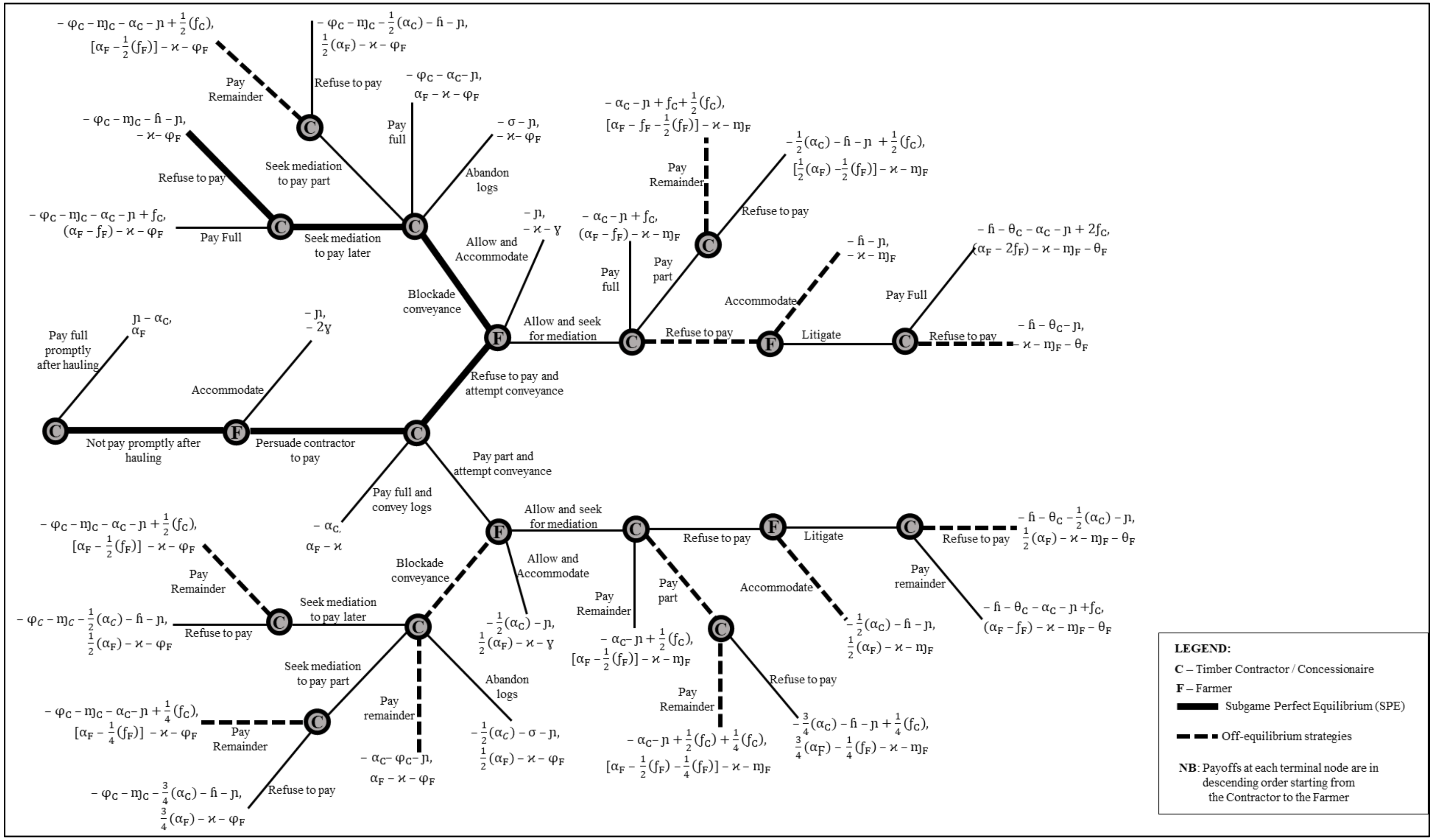
[24] The term 'community' refers to the forest villages or towns within which logging takes place.

[25] Unless specified, 'leader' is used to refer to both top and lower-level leaders.



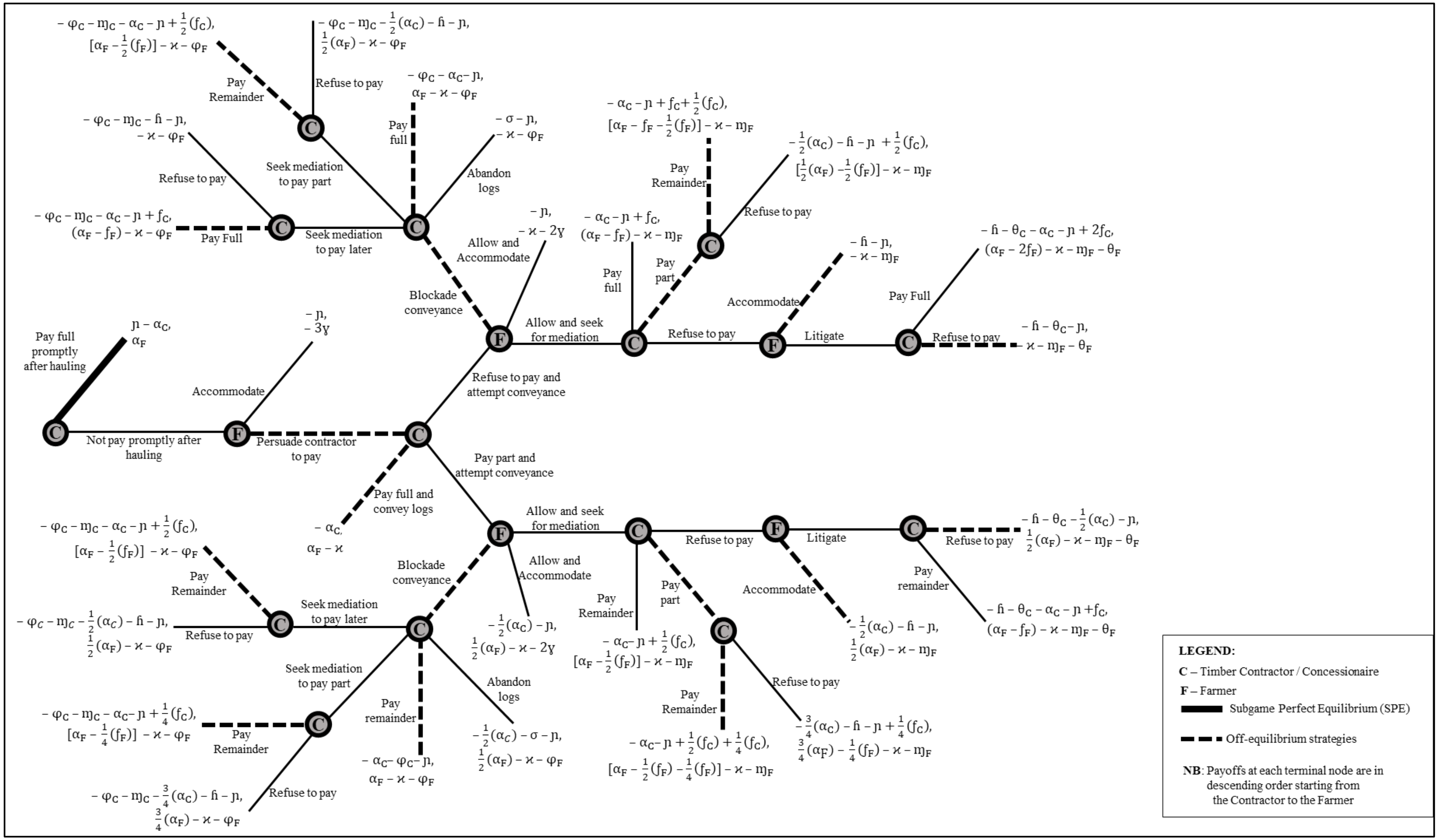
Source: Author's construct, 2017

Figure 6.2 Compensation game model for the 'unconnected non-leader'



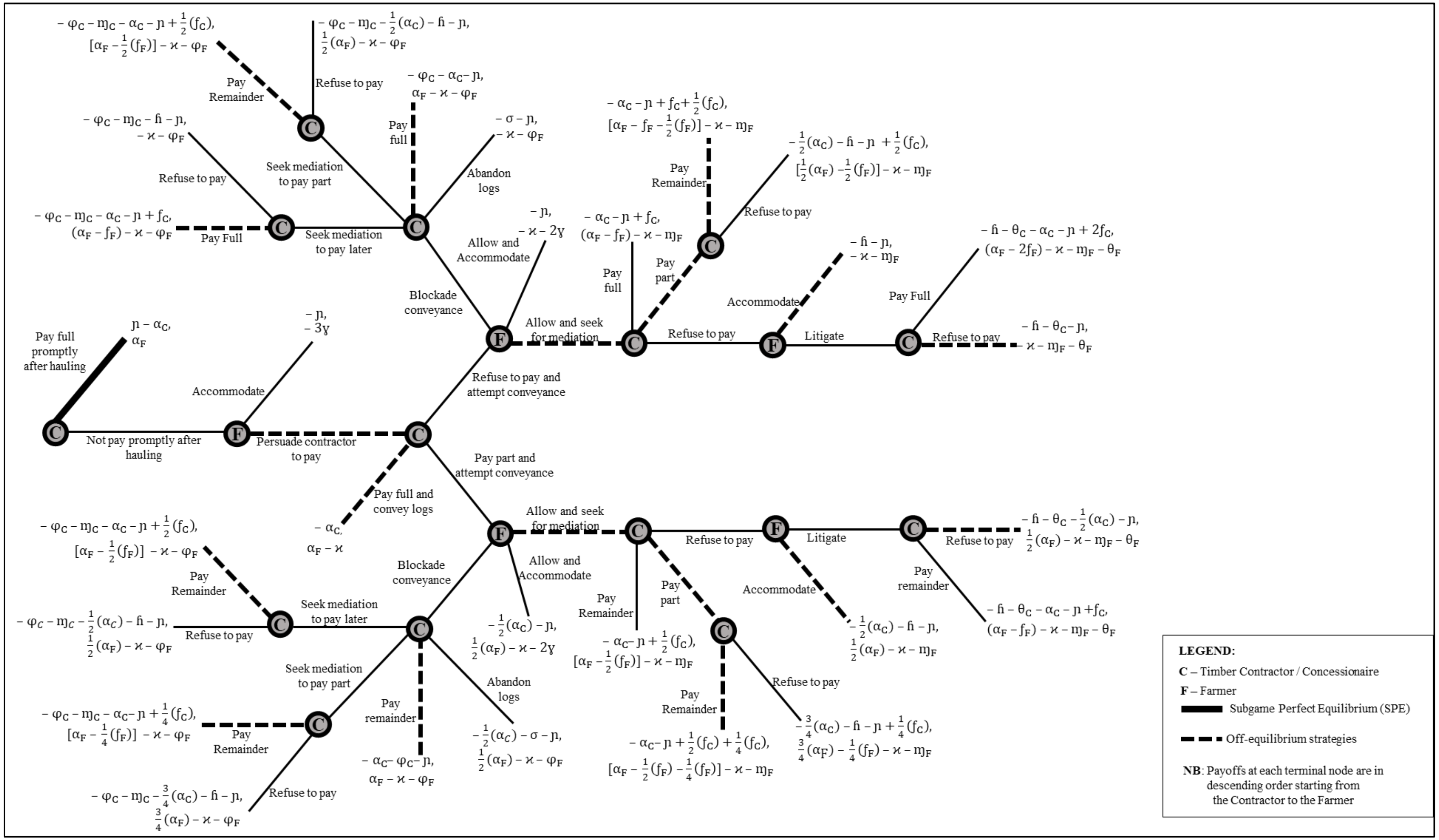
Source: Author's construct, 2017

Figure 6.3 Compensation game model for 'connected non-leader'



Source: Author’s construct, 2017

Figure 6.4 Compensation game model for the ‘lower-level leader’



Source: Author's construct, 2017

Figure 6.5 Compensation game model for the 'top-level leader'

The cost of social reproach for accommodation is directly proportional to the social status of the farmer but is inversely related to the stage at which the farmer accommodates in the game. An unconnected non-leader suffers a social reproach only when accommodation occurs before conveyance. The peers of such farmers sympathise with them after this point because there is little unconnected non-leaders can do when concessionaires attempt to convey the logs without paying the compensation. The social reproach for accommodation for connected non-leaders is greater than that of unconnected non-leaders. Connected non-leaders suffer higher reproach than unconnected non-leaders if they accommodate non-payment of compensation without persuading. For simplicity, it is assumed that connected non-leaders suffer double of the unconnected non-leader's reproach when they accommodate without persuading. Additionally, connected non-leaders suffer reproach, γ, from peers if they allow conveyance and accommodate non-payment of full compensation. This is the social condemnation for failing to at least use mediation after they have allowed conveyance because they have some connections with some higher authorities within the community. Likewise, 'leaders' suffer triple the reproach of the unconnected non-leader if they chicken out without using persuasion. They suffer double the reproach of the connected non-leader if they allow conveyance and accommodate without full compensation. Therefore, the higher the social status of the farmer, the more costly it is to accommodate non-payment of compensation without at least mediation.[26]

6.2.3 Assumptions underlying equilibrium analyses

It could be discerned from the previous discussion on the type of the farmer that even the least cost of reproach in the game is greater than the farmer's cost of mediation and the cost of persuasion. That is:

$$\gamma > \eta_F; \tag{6.1}$$

$$\gamma > \varkappa. \tag{6.2}$$

First, persuasion only involves the farmer trying to verbally convince and plead with the concessionaire to pay the compensation. This appears to be a default action that would be adopted spontaneously by even the weakest farmer in the community. Second, in the

[26] For simplicity, no social reproach for accommodation is suffered beyond this point because the community becomes satisfied that the farmer has exhausted all possible social options for pursuing compensation. Litigation in rural areas in Ghana is regarded as an extreme and costly measure and farmers who fail to litigate are less likely to receive condemnation from their peers irrespective of their social status. Moreover, results of the game are not affected even when the top-level leader incurs γ for not litigating because the net-cost of litigation exceeds the cost of social reproach.

complex social environment within which off-reserve logging takes place in Ghana, to seek the assistance of village-level mediating agents such as the traditional authority and local government representatives (when available) is more socially preferable to doing nothing. Third, some of these mediating agents are easily accessible to farmers within the forest communities (Marfo and Schanz 2009). Therefore, it will take less effort for the farmer to seek for assistance from these mediators. Hence, the farmer's peers will condemn the farmer for failing to seek the intervention of these 'elders'.

The farmer's cost of blockading is assumed to increase with social status. However, except for top-level leaders, all other types of farmers will prefer blockading to mediation. That is;

$$\begin{cases} \text{ɱ}_F < \varphi_F, & \text{if farmer is 'top-level leader'} \\ \text{ɱ}_F > \varphi_F, & \text{if any other farmer} \end{cases}$$

By virtue of their positions, top-level leaders are the custodians of peace and order in the various communities. They are expected to maintain peace and order, follow laid-down procedures for conflict resolution, exercise decorum in conflict situations and demonstrate exemplary behaviour. In Ghanaian custom, mediation is a laudable approach to resolving conflicts. Therefore, leaders who deviate from this societal expectation and instead opt for blockading do so at the expense of their reputation, relationship with superiors and the stability of their position. This is because, considering the enormous powers concessionaires wield within the Ghanaian polity, top-leaders may be regarded by interested superiors and subjects as having violated their oaths of office and would be at risk of destoolment, impeachment, ex-communication or severed relationship with higher authorities (cf. Katanyal 2008). Moreover, concessionaires are able to secure better pre-logging relationships with these top-level leaders within the community through cash, gifts and SRA projects (Marfo and Schanz 2009). It is therefore less likely for these types of farmers to overlook these pre-compensation benefits and pursue compensation through violent means.

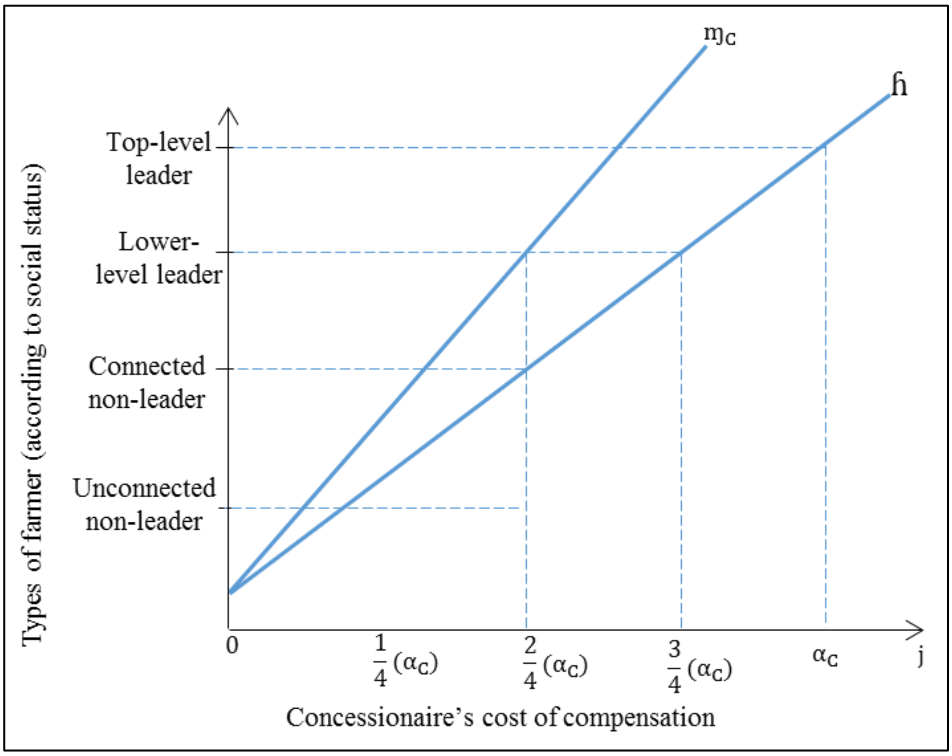
In contrast to the above, blockading is preferable to mediation for any farmer who is not a top-level leader. Though blockading is a defiant action, these farmers are better off blockading than mediating because they believe the neutrality of mediators have been compromised by their (mediators') alliances with concessionaires through their pre-logging interactions (cf. Marfo and Schanz 2009; Otutei 2012).[27] Moreover, the risk of engaging in blockading is expected to be minimal (or negligible) for lower-level leaders. Consequently, they take advantage of their relative influence within the community to easily mobilise people to assist in blockading conveyance. Non-leaders also believe that compensation will delay should they opt for mediation over blockading. In addition, the non-leader gains blockading reputation from the community which serves to signal a caution to future concessionaires.

The farmer's type also affects the concessionaire's cost of social sanctions for defying mediation authority. It can be argued that the higher the social status of the farmer, the higher the authority of the mediator. For instance, 'non-leaders' are expected to seek mediation from community-level traditional leaders or village-level local government representatives due to their usual lack of interaction with higher authorities. However, 'leaders' such as traditional rulers and Assembly members are expected to seek mediation at higher levels of power such as the District Forest Officer (DFO), the District Chief Executive (DCE), the Paramount Chief or people at similar levels on the socio-political ladder. In this case, it will be more costly for the concessionaire to defy the directives of the DFO or DCE than village-level leaders. Defying the DFO or DCE is more likely to affect the concessionaire's ability to secure future concessions because these are active technical and political actors in timber contracting within the off-reserve area. By contrast, it will not be too costly for the concessionaire to defy village-level mediating authorities because it is less likely for the concessionaire to return to the same area for logging activities within the short to medium-term. Also, they can easily be appeased should the concessionaire return to log in the area. Hence, the higher the social status of the farmer the higher the value of the social sanctions associated with the concessionaire's defiant action.

Defined so, the value of $\hbar$ varies with each type of farmer the concessionaire interacts with. To model this, suppose that $\hbar$ is uniformly distributed on the interval [0, j]. On this interval, $\hbar$ can take any value. However, the concessionaire is more likely to compare the value of social sanctions with the value of the compensation in question before choosing between compliance with and defiance of mediated agreement. Thus, depending on the farmer's type, $\hbar$ could be less than the value of half of the compensation to be paid; greater than or equal in value of half of the compensation but less than the value of three-quarters

[27] Farmers who are top-level leaders serve as the mediators of all other types of farmers and the neutrality of these top-level leaders are usually compromised by the pre-logging gifts, cash and drinks as well as SRAs.

of compensation; greater than or equal in value with three-quarters of compensation but less than the value of full compensation; or greater than or equal in value with full compensation. The relation between the concessionaire's defiance cost and the cost of compensation is illustrated in Figure 6.6.



Source: Author's construct, 2017

Figure 6.6 Relationship between concessionaire's defiance cost and compensation cost with respect to farmer's type

For simplicity, it is supposed from Figure 6.6 that $ɦ < \frac{1}{2}(\alpha_C)$ if the farmer is an 'unconnected non-leader' because it is easy for the concessionaire to defy mediators of these farmers by compromising their neutrality during pre-compensation interactions (Marfo and Schanz 2009). It is further assumed that $\frac{1}{2}(\alpha_C) \leq ɦ < \frac{3}{4}(\alpha_C)$ if the farmer is a connected non-leader. This category of farmers are more able to seek mediation from relatively higher authorities than the unconnected non-leader. Also, $\frac{3}{4}(\alpha_C) \leq ɦ < \alpha_C$ or $ɦ \geq \alpha_C$ if the farmer is a lower-level or top-level leader, respectively, because defying the mediators involved in these conflicts is expected to be more deleterious to the concessionaire's future in the logging industry. Likewise, it is assumed from Figure 6.6 that the concessionaire's cost of mediation($ɱ_C$), after the farmer has blockaded is higher if the concessionaire is dealing with 'leaders' than 'non-leaders'. This is because the concessionaire will also require the intervention of more powerful mediators (such as DFOs, Divisional or Paramount Chiefs) to be able to convince 'leaders' during blockading and vice versa. Such powerful mediators are more difficult and costly to approach because they usually reside faraway from logging communities and, customarily, need higher incentives (in cash or in kind) to mediate. For simplicity, it is assumed that $\eta_C \geq \frac{1}{2}(\alpha_C)$ if the farmer is a 'leader' and $\eta_C < \frac{1}{2}(\alpha_C)$ if the farmer is a 'non-leader'.

6.2.4 Equilibrium with complete information

It is taken that both the types of the concessionaire and the farmer are common knowledge and the players are risk neutral. With complete information the game proves to have a subgame perfect equilibrium (SPE) for each type of farmer (refer to Figures 6.2 to 6.4). For the unconnected non-leader, the game predicts that the concessionaire refuses to pay promptly after hauling, refuses to pay at the time of conveyance and attempts conveyance. The best response for the farmer is to use persuasion but then allow conveyance and accommodate non-payment if the concessionaire refuses to pay any compensation. The game involving the connected non-leader predicts that the concessionaire refuses to pay compensation after hauling and refuses to pay at the time of conveyance. The best response of the farmer is to persuade and blockade conveyance. During blockading, the SPE dictates that the concessionaire seeks for mediation to promise to pay the full amount later after conveyance and then refuse to pay any form of compensation after conveyance. By contrast, the SPE of the game involving farmers with leadership positions prescribes that the concessionaire pays the full compensation promptly after hauling when damage assessment and compensation negotiation have been completed. Doing otherwise will not be in the concessionaire's best interest. In sum, the analyses reveal that the receipt of compensation is more related to the types of farmers than the strategy the farmer uses in pursuing compensation. Farmers without higher socio-political status (e.g., leadership position) in the community appear to be less likely to receive compensation for crop damage if they pursue compensation independently.

It is should be noted that blockading or mediation will not be in the best interest of the unconnected non-leader. These actions are more costly than accommodating after the concessionaire has attempted conveyance without paying the compensation. However, blockading is the most rational action for the connected non-leader. It is also the sequentially rational action for the lower-level leader should the concessionaire deviate from the equilibrium path to attempt conveyance without compensating the farmer. By contrast, the top-level leader will always mediate should the concessionaire deviate from equilibrium path. It is interesting to note that a common characteristic for farmers who are likely to use either blockading or mediation as rational actions should the need arise is socio-political network.[28] The study therefore argues that the use of blockading or mediation to pursue compensation within the off-reserve landscape is more likely to be related to the socio-political status of the farmer. The hypotheses thus proposed are:

> **Hypothesis 1**: Farmers with socio-political connections within the community are more likely to use blockading to pursue compensation after persuasion has failed.
>
> **Hypothesis 2**: Farmers occupying top leadership positions in the community are less likely to use blockading to pursue compensation
>
> **Hypothesis 3**: Farmers with socio-political connections within the community are more likely to use mediation to pursue compensation after persuasion has failed

Further, the game indicates that the typical concessionaire will seek for mediation and refuse to pay compensation should the non-leader blockade conveyance.[29] This is because it will be less costly for the concessionaire to mediate and later refuse to pay than even pay part of the compensation during blockading. However, any blockading involving powerful farmers (i.e., leaders) is more likely to lead to full payment of compensation. Since blockading is less likely to occur in the game involving leaders, it can be argued that, in practice, the concessionaire is more likely to mediate and refuse to pay should the farmer blockade. This is because the rational concessionaire expects blockading from only non-leaders in the real-world. Moreover, the game proves that every type of farmer will prefer accommodating non-payment of full compensation after mediation to litigation. The concessionaire is more likely to win the litigation. With this belief, the most rational thing for the farmer to do is not to litigate.

The analyses in Section 6.2 also demonstrate the low likelihood of most concessionaires to fully compensate many farmers should farmers continue to independently pursue compensation within the prevailing socio-political system in forest villages. Hence, theoretically, it will be less effective to rely on the independent actions of farmers for resolving off-reserve compensation conflicts. For this reason, different forms of external interventions are introduced in the forest management models in the next section to observe how concessionaires are likely to respond.

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[28] Farmers who are community leaders are automatically connected.
[29] Note that blockading is a slip for the unconnected non-leader but optimal for the connected non-leader.

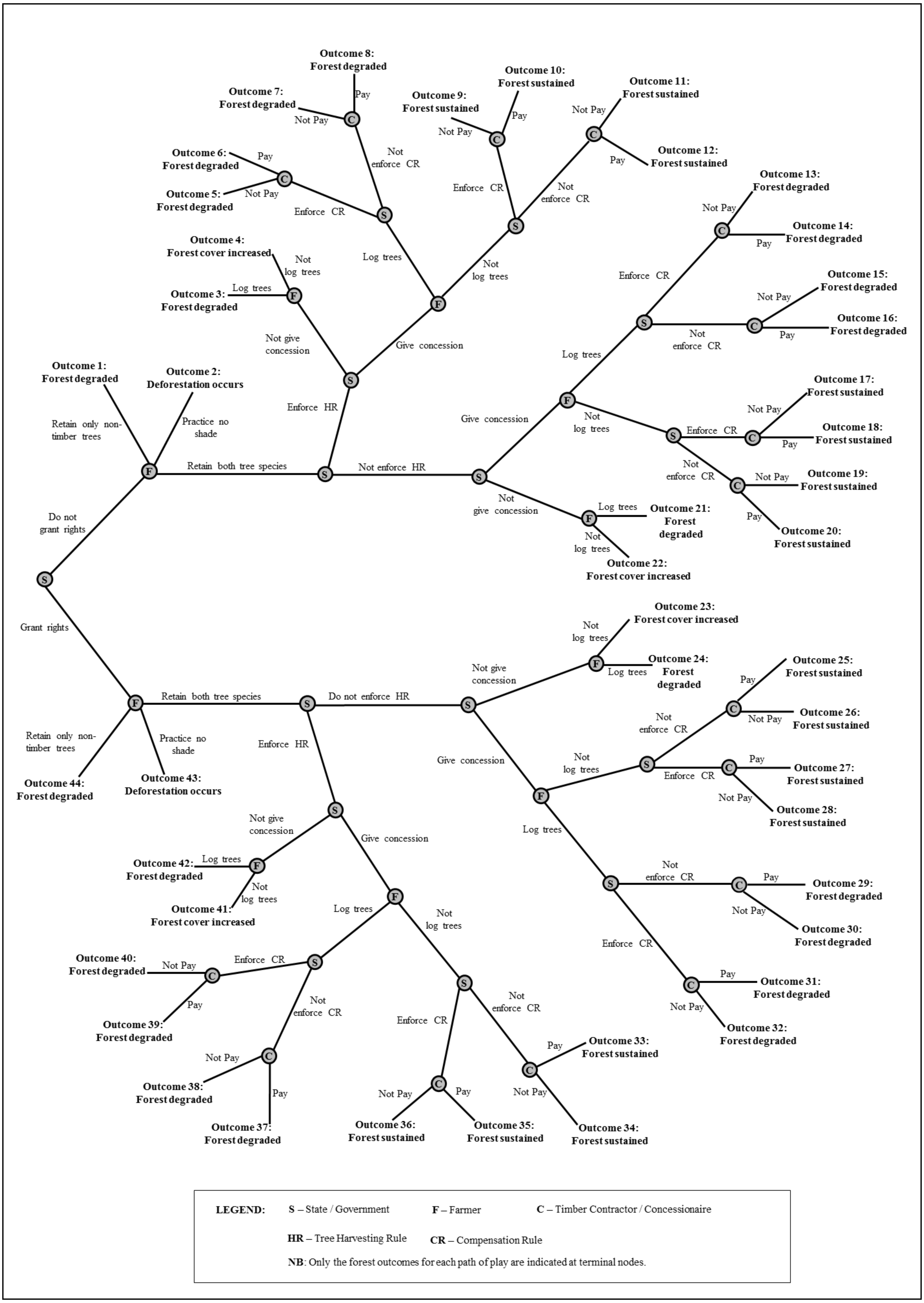
6.3 Understanding Actor-Behaviour in the Off-reserve Forests: A Forest Management Game

The purpose of the forest management model is to give an overall game-theoretic insight into the current non-cooperative behaviour of farmers, concessionaires and the State in the off-reserve area. It seeks to explain farmers' tree retention and illegal logging behaviour. It also provides a rational-choice insight into why the government has refused to grant farmers any economic rights to on-farm trees and has relaxed the enforcement of forest laws regarding tree harvesting and compensation. The section also seeks to explain why non-payment of compensation occurs, in the first place. The model presented here forms the foundation for latter games analysed in this chapter.

6.3.1 Structure of the forest management game model

The original forest management model is illustrated in Figure 6.7. This is a sequential game with three players. These are the State (S) or government represented by the Forestry Commission, a Farmer (F) and a Concessionaire (C). The game is played among these three players until the farm is abandoned to fallow. For simplicity, the game consists of seven principal stages contingent on the path of play adopted in the game tree. The State moves first, choosing either to grant farmers right to formal timber benefits or not.[30] After observing the State's move, the farmer chooses whether to retain only non-timber trees (mostly neutral trees), practice no-shade farming or retain optimal levels of both timber and non-timber trees. The same sets of actions are available to the farmer irrespective of the choice of the State in the first step. The game ends if the farmer chooses either no-shade farming or retention of only non-timber trees. However, the State moves to choose whether to enforce the tree harvesting rule (HR in Figure 6.7) or relax enforcement if the farmer retains both tree types. Irrespective of the choice it makes, the State moves to choose whether to give the on-farm timber trees on concession or not. The farmer moves to choose whether to engage in illegal logging (log trees) or not, if the State does not give on-farm trees out to concession, and the game ends. However, the game continues if the State chooses to grant concession to the concessionaire to log on-farm timber trees. The farmer, after observing the move of the State, then chooses either to engage in illegal logging or not. The State then moves to choose enforcing the compensation rule (CR in Figure 6.7) or relaxing enforcement.

[30] Note that the results of the game would not have been affected had the farmer moved first.



Source: Author’s Construct, 2017

Figure 6.7 The forest management model with forest outcomes

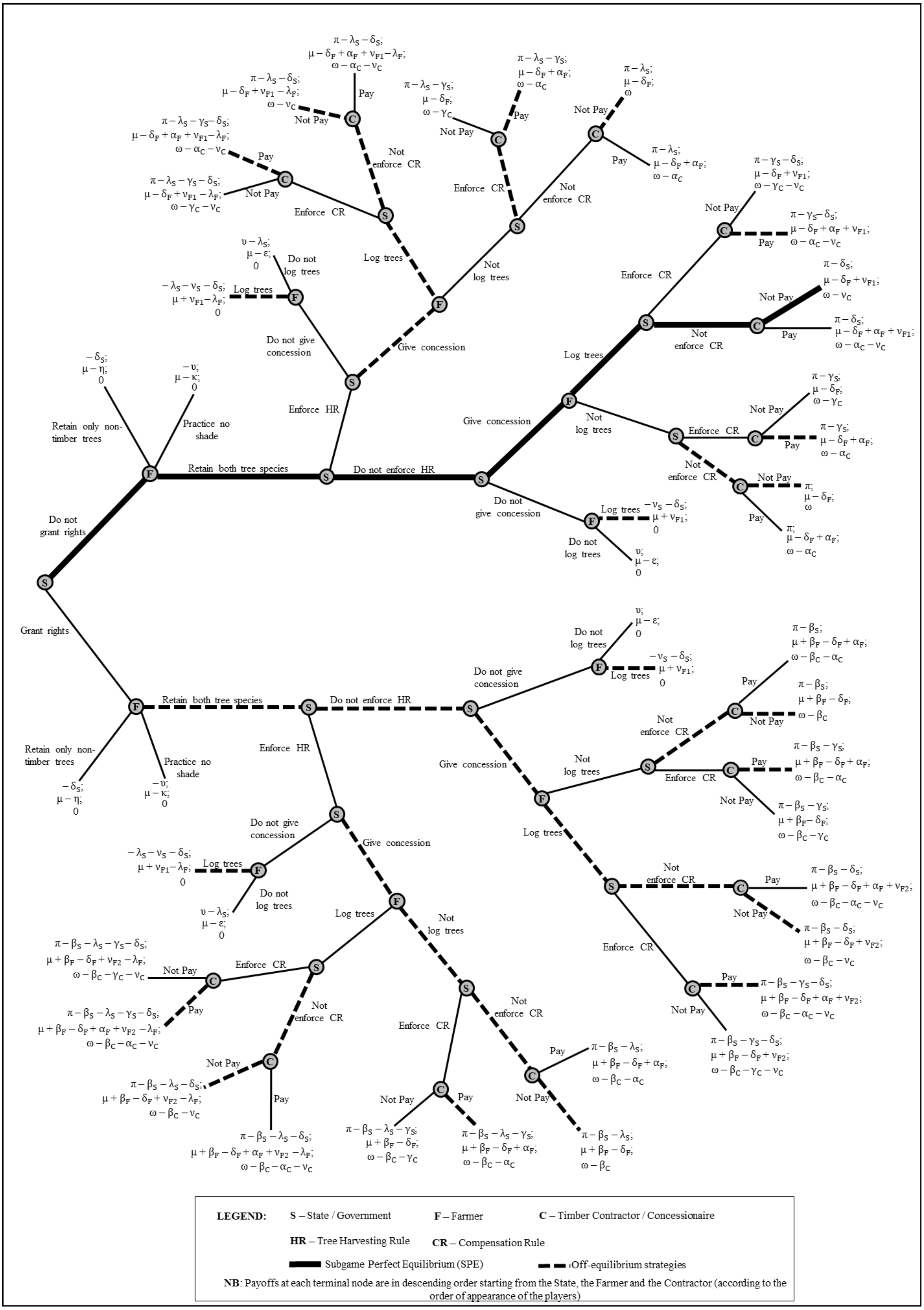
After observing the action of the State, the concessionaire decides whether to fully compensate (pay) or not to fully compensate (not pay) the farmer for crop damage before conveyance and the game ends.

The game yields 44 outcomes. In terms of forest condition, deforestation occurs in two (2) of the outcomes of the game. This is because farmers practice no-shade agriculture: total clearance of all tree species except cocoa crops. In four (4) of the outcomes, forest cover is increased because the famer retains both tree types and no logging occurs on the farm until it is left to fallow. The forest is degraded in 22 of the outcomes through the retention of only non-timber trees or through illegal logging. Finally, the forest is sustained in 18 of the outcomes of the game because logging is by concession only and farmers do not engage in illegal logging. Depending on the path of play, each of these outcomes yield different payoffs to at least one of the players in the game.

6.3.2 Payoffs of the game

Payoffs (expected utility) are represented with Greek letters (all values ≥ 0) as shown in Figure 6.8. For simplicity, it is assumed that the State's expected utility in the game includes the condition of the forest. This is because in carbon politics, the State is the immediate player who stands to lose, maintain or gain *carbon reputation* from the condition of its forests. The State does not obtain any value from forestry if farmers practice 'no-shade' and 'non-timber tree only' farming. Deforestation occurs when the farmer practises no-shade farming, resulting in a deforestation cost to the State valued at υ. If forest cover increases, the State gains a carbon reputation valued at υ. Further, the practice of 'non-timber tree only' farming and illegal logging by farmers result in forest degradation. This generates a cost to the State valued at δ_S.

Technically, it is taken that concession logging is 'sustainable'. Therefore, the State obtains the expected value of forestry, π, by selling on-farm trees to concessionaires on concession. The expected value of forestry, π, consists of the full timber revenue from concessions and a sustained forest. The State incurs an enforcement cost, λ_S, anytime it enforces the tree harvesting rule. Likewise, the State bears an enforcement cost, γ_S, when it enforces the compensation rule. The State loses future timber revenue valued at ν_S when illegal logging occurs on farms without concession. Finally, the State's expected value of forestry is reduced by β_S if it grants farmers rights to formal benefit from concession logging.



Source: Author's Construct, 2017

Figure 6.8 The original forest management model with payoffs

The farmer's expected value of farming is μ when the farmer retains (optimal levels of) both timber and non-timber trees.[31] However, this value is reduced by η and κ when the farmer practises 'non-timber tree only' farming or 'no-shade' farming, respectively. This is because non-timber trees are less compatible with cocoa crops and require substantial quantities of complementary agrochemicals to improve yields. Also, the farmer incurs the cost of huge quantities of substitutionary agrochemicals to mitigate the effect of the absence of shade trees on the cocoa crops in no-shade farming. In the absence of any form of on-farm logging, too much shade on fruit bearing crops reduces farm ventilation thereby resulting in yield loss at latter stages of the farm (Odoom 2005). In such a situation (i.e., without on-farm logging), the farmer's value of farming is reduced by ε.

The farmer obtains ν_{F1} for engaging in on-farm illegal logging when farmers have no right to on-farm timber benefits.[32] However, the farmer's value of illegal logging is reduced by the deterrence cost (λ_F) of illegal logging when the tree harvesting rule is enforced. Further, on-farm concession logging damages crops, saplings and coppices. The cost of this damage to the farmer is valued at δ_F. For this damage, the farmer receives a value of α_F as compensation if the concessionaire fully pays the negotiated compensation amount. Also, if the State recognises the rights of farmers to timber revenue as described in Chapter 5, the farmer obtains formal benefit from concession logging valued at β_F.[33] It should be noted, however, that this right to benefit only applies when the State grants timber concessions. Thus, without concession logging, the farmer does not receive β_F. Again, it is assumed that the farmer's value of illegal logging reduces markedly to ν_{F2} when farmers are in receipt of β_F. This is because farmers engage in illegal logging to partly recover their investments in tree retention and these investments is partly recovered from the receipt of β_F.

Likewise, the concessionaire receives ω for engaging in concession logging. However, the concessionaire's expected value of logging is reduced by the value of compensation paid to the farmer, α_C. It is also reduced by the value of trees lost to illegal logging in the

[31] This refers solely to the farming or agricultural value and does not include non-agricultural benefits from trees.

[32] Since farmers themselves are engaged in the illegal logging activities, it is assumed that the negligible crop damage caused by *in situ* sawing are of little concern to them. Thus, it is supposed that little or no damage cost is incurred by farmers through illegal logging.

[33] β_F also includes the gain in leverage by the farmer in interactions with the concessionaire as a result of the official recognition of the farmer's right of ownership to on-farm trees.

concessionaire's concession, ν_C.[34] If the compensation rule is enforced, the concessionaire will bear the deterrence cost (γ_C) of non-compliance for refusing to fully compensate the farmer for crop damage. Moreover, the official recognition of farmer's right to trees affects the concessionaire's expected value of logging because the farmer gains some leverage in on-farm logging interactions with the concessionaire. This leverage can result in the farmer's ability to influence on-farm haulage tracts, ability to demand that concessionaire sanitizes the farm after felling and an increase in bargaining power in compensation negotiation. In short, the recognition of rights of farmers implies that, to some extent, the concessionaire may have to log on farmer's terms. Logging on farmer's terms will reduce the concessionaire's expected value of logging by β_C. Lastly, the concessionaire stays out of business if farmers practice 'no-shade' or 'non-timber tree only' farming, or if the State does not grant timber concession. Either way, the payoff of the concessionaire is normalised to 0.

6.3.3 Assumptions underlying equilibrium analyses in the forest management game model

Some fundamental conditions underlying some individual elements of the payoff functions of the players need to be specified before proceeding with equilibrium analyses.

Assumptions for analysing the State's payoffs

First, the State (FC) prioritises timber revenue over the condition of the forest. In the off-reserve forests, the State is more interested in timber revenue than efforts to sustain the forests. The official position of the FC regarding the sustenance of the off-reserve forests is that:

> Unlike the forest reserves, where the overall guide is maintenance of the timber yield through sustainable harvesting practices, no such claim can be made for the off-reserve situation. The primary use of this land is agriculture and settlement; in such circumstances, aiming to achieve a level of natural forest regeneration equal to the level of exploitation is outside the control of the Forest Service and would only be achievable if the community is willing to embark on tree planting either small scale at the level of on-farm, or by allowing land allocation for larger scale plantation development. (FC 1998, Section F2.1 p. 1).

[34]The concessionaire has no legal right in the game to refuse to pay compensation to the farmer on the basis of loss of trees to illegal loggers. This is because, legally, compensation payment is not contingent on whether the concessionaire has lost trees or not (FC 1998; GoG 1998a). Moreover, farmers are not mandated to protect on-farm trees from illegal loggers.

It is therefore evident from the above that the State strongly prioritises timber revenue above the condition of the off-reserve forests (cf. Hansen and Lund 2011; Treue 2001). Subsequently, even the least payoff function of the State containing the expected value of forestry (π) is assumed to be greater than the full value of increased forest cover, υ. That is:

$$\pi - \beta_S - \lambda_S - \gamma_S - \delta_S > \upsilon \tag{6.3}$$

Second, it is assumed that the State's value of forestry is greater than the sum of the values of the cost of enforcing both the timber harvesting rule and the compensation rule, the cost of forest degradation and the revenue lost to farmers by granting them a share of the stumpage revenue. That is:

$$\pi > \beta_S + \lambda_S + \gamma_S + \delta_S \tag{6.4}$$

Note that the State's value of forestry (π) consists of the State's share of the stumpage revenue (80% received by the FC, the District Assembly and the OASL); the timber rights fees; export levies; the air-dried lumber levy and the cooperate tax. It also includes the unofficial payments, kick-backs (bribes) and political support from concessionaires to State actors; and the value of the carbon reputation obtained from a sustained forest. This composite value is expected to exceed the sum of the State's costs in the above condition.

Further, it is assumed that within the *status quo*, the cost of enforcing the harvesting rule is greater than the cost of enforcing the compensation rule, and this is, in turn, greater than the cost of the degradation of the off-reserve forests. That is:

$$\lambda_S > \gamma_S > \delta_S \tag{6.5}$$

The cost of enforcing the harvesting rule is greater than the cost of enforcing the compensation rule in terms of government budget and socio-political costs. Enforcing the harvesting rule demands higher expenditure on personnel at both the FSD-level and village level, logistics, and prosecution than that of the compensation rule. In contrast, the detection of non-compliance with the compensation law will be easy because affected farmers will readily inform DFO about non-compliance during the post-felling inspection preceding the issuance of the Conveyance Certificate. Also, since the Ghanaian lumber market is largely supplied by farmer-facilitated chainsaw logging, enforcing the tree harvesting rule is more likely to be a recipe for incessant urban mass protests by sawmill workers, construction workers, and builders (Hansen 2011; Nutakor *et al.* 2011). This will be a huge social and political cost to the ruling government. Moreover, enforcing the harvesting law will sever the social relationship between operators on the one hand and FSD officials, the police, and military officials on the other hand, and erode any anticipated financial gains from this relationship. Several studies have found that the tree harvesting rule is not enforced because this will erode the financial gains of the officials of the FSD (e.g., Marfo 2010; Hansen 2011; Franck and Nelson 2014). Enforcing the compensation rule will also imply severing social-political ties with political elites and foregoing monetary favours from concessionaires (economic elites). However, this value is incomparable to the huge social-economic and socio-political costs of enforcing the tree harvesting law.

Lastly, the cost of enforcing the compensation rule is greater than that of forest degradation because the former involves government expenditure (i.e., loss of 'valuable' revenue) and loss of socio-political ties with and monetary favours from concessionaires. As noted earlier, the condition of the off-reserve forests is subsidiary and the State strictly prefers avoiding expenditure on enforcement to the sustenance of the forest. Moreover, enforcing the compensation law will reduce the profits of concessionaires. This is more likely to affect all levels of the State establishment. Political elites are likely to lose votes and campaign funding from economic elites (concessionaires) and bureaucrats at the macro-level (Hansen 2011; Hansen and Lund 2011). Regional and district level officials of the FSD are more likely to lose financial gains from concessionaires (Hansen and Lund 2011) whereas micro-level officials (field staff of FSD) will, at best, lose tips from concessionaires, or at worst, be demoted (cf. Amanor 2005; Ameyaw *et al.* 2016).

Assumptions for analysing farmer's payoffs

It is assumed that the farmer's value lost to the retention of only non-timber trees (η) is less than that of no-shade (κ). The farmer spends less money on agrochemicals and other high yielding inputs under 'non-timber trees only' farming than 'no-shade' farming (Duguma *et al.* 2001; Darko-Obiri *et al.* 2007). Whereas the use of agrochemicals in 'non-timber tree only' farming is complementary, it is entirely substitutionary under 'no-shade' farming. The farmer has to solely rely on heavy quantities of agrochemicals to improve crop yield under 'no-shade' farming (Darko-Obiri *et al.* 2007; Gockowski *et al.* 2013). Therefore, 'no-shade' farming is more costly than the retention of only non-timber trees. However, research indicates that the typical cocoa farmer lacks the financial ability to purchase agrochemicals and is therefore heavily dependent on the limited quantities supplied by the government (Barrientos *et al.* 2008; Gockowski *et al.* 2013). Yet, the free quantities supplied by the government is only suitable for shaded cocoa (with optimal levels of both timber and non-timber trees). The lack of financial ability to purchase agrochemicals implies that the average farmer is expected to lose more output under 'no-shade' than 'non-timber trees only' farming.

Following from the above, it can be argued that the farmer prefers retaining optimal levels of both tree types to 'non-timber tree only' and 'no-shade' farming even without compensation after crop damages by concessionaires. That is,

$$\mu - \delta_F > \mu - \eta > \mu - \kappa \tag{6.6}$$

Without optimum shade, farmers have to incur huge cost of agrochemicals (fertilisers and insecticides), and cocoa crops are affected by deleterious pests and diseases and frequent weed growth (Darko-Obiri *et al.* 2007). The farm loses all or most of the enormous advantages of shade trees such as the provision of shades, improvement of soil fertility and moisture, regulation of farm temperature, control of pests and diseases, and protection of crops from bushfires and precarious weather (Hansen and Treue 2009; Anglaaere *et al.* 2011; Akrofi *et al.* 2015). Cocoa crops are found to yield higher proportions of smaller pods without optimum shade levels (Darko-Obiri *et al.* 2007). Their life-cycles are also shortened in farming systems (Darko-Obiri *et al.* 2007). Thus, farmers prefer to retain optimum levels of both tree types even in the absence of full compensation because it optimises the profitability of cocoa farming within their economic confines.

Moreover, the value of crop damage by the concessionaire (δ_F) is less than the value of crop yield lost to too much shade on the farm (ε) when no on-farm logging takes place. This is because the farm needs more ventilation during the pod bearing period and farmers need some of the on-farm trees to be logged (either by a concessionaire or operator) to reduce shade tree density. Without this reduction, crops will continue to shed pods prematurely and the farm will continue to record lower productivity till it is abandoned to fallow (Odoom 2005). The cumulative value of this loss is more likely to be greater than the value of the one-stop farm damage by the concessionaire. Note also that damaged cocoa crops will regenerate quickly after logging.

The farmer's value of illegal logging consists of a third of the stumpage fee of the tree, reduced damage to the farm and the value of free lumber boards. It also includes the value of other SRA benefits from operators such as assisting in sanitizing farm; removal of unwanted stumps and provision of free firewood; as well as the social support for illegal logging (cf. Richards and Asare 1999; Marfo 2010; Hansen 2011; Amanor 2004; Amoah and Boateng 2014; Ramcilovic-Suominen and Epstein 2015).[35] Through these, farmers are able to gain some timber and other extra benefits from shade trees. However, the receipt of β_F will partly cover these non-shading benefits. Consequently and consistent with the law of diminishing marginal utility, the farmer's value of illegal logging is expected to reduce markedly if farmers are in receipt of formal timber benefits from the State, (i.e., $\nu_{F1} > \nu_{F2}$). Also β_F is expected to diminish the attractiveness of illegal logging since it addresses one of the fundamental problems underlying the pervasiveness of the phenomenon: the unfairness of the current tree tenure. The value will further be reduced by an expected decline in peer support for illegal logging when farmers are in receipt of β_F.[36]

For simplicity, enforced tree harvesting rule is used in this study to mean that detection and sanctioning in strict accordance with relevant laws is almost certain.[37] Once convicted, the offender is liable to a jail term of between six months and two years or in lieu of this, to a fine of up to 1000% of the cost of lumber involved (GoG 1998a, s. 17[2]). In addition, the timber products are to be confiscated by the court (GoG 1998a, s. 17[3]). Since detection and sanctioning are assumed to be almost certain under enforced rules in the game, the deterrence cost (λ_F) for engaging in illegal logging is simply taken as the farmer's expected cost of the legal sanctions above, relative to any social sanctions or support accompanying these legal sanctions.[38]

It is assumed that the sanctions specified above are inferior to the farmer's value of illegal logging when no timber rights are granted (i.e., $\nu_{F1} > \lambda_F$). First, where the tree harvesting law is enforced, empirical evidence shows that sanctions imposed on culprits of illegal logging in courts averaged a fine of GH¢200 or in default, 12 months in prison with hard labour, and the confiscation of the lumber involved (Derkyi 2012). By receiving about one-third of the stumpage fee (around GH¢282.15 or US74.06), this fine is more likely to be

[35] Many farmers hire the services of operators to log on-farm trees for domestic construction (Hansen 2011). However, lumber recovery rate for chainsaw averaged between 30 and 33% (Marfo 2010) and this is taken to amount to a third of the stumpage value.

[36] Refer to discussion on peer behaviour towards harvesting rule in Marfo (2010), Ramcilovic-Suominen and Hansen (2012) and Ramcilovic-Suominen and Epstein (2015).

[37] Becker (1968) shows that the more an institution spends on enforcement, the easier it is to apprehend and sanction offenders.

[38] Technically, deterrence refers to the product of the likelihood of detection and the likelihood and severity of sanction (Carodenuto and Ramcilovic-Suominen 2014).

easily offset by the farmer.[39] Even if the free lumber provided by the operator is seized in addition, the farmer still enjoys the other SRA benefits provided by the operator. Also, since there is a massive social support for illegal logging within the *status quo*, a sanctioned farmer is expected to receive peer sympathy that is more likely to further reduce the farmer's losses to strict enforcement. Second, offenders have been found to continue to engage in illegal logging after being sanctioned (Derkyi 2012). This implies that for such offenders, the benefit of illegal logging is expected to be greater than the deterrence cost (cf. Becker 1968). Thus, it can be argued that without formal timber rights, the farmer's expected value of illegal logging is greater than the farmer's deterrence cost.

The above notwithstanding, the deterrence cost for illegal logging is expected to be greater than the farmer's expected value of illegal logging when farmers have formal timber rights (i.e., $\lambda_F > \nu_{F2}$). This is because the farmers' real value of illegal logging reduces markedly when in receipt of β_F. In addition, social support for the activity is more likely to dwindle thereby eroding the social sympathy peers would have given to offenders. Though the farmer would still enjoy almost all the nominal benefits from illegal logging as before, the real value attached to these benefits would reduce considerably whereas the deterrence cost stays the same, at the least. With such a reduced value and social disapproval, it is assumed that the farmer will perceive engaging in illegal logging as a net cost because of the risk of fines, imprisonment and social sanctions.

Assumptions for analysing the concessionaire's payoffs

The concessionaire's expected value of logging (ω) is expected to be far greater than the cost of compensating the farmer. That is:

$$\omega > \alpha_C \tag{6.7}$$

The concessionaire's expected value of logging (ω) consists of the value of the concessionaire's disposable profit as well as the socio-political reputation accompanying concession logging in Ghana. Research shows that timber concessionaires make huge profits from logging since timber resources are deliberately undertaxed by forestry officials for political gains (Hansen and Lund 2011). Therefore, α_C is expected to be negligible

[39] Based on the official stumpage rates from the FC (March 2014), the average stumpage value for moderate and high demand tree species is GH¢846.45 (US$222.19). A third of this amount is GH¢282.15 (US74.06). The calculation, here, assumed an average of 20m^3 merchantable timber per tree (cf. Richards and Asare 1999).

when compared to the value of the huge profits made by concessionaires and the social reputation associated with concession logging.

The concessionaire should not be able to transport logs if the agreed compensation is not paid to the farmer because the DFO would not issue a Conveyance Certificate to such a concessionaire when the compensation law is enforced. Transporting the logs without the Conveyance Certificate would be illegal. The law stipulates that any person who is found conveying logs without a Conveyance Certificate is to be fined up to GH¢500 or in default spend up to 12 months jail term (GoG 1998b, r. 41[1]). In addition, the transported logs are to be confiscated and auctioned by the FC (GoG 1998b, r. 41[2]). Therefore, when the compensation law is enforced, non-payment of compensation means the concessionaire will, at best, abandon the logs in the forest. At worst, the concessionaire will incur transportation cost and a fine, and lose the logs to the FC. The FSD may also revoke the logging permits of the concessionaire for a specified period of time if the concessionaire fails to fully compensate the farmer (FC 1998). Either way, the concessionaire runs at a loss because investments in logging are not recovered. Since application of sanctions is almost certain under enforcement, the concessionaire's deterrence cost for non-payment of compensation (γ_C) will be the cost associated with the loss of investment, loss of logging permit and loss of the expected value of logging. Therefore it is assumed that:

$$\gamma_C > \omega \tag{6.8}$$

Indeed, failure to compensate the farmer for crop damage will be a net cost to the concessionaire when the compensation law is being enforced by the State.

6.3.4 Equilibrium analysis: a game-theoretic explanation for the current behaviour of major stakeholders in the off-reserve area

The equilibrium analysis assumes that the State, the Farmer and the Concessionaire are risk neutral and sequentially rational, and that the above payoffs and conditions are common knowledge. The game also assumes complete and perfect information.

The game in Figure 6.8 has several subgames and several subgame equilibria. However, there is one subgame perfect equilibrium (SPE) for the entire game and this corresponds to the path of play leading to Outcome 15 with payoffs ($\pi - \delta_S$; $\mu - \delta_F + \nu_{F1}$; $\omega - \nu_C$). The SPE specifies that the State denies timber rights to farmers, relaxes the enforcement of the harvesting rule, grants concession and relaxes the enforcement of the compensation rule. Further, it dictates that the farmer retains optimum levels of both timber and non-timber trees and follows up later to engage in illegal logging. Likewise, the concessionaire is to refuse to pay compensation to the farmer.

Notice that the State has enormous advantage in the game and manipulates the interaction to maximise its payoff. At the initial node, the state anticipates that regardless of its move, the farmer will retain both tree types. Therefore being sequentially rational, the State denies the farmer formal timber rights because doing otherwise will yield an inferior payoff. If the State grants rights to the farmer, the unique Nash equilibrium of the subgame initiated by the farmer's move (Outcome 30) prescribes that the State follows its previous action with relaxing the harvesting rule, granting concession and relaxing the compensation rule. Since the State is much more interested in timber revenue than the condition of the forests, it will be irrational to enforce forest rules if it is to maximise its payoff in the game. Further, once on-farm trees are harvestable, the State would have no option than to grant timber concession to the concessionaire because doing otherwise is strictly dominated. In response to the State's moves, the farmer would retain both tree types and engage in illegal logging whereas the concessionaire would refuse to pay compensation. The State's payoff resulting from this Nash equilibrium, $(\pi - \beta_S - \delta_S)$, would be inferior to that of the SPE, $(\pi - \delta_S)$. Thus, with the first mover advantage, the State chooses not to grant timber rights to farmers in order to maximise its payoff. With this, the State's value of forestry is only reduced by the negligible cost of forest degradation.

Once the State has moved to deny timber rights, the only rational move for the farmer is to retain both tree types because this action dominates both 'no-shade' and 'non-timber tree only' farming. This should be followed by involvement in illegal logging when the farmer is called upon to make the next move, yielding a payoff of $\mu - \delta_F + \nu_{F1}$. This strategy ensures that the farmer obtains the agricultural value of optimum shading (though reduced by crop damage without compensation); obtains timber benefits from tree retention; and enjoys individualised SRA benefits without any deterrence cost. Also, the concessionaire has no incentive to compensate the farmer once it observes that the State has relaxed the compensation rule. Thus, the concessionaire's value of logging is only reduced by the cost of illegal logging in the concessionaire's concession (i.e., $\omega - \nu_C$).

The above analyses reveal that the current behaviour of the State, concessionaires and farmers in the off-reserve forests are rational. The State has not granted timber rights to farmers, and has relaxed the enforcement of the harvesting and compensation laws because doing otherwise will be deleterious to its off-reserve economic and rent-seeking interests. The State believes that farmers will retain optimum levels of shade trees regardless of the tenure and compensation situation. The condition of the off-reserve forests is also peripheral whereas its economic and rent-seeking interests are paramount. These reasons combined, may well explain why the government deprived farmers of their long-held *de facto* right to sell or harvest on-farm timber trees in 1998; criminalised their sale or harvesting of trees; and extended concession logging to cocoa farms in contravention of existing laws and policies (refer to 3.7.2 in Chapter 3).

Likewise, the relaxation of the compensation law in the *status quo* implies that it will be irrational for typical concessionaires to compensate the farmer for crop damage because this will reduce their profit margins. It will also be irrational for farmers not to retain optimum levels of timber and non-timber trees on their farms. More importantly, farmers are more likely to continue to engage in illegal logging because it is the only rational action to maximise their returns from cocoa agroforestry. Thus, the ubiquity of illegal logging in the off-reserve forests is the result of deliberate actions by rational actors to maximise their benefits from forest resources. The game predicts that the off-reserve forests is more likely to remain degraded insofar as the current tenure and compensation regime remains unchanged. Therefore, the following sections evaluate options for altering the behaviour of concessionaires and farmers based on hypothetical *commitments* by the State.

6.4 The Effect of the State's Commitments on Farmers and Concessionaires: A Modified Forest Management Game

The game models analysed in this section are variants of the forest management game analysed in Section 6.3. The analyses in this section seek to theoretically explore policy options and prescribe (an) optimal policy option(s) for inducing sustainable practices among farmers. The section also seeks to evaluate external interventions for resolving the compensation problem since the analyses in Section 6.2 revealed that the concessionaire is less likely to compensate farmers if they (farmers) pursue compensation independently.

6.4.1 Predicted responses to potential 'commitments' by the State

The forest management game in Section 6.3 reveals that the State has enormous advantage in the game to influence the actions of both the concessionaire and the farmer. The State can commit itself to a particular path of play to compel the concessionaire and the farmer to adapt to it. However, the farmer's decision to retain both tree types is less dependent on the actions of the State and the concessionaire. Choosing either 'no-shade' or 'non-timber tree only' farming is expected to be irrational for the farmer irrespective of the actions of the other players. The following hypothesis is hereby posited:

> **Hypothesis 4**: Farmers willingness to retain both trees is likely to be higher than that of 'non-timber trees only' and 'no-shade' farming regardless of the policy scenario.

Unlike tree retention behaviour, the farmer's involvement in illegal logging can be influenced by the State. However, the question that still remains is: *which of the strategies of the State is more likely to induce cooperative behaviour among farmers and concessionaires*? This question is addressed in this section. The section examines each of the major actions of the State (and combinations thereof) in the forest management game presented in Section 6.3 to observe how they would affect the behaviour of farmers and concessionaires. The analyses rely on the use of hypothetical policy scenarios in the form of *commitments* by the State.

Suppose that the State commits to enforcing *only* the harvesting rule within the *status quo* tenure system. Rationality demands that the State grants concessions on farms. Since the compensation rule would be relaxed, the unique Nash equilibrium of the State's commitment in the game would be Outcome 7 with payoffs ($\pi - \lambda_S - \delta_S$; $\mu - \delta_F + \nu_{F1} - \lambda_F$; $\omega - \nu_C$). Note that the concessionaire's best response to the State's commitment is not to pay compensation regardless of whether the farmer will engage in illegal logging or not. Moreover, the farmer engages in illegal logging based on the belief that the expected value of illegal logging is greater than the deterrence cost and that the concessionaire will not pay compensation. This implies that the farmer is more likely to continue to engage in illegal logging even if the State enforces only the tree harvesting rule within the current tenure and compensation regime.

It could be discerned from the foregoing argument that, *ipso facto,* the off-reserve forests are less likely to be sustained should the State enforce *only* the harvesting rule within the *status quo*. Now, consider a scenario whereby the government, after granting concession to the concessionaire, commits to enforcing *only* the compensation rule within the current tenure regime. The unique Nash equilibrium of such a commitment would be Outcome 14, with payoffs ($\pi - \gamma_S - \delta_S$; $\mu - \delta_F + \alpha_F + \nu_{F1}$; $\omega - \alpha_C - \nu_C$). Here, it will be irrational for the concessionaire to refuse to compensate the farmer because 'pay compensation' strictly dominates 'do not pay compensation'. Note that wherever the compensation rule is enforced in the game, the concessionaire's best response is to pay compensation and vice versa. The hypothesis thus proposed is:

> **Hypothesis 5**: The concessionaire will compensate the farmer if the State enforces the compensation law.

In contrast, the farmer will have no incentive to desist from illegal logging if only the compensation rule is enforced.

The above analyses show that committing to enforcing either of the forest rules within the current tenure and compensation regime is less likely to alter farmers' illegal logging behaviour. Consequently, the study assumes a scenario where the State commits to enforcing both the harvesting rule and the compensation rule while still denying farmers any timber rights. This commitment will yield a unique Nash equilibrium corresponding to Outcome 6, with payoffs ($\pi - \lambda_S - \gamma_S - \delta_S$; $\mu - \delta_F + \alpha_F + \nu_{F1} - \lambda_F$; $\omega - \alpha_C - \nu_C$). Since the compensation rule is enforced, the concessionaire will compensate the farmer for crop damage. On the contrary, the equilibrium dictates that the farmer engages in illegal logging. Therefore, the concurrent enforcement of the tree-harvesting and compensation rules will not dissuade the farmer from illegal logging. In summary, enforcing either the harvesting rule, the compensation rule or both within the current off-reserve tenure regime is less likely to induce sustainable behaviour among farmers. This demands that the evaluation moves beyond the restrictive confines of the current tenure regime.

Now, consider a scenario where the State commits to recognising farmers' rights to timber revenue without enforcing either of the forest rules. The unique Nash equilibrium resulting from this commitment is Outcome 30, with payoffs ($\pi - \beta_S - \delta_S$; $\mu + \beta_F - \delta_F + \nu_{F2}$; $\omega - \beta_C - \nu_C$). Notice that this outcome leads to forest degradation because the farmer's best response is to retain both tree types and then engage in illegal logging. As expected, the concessionaire will not pay the compensation regardless of the action by the farmer because the law is relaxed. Therefore, committing to granting timber rights to farmers without enforcing either of the forest rules is less likely to motivate farmers to desist from illegal logging.

Suppose that the State commits to enforcing the compensation rule in addition to granting timer rights to farmers. The unique Nash equilibrium for such a commitment would be Outcome 31 with payoffs ($\pi - \beta_S - \gamma_S - \delta_S$; $\mu + \beta_F - \delta_F + \alpha_F + \nu_{F2}$; $\omega - \beta_C - \alpha_C - \nu_C$). Here, the concessionaire will have no option than to compensate the farmer. In contrast, the strictly dominant strategy of the farmer is to retain both trees types and engage in illegal logging. Note that there will be no deterrence cost for illegal logging which makes engaging in illegal logging more attractive than otherwise. Therefore, enforcing the compensation rule in addition to granting timber rights to farmers without enforcing the harvesting rule is less likely to sustain the forest.

Now suppose that instead of enforcing the compensation rule, the State commits to enforcing only the tree harvesting rule in addition to the recognition of farmers' right to formal benefits from concession logging. The unique Nash equilibrium for such a commitment will be Outcome 33 with payoffs ($\pi - \beta_S - \lambda_S$; $\mu + \beta_F - \delta_F$; $\omega - \beta_C$). Equilibrium play specifies that the concessionaire refuses to pay compensation to the farmer. In contrast, the equilibrium dictates that the farmer retains both tree types and desists from illegal logging because illegal logging becomes a net cost after recognition of farmers' rights (i.e., $\lambda_F > \nu_{F2}$). This implies that the forests are more likely to be sustained should the government grant right to farmers and enforce the tree harvesting rule. The hypothesis thus proposed is:

> **Hypothesis 6**: Granting timber rights in addition to enforcing the tree harvesting rule is more likely to reduce farmer's willingness to engage in illegal logging

Two main issues arise from the above prediction. First, the commitment lacks credibility in the forest management game. Granting timber rights to farmers is dominated by 'do not grant timber rights'. Therefore, the State has no incentive to commit to granting timber rights and enforcing the tree harvesting rule. Second, the equilibrium strategies prescribed by this commitment leads to non-payment of compensation. This will violate farmers' right to appropriate compensation as legally required. Thus, whereas the commitment can resolve tenure conflicts and the farmer-driven illegal logging menace, it will fail to resolve compensation conflicts in the off-reserve landscape. The following sections will therefore address these issues by altering some of the conditions of the original game.

6.4.2 Achieving credibility for the State's optimal *commitment*: a modified forest management game

To achieve credibility, the commitment must be an optimal action in the entire game (Dixit *et al.* 2015). This can be achieved by changing one's payoffs in the original game to rationalise the commitment made (Dixit *et al.* 2015). Therefore, granting rights to farmers and enforcing the tree harvesting rule must be specified by the subgame perfect equilibrium (SPE) of the game. This calls for a change in at least one of the assumptions underlying some of the parameters of the State's payoffs in the original game to make $\pi - \delta_S$ inferior to $\pi - \beta_S - \lambda_S$. Notice that one possible condition is $\delta_S > \beta_S + \lambda_S$. However, this can occur only when there is a change in the State's current preferences.

Now consider a situation where the preferences of the State change in favour of the conservation of the off-reserve forests such that the value of forest degradation becomes greater than the sum of the values the State loses to granting timber rights to farmers and enforcing the tree harvesting rule.[40,41] That is:

$$\delta_S > \beta_S + \lambda_S \tag{6.9}$$

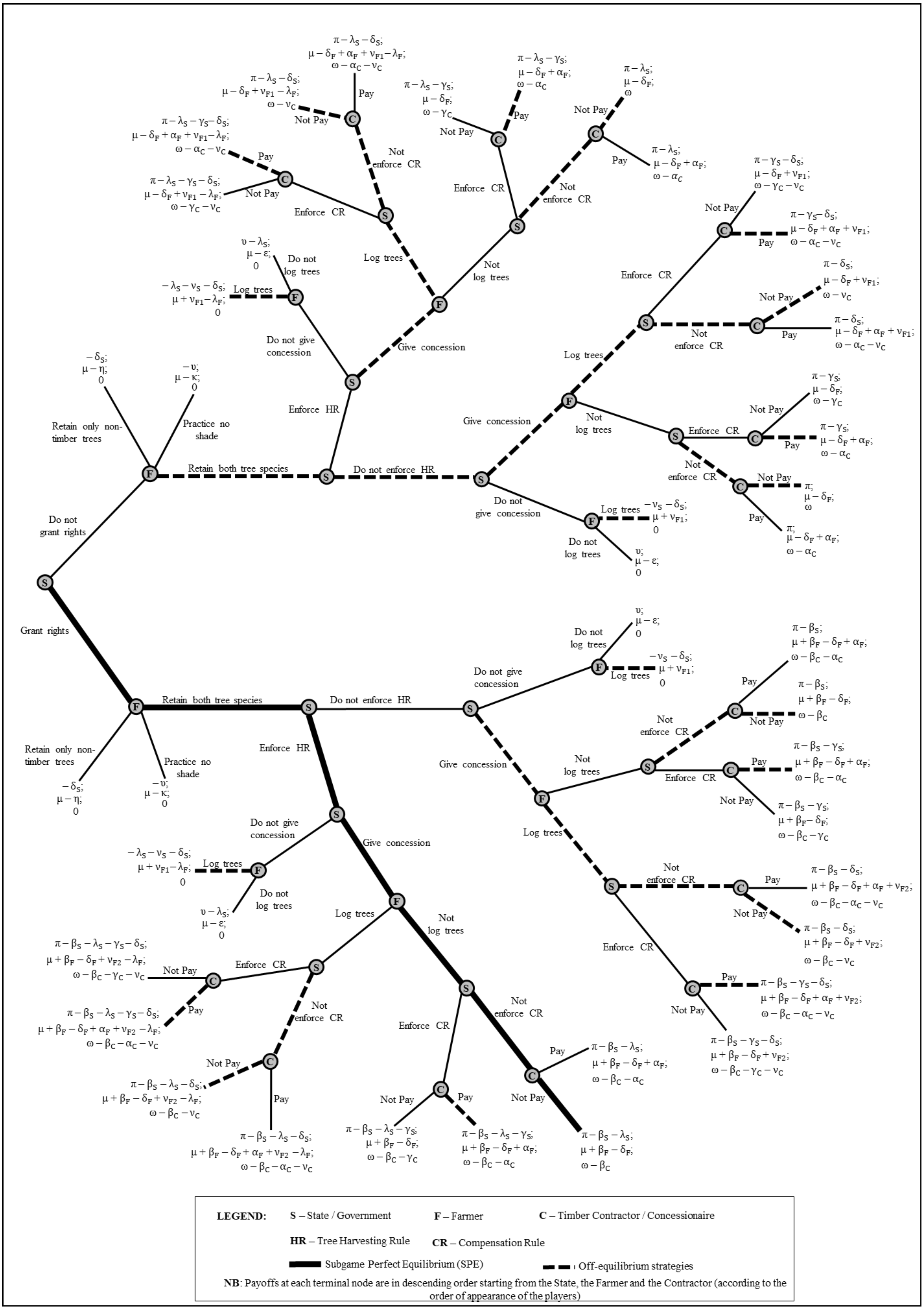
In such a scenario, forest degradation becomes more costly to the State.[42] Thus defined, the modified or induced game proves to have several subgame equilibria.[43] However, Outcome 34 becomes the SPE with payoffs ($\pi - \beta_S - \lambda_S$; $\mu + \beta_F - \delta_F$; $\omega - \beta_C$). This is depicted in Figure 6.9.

[40] This is the minimal plausible condition that is required to optimise the commitment. All other conditions specified in the original game remain unchanged.

[41] Changes in priority can occur through change in government, alarming rates of degradation or deforestation, civil society pressure for the sustainability of the off-reserve forests and donor incentives such as REDD+, MTS and FLEGT. However, the mechanisms through which such a change in priority can occur is beyond the scope of the current study.

[42] Note that the payoff functions for this modified game remain the same as that of the original game (Figure 6.9). Only the assumptions underlying the above parameters differ.

[43] It is assumed that the payoffs of the modified game are common knowledge.



Source: Author's Construct, 2017

Figure 6.9 Modified forest management model

The strategy specified by the SPE (Outcome 34) corresponds to the State's commitment under review. The SPE specifies that the State grants farmers the right to formal benefits from concession logging together with the enforcement of the tree harvesting rule. It would be irrational for the State to deny farmers the right to formal benefits from concession logging. This is because the unique Nash equilibrium of the subgame initiated by this action (Outcome 15) is inferior to Outcome 34 (i.e., $\pi - \delta_S < \pi - \beta_S - \lambda_S$). Based on this belief, the State moves to grant farmers rights to formal timber revenue. Following this, the State will enforce the tree harvesting rule because relaxing the rule will yield an inferior payoff (Outcome 30). The State will have to grant timber concession after enforcing the tree harvesting rule. However, it will not be in the State's interest to enforce the compensation rule because this will reduce its expected payoff by at least γ_S (Outcome 35). Accordingly, the State proceeds to relax the compensation rule leading to Outcome 34. Here, the best response of the farmer is to retain both tree types and desist from illegal logging. In contrast to this, the best response of the concessionaire is to refuse to compensate farmers for crop damage. In short, the SPE of such a modified game will lead to sustained forests.

The above analysis is therefore a game-theoretic proof that a marked change in the State's value (or cost) of forest degradation is more likely to achieve credibility for the State's commitment to grant rights to farmers in addition to enforcing the tree harvesting rule. However, the change will be effective only if the resultant value of forest degradation exceeds at least the sum of the cost of granting timber rights and enforcing the tree harvesting rule. This is expected to, theoretically, control the illegal logging menace and sustain the forests. Yet, such a strategy will not be morally compatible and legitimate because it will violate the legal right of farmers to appropriate compensation for crop damage. This concern is addressed next.

6.4.3 Addressing legality and legitimacy in the modified game: A modified forest management game with third-party litigation

To address issues of legality and legitimacy, the rules of the modified game (Figure 6.9) need to be altered. Suppose that a third-party advocate such as a more resourced individual, cocoa farmers' association, or a civil society organisation pursues compensation on behalf of farmers through the court system anytime the farmer is not compensated. If the non-payment is as a result of failure to enforce the compensation rule, both the State and the concessionaire become the defendants of the compensation suit and are therefore liable to bear the costs of the sanctions imposed by the court. If the concessionaire fails to pay compensation even when the law is enforced by the State, the concessionaire will solely bear the cost of the sanctions imposed by the court. Since the mission of the advocate is to ensure that farmers are compensated, it is taken that there will be no court action if the concessionaire pays compensation when the compensation law is relaxed by the State.

Let θ_S and θ_C respectively represent the litigation costs of the State and the concessionaire in the above litigation scenario. It is assumed that justice will prevail and the court will order the FC to retrieve the outstanding compensation from the concessionaire. This implies that θ_S includes the cost incurred by the State during the litigation process and the sanctions imposed (fines as well as the cost of retrieving the compensation after litigation). Likewise, θ_C includes cost incurred during the litigation process, the cost of sanctions imposed by the court (court fines plus cost of paying compensation after the ruling) and a diminished logging reputation in the public domain. It therefore follows that the State's cost of litigation is expected to be greater than the cost of enforcing the compensation rule without litigation. That is:

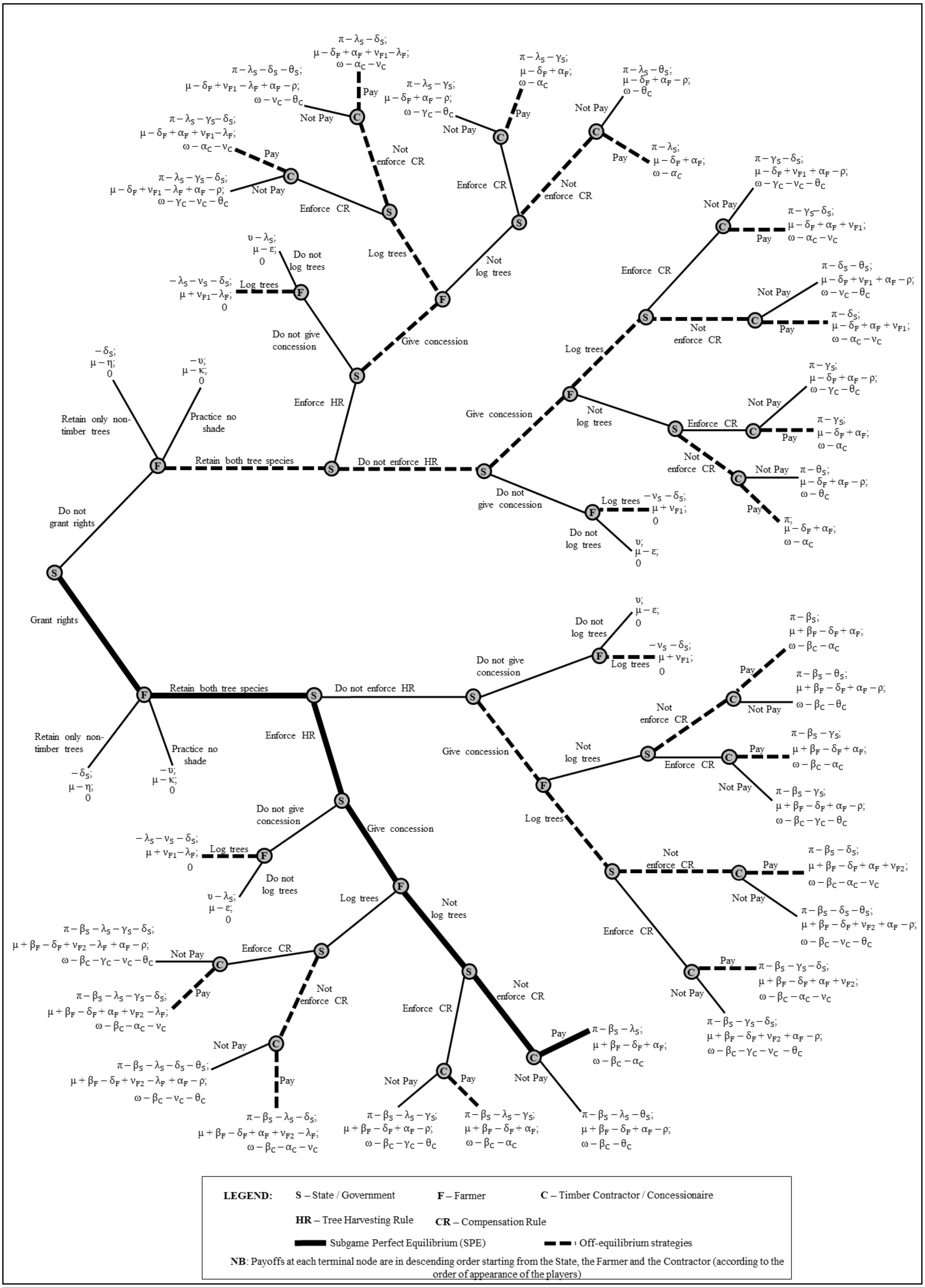
$$\theta_S > \gamma_S \tag{6.10}$$

Likewise, the concessionaire's cost of litigation is expected to be greater than the cost of compensating the farmer without litigation. That is:

$$\theta_C > \alpha_C \tag{6.11}$$

By contrast, it is expected that the farmer will receive compensation for crop damage as a result of the legal action. However, the value of the compensation is expected to be reduced by the cost of the farmer's involvement in the legal action and delayed compensation.[44] Let ρ be the value of compensation amount lost by the farmer due to the court action. It therefore follows that the farmer is expected to receive $\alpha_F - \rho > 0$, as compensation after the litigation. Figure 6.10 depicts the modified model incorporating the values for litigation. It can be observed that the payoff functions of 16 outcomes have changed to reflect the values from the compensation litigation. The payoff functions of all other outcomes that do not involve non-payment of compensation in the modified game remain unchanged.

[44] The value of compensation can be reduced by the farmer's value of the productive hours lost to the litigation process as a witness. It can also be reduced by (an unlikely) contract with the advocacy group to have a small share (e.g., 10%) of the compensation payment deducted as honorarium or service fee.



Source: Author's Construct, 2017

Figure 6.10 Modified forest management model with third-party litigation

These new assumptions, in addition to the unchanged assumptions specified under the previous games, are assumed to be common knowledge. Thus defined, the model has several subgame equilibria. However, the subgame perfect equilibrium of the game corresponds to Outcome 33 with payoffs ($\pi - \beta_S - \lambda_S$; $\mu + \beta_F - \delta_F + \alpha_F$; $\omega - \beta_C - \alpha_C$). The SPE prescribes that the State grants formal rights to farmers, grants concession and enforces *only* the harvesting rule if forest degradation is more costly and there is a credible external threat of court action for non-payment of compensation. Conversely, the SPE dictates that the concessionaire pays the agreed compensation whenever there is a credible external threat of litigation. It was observed in previous models that the concessionaire has no incentive to compensate the farmer so long as the State relaxes the compensation rule. However, this observation changes when a third-party court action is introduced. Here, not paying compensation is strictly dominated in the entire game irrespective of the enforcement situation. The hypothesis thus proposed is:

> **Hypothesis 7**: The concessionaire is more likely to pay the agreed compensation to the farmer if there is a credible external threat of litigation.

The SPE specifies that the farmer retains optimal levels of both tree types and desists from illegal logging if farmers' rights are recognised by the State, the harvesting rule is enforced and full compensation is paid. It can be observed from the subgame leading to Outcomes 33 to 42 that engaging in illegal logging is strictly dominated and that the farmer will desist from illegal logging regardless of the compensation situation. Hence, the payment of compensation as specified by the SPE will be an additional incentive for farmers to retain both tree types and desist from illegal logging. This argument is summarised in hypothesis 8:

> **Hypothesis 8**: Farmers' willingness to engage in illegal logging is more likely to reduce if they have rights to timber trees, receive agreed compensation and the tree harvesting rule is enforced.

In sum, the above analysis indicates that the addition of a third-party litigation is more likely to ensure that farmers are fully and promptly compensated for crop damage in the off-reserve landscape. This will help address issues of legality and legitimacy arising from the move to ensure sustainable farming through tenure reforms and deterrence.

6.5 Conclusion

The game-theoretic models in this chapter have provided formal theoretical explanations for the uncooperative behaviour of farmers, concessionaires, and the State in their off-reserve interactions. The analyses reveal that the current behaviours of these actors are consistently rational. The models on the compensation conflicts have proven that average cocoa farmers are less likely to receive full compensation from concessionaires when they continue to pursue compensation within the strictures of the prevailing socio-political system regardless of the strategy adopted. In fact, the receipt of compensation, part or full; prompt or delayed, is more likely to be dependent on the social-political status of farmers and the altruistic characteristics of concessionaires. This notwithstanding, concessionaires are more likely to fully and promptly compensate farmers for crop damage when the compensation law is enforced by the State or when there is a credible threat of litigation by a third-party advocate. Further, farmers will be more willing to desist from unsustainable practices such as illegal logging when they are given a competitive proportion of on-farm timber revenue, fully compensated and the tree harvesting law is strictly enforced by the State. The forest management models give a theoretical proof that such a policy mix option is more likely to be optimal in resolving tenure and compensation conflicts and, ultimately, in inducing sustainable behaviour among farmers in the off-reserve forests.

Chapter 7. Empirical Results on the Current Behaviour of Farmers and Concessionaires

This chapter presents results of the empirical analyses to verify the game-theoretic insights into the current behaviour of farmers and concessionaires (presented in Chapter 6). It presents the survey results on the characteristics of sampled cocoa farmers and concessionaires, farmers' current tree retention behaviour, illegal logging and on-farm logging compensation. The chapter begins with the presentation of the demographic and socio-economic characteristics of farmers. These are followed by farming characteristics. The chapter then proceeds to present background information about surveyed concessionaires. It follows this with empirical results on farmers' current tree retention behaviour. Results on on-farm concession logging compensation including logging consent, extent of crop damage, compensation payment and factors influencing farmers' receipt of full compensation are presented next. These are followed by results on the current illegal logging activities of farmers.

7.1 Characteristics of Respondents

This section provides the demographic, socio-economic and farming characteristics of cocoa farmers. It also presents the profile of surveyed concessionaires

7.1.1 Characteristics of farmers

The farmers survey revealed that cocoa farmers are ageing. The mean age for farmers was 51 years (within the 50 – 54 age cohort), with about 55% of farmers aged 50 years and above (Table 7.1). The median age for cocoa farmers was 50.5 years. Males constituted 75% of the survey respondents. The majority of the sampled farmers were married (77.5%) and the average household size was 8.1 (Std. Dev. = 5.097). These results are consistent with results from other cocoa farmers surveys within the past decade (e.g., Teal *et al.* 2006; Opoku *et al.* 2009; Hainmueller *et al.* 2011; Svaton 2012; Kuklinski and Adhuze 2013; Ogoe 2015).

The five study regions are predominantly Akan regions (GSS 2013b). Therefore, the ethnicity of the respondents as indicated in Table 7.1 is a reflection of the general ethnic compositions of the regions. The majority of the farmers (71.3%) identified themselves as Akans, which is closer to the average of 68.8% for the five regions reported by the 2010 Population and Housing Census (GSS 2013c, 2013d, 2013e, 2013f, 2013g) and that of

Hainmueller *et al.* (2011). Moreover, 56.5% of the respondents were natives of their respective villages while 43.5% were migrants.

Table 7.1 Socio-demographic characteristics of farmers

Variable	**N**	**%**
Age (years)		
25 – 29	10	2.5
30 – 34	21	5.2
35 – 39	47	11.8
40 – 44	44	11.0
45 – 49	59	14.8
50 – 54	74	18.5
55 – 59	43	10.2
60 – 64	32	8.0
65+	70	17.5
Total (N)	400	100.0
Ethnicity		
Akan	285	71.3
Northern	73	18.2
Ewe	28	7.0
Ga-Adangbe	8	2.0
Guan	2	0.5
Missing	4	1.0
Total (N)	400	100.0
Education		
No formal education	103	25.7
Primary education	47	11.7
Middle School/JSS	191	47.8
Secondary Education (SSS/Voc/Tech)	39	9.8
College/Tertiary	20	5.0
Total (N)	400	100.0
Monthly per capita income (GH¢)		
Below 66.0	72	18.0
66.0 – 109.4	81	20.2
109.5 and above	247	61.8
Total (N)	400	100.00
Leadership position in community		
Top-level leader (Chief, Regent, Assembly member, spiritual leader)	61	15.2
Lower-level leader (all other positions of authority in the village)	157	39.3
No leadership position	182	45.5
Total (N)	400	100.0

Source: Field Survey, 2016.

The educational levels of farmers were low. The survey results shown in Table 7.1 indicate that 25.8% of respondents have had no formal education whiles 44.8% only completed basic education (Middle School or Junior High School). The Ghana Cocoa Farmers Surveys (GCFS) revealed similar findings about the educational statuses of cocoa farmers

(Svaton 2012). The analysis also revealed that 55.5% of the surveyed farmers occupied positions of authority in their respective communities of residence with 15.3% occupying top-level leadership positions. Moreover, 69.3% of farmers were connected to people in positions of authority in villages either as close relatives or friends. Again, 58.2% of respondents who had no positions of authority had close relatives or friends in positions of authority in their respective communities of residence.

The average monthly income per capita for farmers was GH¢ 202.06 (Std. Dev. = 237.82): an equivalent of US$53.04 per month.[45] Table 7.1 shows the categorisation of farmers according to the poverty lines used by the Ghana Statistical Service in its recent Ghana Living Standards Survey (GLSS6).[46] Using the upper poverty line of GH¢1314.00 (GH¢109.5 per month), the analysis revealed that about 38.3% of respondents can be classified as poor. This result is close to the national poverty incidence of 39.2% among self-employed agricultural workers in 2013 (GSS 2014).

Cocoa farming in Ghana is a smallholder activity, and this was confirmed by results from the survey. The average farm size for the sample was 4.9 ha (Std. Dev. = 3.62). This is closer to the GCFS which reported an average farm size of around 4.1 ha for the 2008/2009 crop year (Opoku *et al.* 2009; Svaton 2012). As indicated in Table 7.2, most of the cocoa farms were in their peak yield period (between 11 to 20 years), with an average age of 19.1 years (Std. Dev. 10.86). The majority of respondents (about 70% in Table 7.2) owned the farms they cultivated, whereas the remaining 30% practiced sharecropping (*abunu* and *abusa*). This is consistent with the results of Hainmueller *et al.* (2011) referred to in Chapter 3.

The average cocoa farmer has been farming for 23.7 years (Std. Dev. = 11.36). This implies that respondents have much experience in cocoa farming and its associated activities. Cocoa farmers in Ghana cultivate three main varieties of cocoa. These are the *Almenado (Tetteh Quarshie*), the *Amazonia* and the Hybrid *Amazonia* varieties. Table 7.2 indicates that about 61.3% of the sample cultivated the Hybrid *Amazonia* as the main variety, compared with only 12.5% for the traditional *Almenado*.

[45] Exchange rate: GH¢3.8096 to US$1 (BoG, Friday 13th May, 2016). https://www.bog.gov.gh/index.php?option=com_wrapper&view=wrapper&Itemid=89

[46] Adults classified as extremely poor spend below GH¢792.05 per annum whereas those who spend more than the extremely poor but their annual expenditure are below GH¢1314.00 are classified as absolutely poor (GSS 2014).

Table 7.2 Farming characteristics of cocoa farmers

Variable	N	%
Age of farms of respondents (years)		
0 – 4	7	1.8
5 – 10	99	24.7
11 – 20	167	41.8
21 – 30	71	17.7
31 – 40	40	10.0
41 – 50	14	3.5
51 and above	2	0.50
Total (N)	400	100.0
Cropping Arrangement		
Own Farm	278	69.5
Abunu	114	28.5
Abusa	8	2.0
Total (N)	400	100.0
Variety of cocoa cultivated		
Almenado (Tetteh Quarshie)	50	12.5
Amazonia	105	26.2
Hybrid Amazonia	245	61.3
Total (N)	400	100.00

Source: Field Survey, 2016.

7.1.2 Characteristics of concessionaires

The managing director (owner or contractor) of each of the sampled firms served as the respondent in the concessionaire survey. The average concession size was 18.89 km^2 (n = 14, s = 13.48). Table 7.3 shows that only five (5) of the 14 firms who provided data on concession size had concession sizes more than 20 km^2.

Table 7.3. Total area of concession (km^2)

Range of concession size	N	%
Below 20 km^2	4	28.6
20 km^2	5	35.7
Above 20 km^2	5	35.7
Total (N)	14	100.0

Source: Field Survey, 2016

Based on the classification of firms by the *Timber Resources Management Regulations* discussed in Chapter 3, the concessionaires in the survey can be classified as small-scale. This is not surprising since, by law, only small-scale companies can be granted concessions solely off-reserve (GoG 1998b). The logging firms were also small-scale with regards to the number of employees. Only 5 of the 14 concessionaires who responded to the questions on employee size had 30 or more employees. The rest had 10 employees or below. The concessionaires were found to have considerable experience in off-reserve logging. The average concessionaire has been logging for about 7.23 years (n = 22, s = 5.22), though about 27.73% have been logging off-reserve for close to 15 years. The duration of concession holdings ranged between 5 and 40 years with an average of 21.39 years (n = 18, s = 12.53). Concessionaires revealed that, to be able to operate, they have to renew their operational licence (property mark for operation) every six months irrespective of the contract duration.

7.2 Current Tree Retention Behaviour of Farmers

This section discusses the empirical results on shade tree density and diversity on cocoa farms and farmers' reasons for tree retention besides shading.

7.2.1 Overall on-farm tree retention

The average number of shade trees per ha on cocoa farms of respondents was 6.8 (Std. Dev. = 6.37).[47] As indicated in Table 6.4, 1% of farmers reported that they had no shade trees on their farms. Also, about 9.8% of farmers had farms with shade tree density of 15 per ha or above.

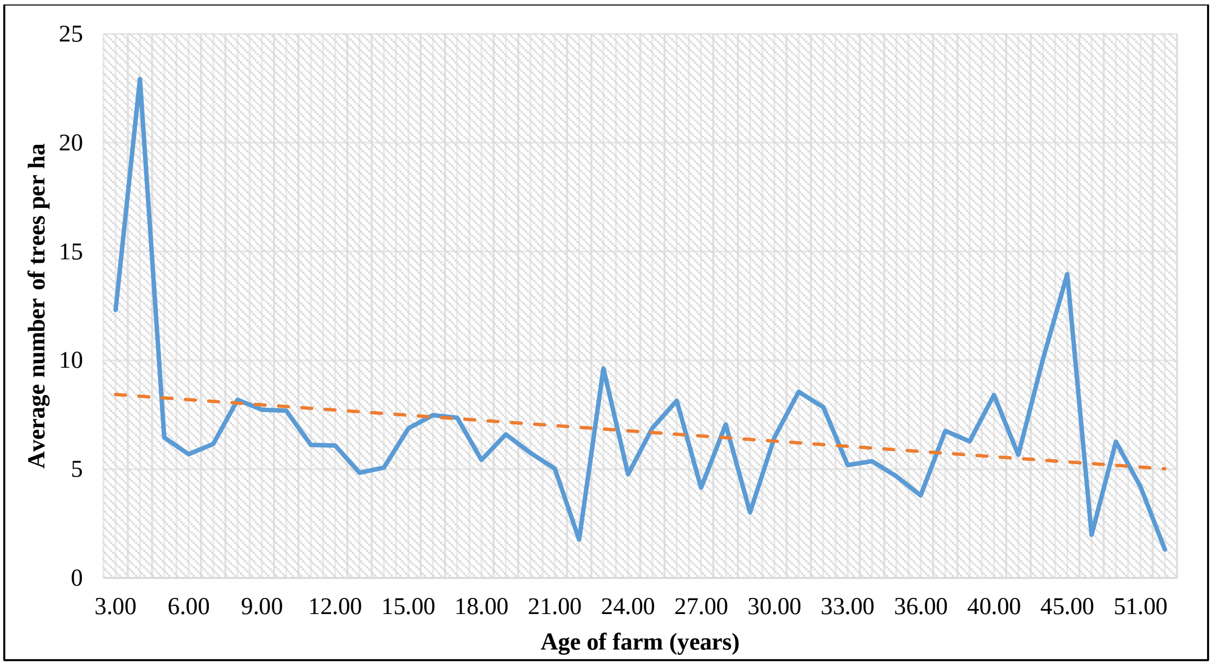
Table 7.4 Number of shade trees per hectare on respondents' farms

Number of shade trees per ha	N	%
0	4	1.0
1 – 4	168	42.0
5 – 9	159	39.8
10 – 14	30	7.5
15 and over	39	9.8
Total (N)	400	100.0

Source: Field Survey, 2016.

It was found that the number of trees on farms declines with the age of farm. This decline is sharp after four years and becomes steady afterwards (refer to Figure 7.1). For instance, the average number of shade trees per ha on new farms (farms aged below 5 years) was about 21. However, this declines sharply to about seven (7) after four years, with only about three (3) trees per ha on farms aged above 50 years.

[47] Farmers also plant or retained fruit trees such as citrus and avocadoes on their farms. However, farmers do not regard them as shade trees. Therefore they were not included in their responses to questions on shade trees.



Source: Field Survey, 2016.

Figure 7.1 Average number of trees existing on the farm by age of cocoa farms

Shade tree density varied slightly among the three varieties of cocoa. Table 7.5 shows that farmers cultivating the *Almenado* variety had more trees on farms than the *Amazonia* and Hybrid varieties. However, a one-way ANOVA conducted on shade tree density by cocoa variety indicated that shade tree density did not significantly differ among the variety of cocoa cultivated (F = 1.134, p = 0.325).

Table 7.5 Average number of shade trees per hectare by variety of cocoa cultivated

Variety of Cocoa	N	Mean	Std. Dev.
Tetteh Quarshie (Almenado)	50	7.6	4.9
Amazonia	105	6.4	4.7
Hybrid Amazonia	245	6.8	7.2
Total (N)	400	6.3	6.4

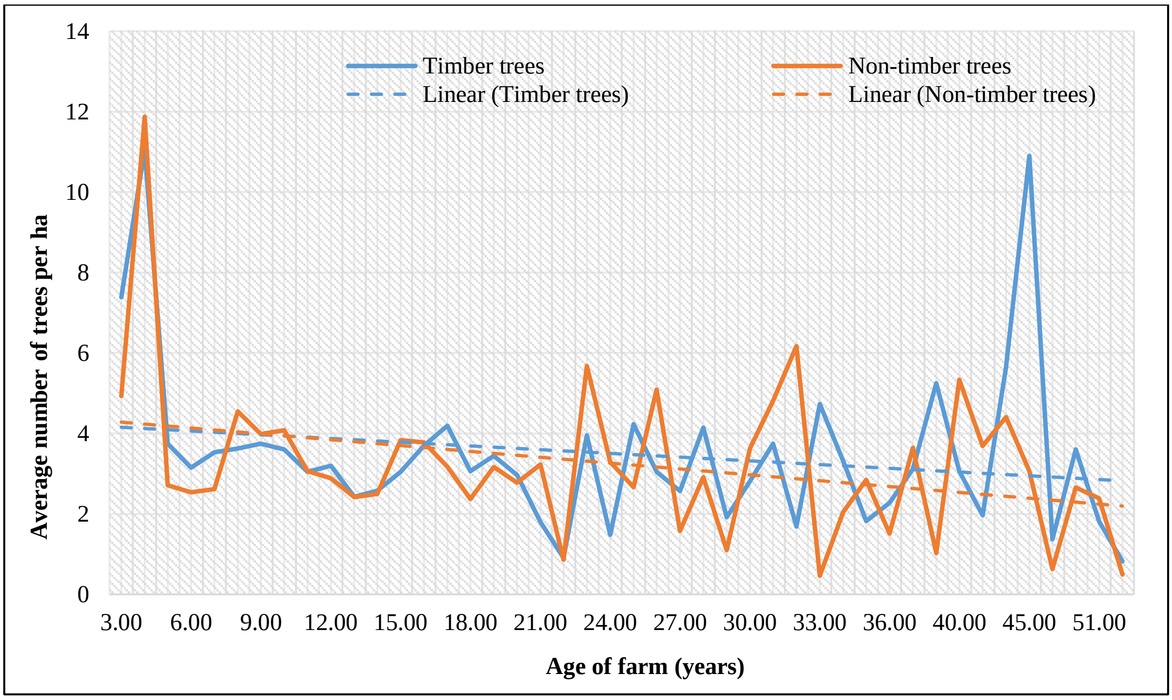
Source: Field Survey, 2016.

The survey also revealed that about 38% of shade trees on farms were nurtured by farmers from infancy either as saplings or coppices. On average, close to three shade trees (per ha) on farms have been nurtured by farmers from infancy. For saplings, farmers sometimes purchased seeds and nursed them before inter-planting with cocoa seedlings.

7.2.2 Tree retention by type of trees

The survey revealed that timber trees retained on farms were slightly more than non-timber trees. About 52% of shade trees on farms were timber species and the average number of timber trees and non-timber trees on a typical farm were 3.5 and 3.3 per ha respectively. However, a paired-sample *t-test* conducted on the types of shade trees did not show any statistically significant difference between the number of timber trees and non-timber trees retained by farmers (t = – 0.066, p = 0.952).

The density of non-timber trees was found to be slightly higher on new farms. The average number of non-timber trees on these farms was 10.9 compared to 10.5 for timber trees. However, this difference evened-out as the age of farms increased. The trend indicates that farmers retained close to equal proportions of timber and non-timber tree species until after peak production years (20 to 30 years, depending on the variety).



Source: Field Survey, 2016.
Figure 7.2 Average number of timber and non-timber trees existing on the farm

7.2.3 Reasons for retaining shade trees

Besides shading, the most important reason for farmers' tree retention is their intention to harvest them for personal domestic construction. As indicated in Table 7.6, 76.8% of respondents revealed that they retain trees with the intention of harvesting them for domestic construction. This reason was followed by intention to sell trees to make a living (50.8% of respondents). It can therefore be said that apart from shading, economic motivations underlie farmers' on-farm tree retention since only 6.7% of the respondents did not retain trees for either or both of the economic reasons (harvest for construction or sell for a living).

Table 7.6 Reasons respondents retain shade trees apart from shading

Reasons	%	Rank
Harvest for construction	76.8	1st
Sell for a living	50.8	2nd
Fruits or medicinal purposes	37.3	3rd
Cultural (religious) reasons	6.8	4th

Source: Field Survey, 2016.
Note: Multiple responses, percentages based on N = 400

It is worth nothing that tree density differed markedly among farmers with respect to their non-shading purposes for tree retention. The reasons in Table 7.6 can be broadly categorised as illegal logging intentions (harvest for construction and sell for a living) and other intentions (fruits, medicinal and cultural). Table 7.7 captures shade tree density according to these broad categorisation. It shows that about 93.3% of farmers have illegal logging intentions for retaining shade trees. This category of farmers have 3.5 trees per ha more than those without illegal logging intentions. A t-test showed this mean difference to be statistically significant with a large effect size (t = 5.799; p = 0.001; r = 0.618)

Table 7.7 Non-shading purposes of tree retention and shade tree density

Reasons	N	Mean shade density per ha	Std. Dev.
Illegal logging intentions	373	7.1	6.5
Other intentions	27	3.6	2.6
Total	400	6.3	6.4

Source: Field Survey, 2016.

7.3 On-farm Concession Logging and Compensation for Crop Damage

This section presents the survey results on on-farm logging interactions between farmers and concessionaires.

7.3.1 Compensation payment investigated from the side of farmers

The survey revealed that concessionaires have logged trees on the farms of 181 farmers out of the 400 farmers interviewed. Contrary to legislative requirements, only 43.7% of these farmers were consulted by the concessionaires before commencing logging. Moreover, only 52.2% of those who responded to questions on consent to logging consented to logging on their farms. This indicates that almost half of the respondents did not consent to logging on their farms but the concessionaires went ahead to log. Also, only 3.7% gave written consent to concession logging on their farms.

On-farm logging by concessionaires damages cocoa and other inter-planted crops such as oil palm, plantain, cassava, and cocoyam. It was found that only about 61% of farmers who have had concession logging on their farms were able to make compensation agreements with farmers. Again, only 25.9% of those who have had concession logging on their farms received full compensation as agreed with respective concessionaires (Table 7.8). About 30.9% were partly compensated for crop damage whereas 44.2% did not receive any form of compensation. The average compensation received by farmers was GH¢11.63 (US$3.05) per damaged cocoa crop. However, about 44.2% of the farmers compensated received less than GH¢5 (US$1.31) per damaged cocoa crop. There was no updated government standards for compensation payment (cf. Hansen 2011).[48] Therefore, farmers and concessionaires resorted to negotiations to arrive at an acceptable compensation amounts. The compensation negotiation was made after felling and hauling, when the extent of farm damage has been ascertained. It was paid as a lump-sum for each of the types of crops damaged on the farm. Per crop compensation rates were scarcely applied. Farmers who received compensation for crop damage were somewhat dissatisfied with the compensation they received (mean satisfaction level: 2.49).[49] Moreover, about 48.0% of the farmers who received some form of compensation received them after conveyance.

Table 7.8 On-farm logging compensation investigated from the side of farmers

Level of compensation received	**N**	**%**
Full payment as agreed between farmer and concessionaire	45	24.9
Part of agreed amount	56	30.9
Not at all	80	44.2
Total (N)	181	100.0

Source: Field Survey, 2016.

The study sought to investigate the payment of tree-tending fee by concessionaires to farmers in accordance with the Manual of Procedures (FC 1998). It was found that only 10.5% of farmers who have had concession logging on their farms received payment from concessionaires as tree-tending fee. The average amount received by these farmers was GH¢80.78 (US$21.20) per timber tree. However, about 44.4% received GH¢50

[48] The “official” compensation rate provided by the Land Valuation Board and reported by Richards and Asare (1999) was GH¢0.96 (US$ 0.25). However, farmers and concessionaires in the survey were not aware of any compensation standards.
[49] Satisfaction was measured on a 5-point Likert scale.

(US$13.12) or less. The average tree tending fee is about 10% of the stumpage value of timber trees (moderate and high demand species). Farmers in the survey rated the performance of concessionaires as poor (mean performance rating: 2.491.7) due to non-payment of compensation, unsatisfactory compensation, delayed payment of compensation and non-payment of tree-tending fees. [50]

7.3.2 Compensation payment investigated from the side of concessionaires

All concessionaires (N = 30) revealed in the survey that they do consult and secure the verbal consent of farmers before logging on farms. To them, there cannot be on-farm logging without farmer-consultation and consent. However, some concessionaires revealed that 'other' concessionaires do not consult farmers or seek for their consent before logging and this usually leads to violent conflicts and other physical confrontations. About 26.7% of the concessionaires indicated that they are aware of government standards for compensation. Yet, none of these respondents was able to give details of these standards. Only 13.3% of the concessionaires agreed with standard setting by the government. To concessionaires, the same compensation standard applies to temporary damages, permanent damages, and displacement in all industries. However, unlike the mining and construction industries, logging is only temporary, farmers are not displaced, and damaged crops and saplings are able to regerminate. Thus, they were of the view that compensation standards are inappropriate for and inapplicable to the forestry sector. About 60% of the concessionaires were also of the view that the one-size-fits-all standards are not applicable to on-farm crop damage because farms differ in ages and cocoa variety.

Concessionaires did not appear to have compensation problems with farmers. Only two of the respondents (7%) indicated that they have ever had problems with farmers with regards to compensation payment. One (3.5%) had a disagreement with the farmer with regards to the compensation amount which led to delayed payment and verbal confrontations. The other concessionaire had a disagreement with the farmer during negotiation and did not pay the compensation. Therefore, non-payment of compensation was rare when examined from the side of concessionaires. This result contradicts the data from farmers that showed that off-reserve logging is replete with compensation conflicts. Nonetheless, the study gave much credence to the data from farmers for two main reasons. First and most importantly, the data from farmers are consistent with the findings of previous research on off-reserve logging compensation (Inkoom 1999; Marfo *et al.* 2006; Hansen 2011; Otutei 2012).

[50] Performance of concessionaires was measured on a 5-point Likert scale.

Second, concessionaires have been found to respond strategically to questions on compliance with regulations on consultation, consent and compensation payment (Hansen 2011).

Concessionaires in the survey revealed that the Forest Service Division (FSD) is seldom involved in on-farm logging compensation issues. Concessionaires indicated that the FSD officials only check for the satisfaction of the technical logging requirements for issuing the Conveyance Certificate. It usually issues the certificate once these technical requirements are satisfied by concessionaires. They do not check for the satisfaction of the compensation requirement before issuing the certificate. Compensation negotiations, agreements and payments are mostly left to the concessionaires and farmers to settle. Personal communications with some FSD officials confirmed this information from the concessionaires.

About 14% of the concessionaires indicated that they sometimes make payments for each tree to farmers before they (farmers) consent to logging on their farms. This is the tree tending fee. However, both farmers and concessionaires regarded it as tree payment. Due to this, some concessionaires (10.5%) revealed that some farmers do not demand compensation for crop damage when they make acceptable tree payments.

7.3.3 Factors influencing farmers' receipt of compensation from concessionaires

The game-theoretic models revealed that the receipt of compensation is dependent on the type (i.e., social status) of farmers. A binary logit model was estimated to verify this theoretical finding. The social status of a farmer was represented by two proxy variables. These are leadership position within the village and higher education. Leadership position and higher education are highly esteemed in rural areas in Ghana and these confer some higher statuses on farmers. The dependent variable was actual *receipt of full compensation* with 1 being fully compensated and 0 representing not fully compensated. There were eight (8) independent variables. These are described in Table 7.9. All independent variables were dichotomous. Age and household income, as continuous variables, violated the assumption of linearity in the logit models. Hence, they were recoded into dummy variables following the advice in the literature (e.g., Hosmer and Lemeshow 2000; Field 2013). Age was recoded into whether a farmer is below median age (50 years) or Not. Household income was recoded into whether a farmer is poor (earns below GH¢109.5 per capita per month) or non-poor (earns GH¢109.5 per capita per month and above).

Table 7.9 Description of variables in the binary logit model for full compensation

Variables	Description and coding	Mean	Std. Dev.
Age	Whether a farmer is below median age (50 years) or Not. 'No' = 0; 'Yes' = 1	0.45	0.50
Sex	Whether a farmer is male or female. 'Female' = 0; 'Male' = 1	0.75	0.43
Education	Whether a farmer has at least secondary education. 'No' = 0; 'Yes' = 1	0.15	0.36
Income poverty category	Whether a farmer is poor (earns below GH¢109.5 per capita per month) or non-poor (earns GH¢109.5 per capita per month and above). 'No' = 0; 'Yes' = 1	0.38	0.49
Top-level leadership	Whether a farmer is a top-level leader in the forest village. 'No' = 0; 'Yes' = 1	0.15	0.36
Lower-level leadership	Whether a farmer is a lower-level leader in the forest village. 'No' = 0; 'Yes' = 1	0.39	0.49
Socio-political connection	Whether a farmer has a close relative or friend in leadership position in the village. 'No' = 0; 'Yes' = 1	0.69	0.46
Residency Status	Whether a farmer is a native of the village or non-native. 'No' = 0; 'Yes' = 1	0.57	0.59

Source: Field Survey, 2016.

The results of the logit model are reported in Table 7.10. The model is a good fit to the data (Hosmer and Lemeshow Test: $\chi^2 = 5.246$, $p = 0.731$) and correctly predicts 72.9% of the cases. Also, the model explained about 33.6% ($R^2 = 0.336$) of the variations in the logit of receipt of full compensation. Only three of the independent variables made statistically significant contributions to the model. These include higher education, top-level leadership and lower-level leadership. The model revealed that farmers with secondary education or higher were about 36% more likely to receive full compensation than those with no secondary education. Top-level leaders in the community were 58% more likely to receive full compensation than non-leaders. Similarly, lower-level leaders were about 38% more likely to receive full compensation than non-leaders. Thus, there is ample evidence from the data to support the game-theoretic findings that the receipt of full compensation is directly related to the social statuses of farmers within the forest communities.

Table 7.10 Results of the binary logit model on receipt of compensation by farmers

Individual factors	*β*	Marginal Effects
Age	-0.610 (0.416)	-0.15
Sex	-0.465 (0.484)	-0.12
Education	1.553 (0.605)	0.36**
Residency Status	-0.451 (0.419)	-0.11
Income poverty category	-0.423 (0.419)	-0.10
Top-level leader	3.224 (2.608)	0.58***
Lower-level leader	1.594 (0.509)	0.38**
Socio-political connection	-0.467 (0.472)	-0.12
Constant	-0.321 (0.590)	
Model χ^2	52.346***	
Nagelkerke R^2	.336	
Correctly predicted (%)	72.9	
N	181	

*$p<0.05$; ** $p<0.01$; *** $p<0.001$. Standard errors in parentheses

Source: Field Survey, 2016

7.4 Current Illegal Harvesting Behaviour of Farmers

This section presents results on farmers' direct involvement in illegal logging, support for farmer-driven illegal logging and preference for chainsaw logging to conventional logging.

7.4.1 Involvement in illegal logging

Farmer-driven illegal logging was found to be widespread in the off-reserve forests. Out of the 400 cocoa farmers interviewed, 92.3% of them have had at least a tree harvested on their farms by chainsaw operators. These farmers either sold the trees to operators, hired their services for a cash fee, shared lumber with operators or did a combination of these. On the average, farmers who sold trees to chainsaw operators were paid GH¢231.55 (US$60.78) per tree. This constitutes about 27.4% of the average stumpage value of the timber trees (moderate and high-demand species). This is not far from the one-third reported in the literature. Illegal harvesting of on-farm trees was also found to be a prevalent phenomenon in the study communities. For instance, the survey showed that 91.5% of the respondents were aware that farmers in their respective communities harvest trees from their farms. Moreover, farmers strongly agreed with the statement that 'farmers should harvest timber trees on their farms' (mean level of agreement = 4.60; Std. Dev. = 1.07). In fact, only 10% of the 400 farmers did not agree to this statement, whereas 83.3% of them strongly agreed with the statement. The survey results also show that farmers perceived both the tree harvesting rule and off-reserve timber revenue sharing as unfair to them. Farmers strongly disagreed with the statement that 'the current tree harvesting rule is fair to farmers' (mean level of agreement= 1.41; Std. Dev. = 0.81).[51] Likewise, farmers strongly agreed with the statement that the 'current revenue-sharing arrangement is unfair to farmers' (mean level of agreement = 4.78; Std. Dev. = 0.71).

7.4.2 Preference for chainsaw logging

The survey revealed that farmers prefer chainsaw logging to concession logging on their farms. About 88% of the respondents preferred chainsaw operators to timber concessionaires due to the reasons given in Table 7.11.

Table 7.11 Respondents' level of agreement with statements on the relative compatibility of chainsaw operators to farmers' cocoa-based livelihoods

Actions	N	Mean	Std. Dev.
Operators cause less damage to farms than concessionaires	400	4.3	1.4
Operators pay less compensation for crop damage than concessionaires	400	4.0	1.4
Operators provide farmers with firewood	400	4.6	1.0
Operators assist farmers in removing stumps	400	3.8	1.6
Operators provide free lumber boards to farmers	400	4.8	1.6

Source: Field Survey, 2016.

It is worth noting that farmers agreed that chainsaw loggers pay less compensation than concessionaires. Most farmers in the survey revealed that chainsaw logging on farms in the off-reserve forests is oftentimes driven by them (farmers). Thus, by virtue of hiring operators to log on their farms for domestic use, farmers forfeit compensation for crop damage. For those who sold trees to operators, much premium was placed on tree payment than compensation for crop damage. Others indicated that crop damage is minimal and economically negligible under chainsaw logging considering all the other benefits accruing to farmers from chainsaw operators.[52]

7.4.3 Factors influencing farmers' involvement in illegal logging

Subsequent to the above results, a binary logit model was fixed to observe how farmers' (illegal) logging motives for retaining shade trees and the compensation behaviour of concessionaires influence illegal logging among farmers. The dependent variable was

[51] Fairness/Unfairness was measured on a 5-point Likert scale.

[52] It can be discerned from the survey results that compensation for crop damage becomes an important issue only when farmers do not receive any substantial benefit from the logging process—which is usually the case in concession logging.

actual *involvement in illegal logging*. There were seven (7) independent variables in the model. These, together with the dependent variable, are described in Table 7.12.

Table 7.12 Description of variables in the binary logit model for illegal logging

Variable	Description and coding	Mean	Std. Dev.
Involvement in illegal logging	Whether a farmer has ever harvested on-farm tree or sold an on-farm tree to an operator. 'No' = 0; 'Yes' = 1.	0.92	0.27
Hope for economic returns from timber trees	Whether the intention to sell or harvest trees on farm was farmers' non-shading reason for retaining trees. 'No' = 0; 'Yes' = 1.	0.93	0.25
Relative incompatibility of concession logging	Whether a farmer agrees that concession logging is less compatible with farmers' cocoa-based livelihoods compared to chainsaw logging.^ 'No' = 0; 'Yes' = 1.	0.68	0.47
Non-payment of compensation	Whether a farmer was not fully compensated for crop damage by a concessionaire. 'No' = 0; 'Yes' = 1.	0.34	0.47
Age*			
Income poverty category *			
Sex*			
Higher Education *			

*Note: The descriptions and coding of variables marked with asterisks are already provided in Table 7.9.
^Note: Computed using data from the responses to variables in Table 7.11
Source: Field Survey, 2016.

Table 7.13 reports the results of the logit model. The model is a good fit to the data (Hosmer and Lemeshow Test: χ^2 = 7.966, p = 0.437). It explained about 25.5% (R^2 = 0.255) of the variations in the logit of farmers' direct involvement in illegal logging. Farmers' hope for timber benefits from shade trees, non-payment of full compensation by concessionaires, and farmers' perception about the relative incompatibility of concession logging to farmers' cocoa-based livelihood had statistically significant effects on farmers' direct involvement in illegal logging. Farmers who retain shade trees with the hope of economic returns from timber trees (through illegal logging) were 17.0% more likely to engage in illegal logging than those who did not have such an intention. Similarly, farmers who did not receive full compensation for crop damage from concessionaires were 11.1% more likely to engage in illegal logging than farmers who were either fully compensated or had not experienced concession logging on their farms. Also, farmers who perceived concession logging to be less compatible with their cocoa-based livelihood are 23.7% more likely to engage in illegal logging than those who perceived otherwise. These empirical results indicate that farmers' involvement in illegal logging is influenced by their intention to reap the timber benefits of tree retention and the behaviour of concessionaires.

Table 7.13 Results of the binary logit model on farmers' involvement in illegal logging

Variables	***β***	***Marginal effect***
Hope for economic returns from timber trees	1.241 (1.144)	0.170*
Non-payment of full compensation	1.400 (2.166)	0.111**
Incompatibility of concession logging	1.923 (0.509)	0.237**
Age	-0.456 (0.484)	-0.043
Sex	-0.244 (0.608)	-0.021
Income	0.404 (0.768)	0.033
Higher Education	-0.740 (0.501)	-0.073
Constant	-0.151 (9.979)	
Model χ^2	45.316***	
Nagelkerke R^2	.255	
Correctly predicted (%)	92.5	
N	400	

*$p<0.05$; ** $p<0.01$; *** $p<0.001$. Standard errors in parentheses.
Source: Field Survey, 2016

7.5 Conclusion

The chapter has presented the results on the characteristics and current behaviour of farmers and concessionaires. The average shade density on cocoa farms was seven (7) trees per ha. The number of trees on farm was found to be rationally reducing steadily as the age of the farm increases. Farmers rationally retained fairly equal proportions of timber and non-timber trees as shade trees. The majority of farmers were not compensated for crop damage by concessionaires. The logit model on farmers' receipt of compensation revealed that receipt of compensation was dependent on farmers' leadership position and educational attainment. Illegal logging was common among farmers and oftentimes they invited chainsaw operators to harvest trees on their farms for domestic construction. Farmers' hope for economic returns from timber trees and the behaviour of concessionaires had a relationship with farmers' likelihood to engage in illegal logging. The empirical results presented in this chapter support the game-theoretic perspective on the current behaviour of farmers and concessionaires in the off-reserve forests.

Chapter 8. Empirical Results on Predicted Future Behaviour of Farmers and Concessionaires under Hypothetical Policy Scenarios

Chapter 7 presented empirical results on the current behaviour of farmers and concessionaires. This chapter builds on Chapter 7 to present empirical results to verify the game-theoretic predictions about the future behaviour of these stakeholders under hypothetical policy scenarios. Eight hypotheses were proposed in Chapter 6 on the effects of hypothetical policy actions on farmers' tree retention behaviour; farmer's involvement in illegal logging; farmers' use of actions to pursue compensation; and concessionaires' likelihood to pay full compensation. This chapter presents the empirical results from the analyses of primary data to test these hypotheses. It starts with the results on experimental scenarios relating to options to resolve compensation conflicts. The chapter then proceeds to present the results on the mixed design ANOVA to test the hypothesis on farmers' tree retention. This is followed by a presentation of the results of the 2×2×2 factorial ANOVA to test the two hypotheses relating to farmers' willingness to engage in illegal logging. Table 8.1 provides an overview of the hypothetical actions and their corresponding hypotheses tested in this chapter.

Table 8.1 Hypothetical actions and the corresponding hypotheses tested in the chapter

Type of Game	**Specific behaviour**	**Hypothetical action**	**Proposed hypothesis**
Compensation games	Actions by farmers to pursue compensation independently	Accommodation	None*
		Persuasion	None*
		Blockading	Farmers holding top leadership positions in the community are less likely to use blockading to pursue compensation (**Hypothesis 1**).
			Farmers with socio-political connections within the community are more likely to use blockading to pursue compensation after persuasion has failed (**Hypothesis 2**).
		Mediation	Farmers with socio-political connections within the community are more likely to use mediation to pursue compensation after persuasion has failed (**Hypothesis 3**).
		Litigation	None*
	Concessionaires' responses to farmers' actions	Persuasion	None*
		Mediation	None*
		Blockading	None*
		Litigation	None*
Forest management games	Concessionaires' responses to external interventions	Enforcement of compensation law by the State (FSD)	The concessionaire will compensate the farmer if the State enforces the compensation law (**Hypothesis 5**).
		Third-party compensation litigation	The concessionaire is more likely to pay the agreed compensation to the farmer if there is a credible external threat of litigation (**Hypothesis 7**).

Table 8.1 Hypothetical actions, corresponding hypotheses tested and the analytical techniques used in the chapter (continued)

Type of Game	Specific behaviour	Hypothetical action	Hypothesis proposed
Forest management games	Tree retention by farmers	Strict enforcement	Farmers' willingness to retain both trees is more likely to be higher than that of 'non-timber trees only' and 'no-shade' farming regardless of the policy scenario (**Hypothesis 4**).
		Full compensation	
		Right to trees	
		Strict enforcement and full compensation	
		Full compensation and right to trees	
		Strict enforcement and right to trees	
		Strict enforcement, full compensation and right to trees	
	Illegal logging by farmers	Strict enforcement	None*
		Full compensation	None*
		Right to trees	None*
		Strict enforcement and full compensation	None*
		Full compensation and right to trees	None*
		Strict enforcement and right to trees	Granting timber rights in addition to enforcing the tree harvesting rule is more likely to reduce farmer's willingness to engage in illegal logging (**Hypothesis 6)**.
		Strict enforcement, full compensation and right to trees	Farmers' willingness to engage in illegal logging is more likely to reduce if they have rights to timber trees, receive agreed compensation and the tree harvesting rule is enforced (**Hypothesis 8**).

Note: *Chapter 6 revealed that the hypothetical actions marked with asterisks are less likely to induce behavioural changes among farmers and concessionaires. Hence, this study did not propose any testable hypotheses for these actions. This accounts for the disparity between the number of hypothetical actions and hypotheses.

8.1 Hypotheses on Compensation Payment

This section presents the empirical results on farmers' likelihood to use actions to independently pursue compensation and test of hypotheses relating to factors influencing likelihood to use actions and concessionaires' responses to farmers' independent actions.

8.1.1 Farmers' use of actions to independently pursue compensation

Likelihood to use actions

Farmers were likely to use various actions to independently pursue compensation for crop damage. The results captured in Table 8.2 indicate that farmers were more likely to use 'persuasion' to pursue compensation than any other action. When this fails, the best alternative was to blockade conveyance of logs. Farmers were also likely to use 'mediation' to pursue compensation, when necessary. Besides accommodation, the action with the lowest likelihood was litigation.

Table 8.2 Likelihood for farmers to use actions to pursue compensation

Actions	N	Mean	Std. Dev.
Accommodation	394	1.26	0.82
Persuasion	388	4.21	1.41
Mediation	383	3.92	1.60
Litigation	385	3.49	1.70
Blockading	391	4.05	1.48

Source: Field Survey, 2016.

Factors influencing farmers' likely use of actions

Two OLS models were fitted to identify the factors influencing farmers' likelihood to use blockading and mediation and subsequently test the hypotheses relating to farmers' actions for pursuing compensation when the concessionaire fails to pay after persuasion.[53] These hypotheses include:

> **Null hypothesis 1**: There is no relationship between farmers' socio-political connections and their likelihood to adopt blockading when persuasion fails.
>
> **Alternative hypothesis 1 (H1)**: Farmers with socio-political connections within the community are more likely to use blockading to pursue compensation after persuasion has failed.
>
> **Null hypothesis 2**: There is no relationship between top-level leadership position and farmers' likelihood to adopt blockading when persuasion fails.
>
> **Alternative hypothesis 2 (H2)**: Farmers holding top-level leadership positions in the community are less likely to use blockading to pursue compensation.

[53] Refer to Chapter 5 (Section 5.8) for the justification for the suitability of the OLS for Likert data.

> **Null hypothesis 3**: There is no relationship between farmers' socio-political connections and their likelihood to use mediation when persuasion fails
>
> **Alternative hypothesis 3 (H3)**: Farmers with socio-political connections within the community are more likely to use mediation to pursue compensation after persuasion has failed.

The two dependent variables are the likelihood to use blockading and the likelihood to use mediation. Both were measured on 5-point Likert scales. There were 8 independent variables in each model. These variables are age (years), sex, higher education, household size, per-capita household income, top-level leadership, lower-level leadership and socio-political connections. The same independent variables were used in both models. These variables are described in Table 8.3.

Table 8.3 Description of variables in the OLS models

Independent Variable	Description and coding	Mean	Std. Dev.
Age	The age of a farmer in years. Scale = [27, 96].	51.16	12.76
Sex	Whether a farmer is male or female. 'Female' = 0; 'Male' = 1	0.75	0.43
Education	Whether a farmer has at least secondary education. 'No' = 0; 'Yes' = 1	0.15	0.36
Household size	The number of individuals within a household. Scale = [1, 40]	8.1	5.1
Per Capita household income (GH¢)	The monthly per capita household income of a farmer. Scale = [0, 2575]	202.08	237.81
Top-level leadership	Whether a farmer is a top-level leader in the forest village. 'Yes' = 0; 'No' = 1	0.15	0.36
Lower-level leadership	Whether a farmer is a lower-level leader in the forest village. 'No' = 0; 'Yes' = 1	0.39	0.49
Socio-political connection	Whether a farmer has a close relative or friend in leadership position in the village. 'No' = 0, 'Yes'= 1	0.69	0.46

Source: Field Survey, 2016.

Table 8.4 reports the results of the OLS models for blockading and mediation. Overall, the model on blockading explained 9.0% of the variability in likelihood to use blockading to pursue compensation (R^2 = 0.09).[54] Only two of the independent variables had statistically significant effects on likelihood to blockade. These were socio-political networks and top-level leadership position. The results indicate that likelihood to blockade was significantly higher for farmers who had some (socio-political) connections. Therefore, there is enough

[54] The low R^2 values for both models indicate that explanatory power of the models are low (Field 2013). However, this does not affect the relationship the significant variables have with the dependent variables.

evidence in the data to reject the null hypothesis in favour of the alternative hypothesis (H1) that 'farmers with socio-political connections within the community are more likely to use blockading to pursue compensation after persuasion has failed'.

Farmers' likelihood to blockade significantly decreased by 0.76 when they occupy top-leadership position within the community (Table 8.4). The survey revealed that the mean likelihood to blockade was 4.11 (s = 1.49) for non-leaders, 4.29 (s = 1.27) for lower-level leaders and 3.28 (s = 1.74) for top-level leaders. Hence, whereas the likelihood to blockade was higher for lower-level leaders compared to non-leaders, that of top-level leaders was lower than non-leaders. However, the variation between non-leaders and lower level leaders was not statistically significant, suggesting that both non-leaders and lower-level leaders had similar but high likelihood to blockade should persuasion fail. In contrast, the variations in likelihood to blockade between non-leaders and top-level leaders were statistically significant, indicating that top-level leaders were less likely to adopt blockading. Hence, the null hypothesis is rejected in favour of the alternative hypothesis (H2) that 'farmers occupying top-level leadership positions in the community are less likely to use blockading to pursue compensation'.

Table 8.4 Results of OLS models on blockading and mediation

Variables	**Blockading**		**Mediation**	
	β	t	β	t
Age (years)	-0.008 (0.007)	-1.251	-0.011 (0.007)	-1.656
Sex	-0.037 (0.163)	-0.211	-0.098 (0.195)	-0.518
Education	-0.369 (0.225)	-1.744	0.452 (0.196)	1.956*
Household size	-0.015 (0.019)	-0.918	0.018 (0.019)	1.028
Per capita household income (GH¢)	0.000 (0.000)	-0.180	0.000 (0.000)	1.257
Social-political connection	0.503 (0.171)	3.082**	0.792 (0.200)	4.449***
Lower-level leader	0.154 (0.156)	0.906	-0.087 (0.179)	-0.471
Top-level leader	-0.756 (0.263)	-3.327**	-0.170 (0.263)	-0.697
Constant	4.376 (0.386)	12.481***	3.785 (0.405)	9.921**
F-Statistic		4.595***		4.374***
R^2		0.09		0.09
N		391		383

p<0.05*; ** *p<0.01*; * *p<0.001*. Standard errors in parentheses.
Source: Field Survey, 2016.

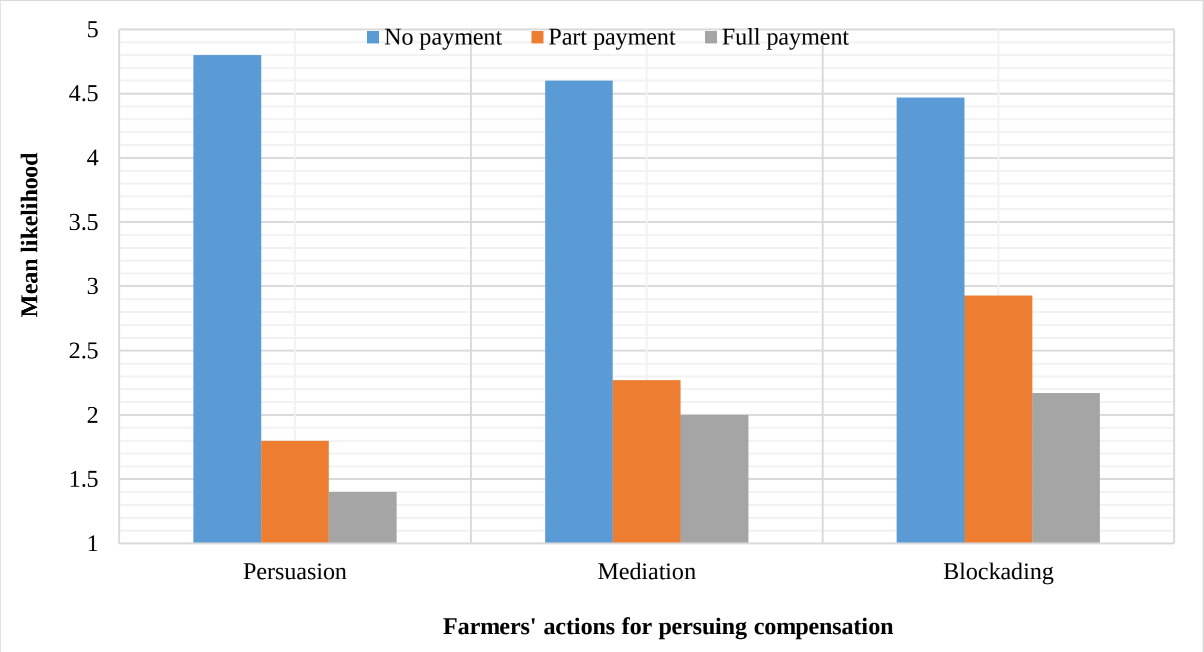
Likewise, the OLS model on mediation explained only 9.0% of the variability in farmers' likelihood to use mediation to pursue compensation should persuasion fail (R^2 = 0.09). Only the effects of education and socio-political connection were statistically significant.

Table 8.4 shows that farmers with Secondary education or higher are more likely to use mediation to pursue compensation. Mean likelihood to mediate for these farmers was 0.45 more than that of farmers who did not have Secondary education. Likewise, the model revealed that the likelihood to adopt mediation was 0.84 more for farmers with socio-political connections within the community compared to those without socio-political connections. This significant result implies that the null hypothesis is rejected in favour of the alternative hypothesis (H3) that 'farmers with socio-political connections within the community are more likely to use mediation to pursue compensation after persuasion has failed'.

8.1.2 Concessionaires' response to farmers' actions to pursue compensation

The game-theoretic analyses predicted that the average farmer (non-leader) is less likely to receive compensation for crop damage from the typical concessionaire regardless of the strategy adopted by the farmer. For this reason, concessionaires were surveyed to examine how they are likely to respond to the actions farmers are likely to adopt to pursue compensation. These responses were in relation to their likelihood to pay full compensation, pay part of the compensation or pay nothing after the farmer has carried out the action.

Figure 8.1 depicts the responses of the concessionaires. Overall, concessionaires were highly likely *not* to pay any form of compensation should farmers adopt persuasion only, mediation or blockading. Again, they were moderately unlikely to pay part of the compensation should the farmer use persuasion only or mediate. However, blockading performed relatively better than any other action with regards to reducing concessionaires' likelihood *not* to pay any compensation and increasing their likelihood to pay part or full compensation. It is also worth noting that though concessionaires were of the view that court actions by farmers seldom occur, they were very likely to pay full compensation ($\bar{x}$ = 4.20, s = 0.61) should the farmer's litigation be successful. However, the bottom line is that concessionaires are less likely to fully compensate the average farmer regardless of the actions taken by the farmer to pursue compensation.



Source: Field Survey, 2016.

Figure 8.1 Farmers' likelihood to use actions to pursue compensation

8.1.3 Effects of experimental scenarios of external involvement on concessionaires likelihood to fully compensate farmers

It was hypothesised in Chapter 6 that concessionaires will be more likely to promptly and fully compensate farmers should the Forest Service Division of the Forestry Commission enforce the compensation law. Also, they will be more likely to promptly and fully compensate farmers should there be a credible threat of litigation by a third-party advocacy group. A way to test these hypotheses is to compare the likelihood for concessionaires to fully compensate farmers in scenarios involving the above forms of external involvement to that of the best performing independent action of the farmer. The previous section revealed that blockading was the best performing independent action by the farmer with regards to concessionaires' likelihood to pay full compensation. Thus, the hypotheses tested are:

Null hypothesis 4: Concessionaires' likelihood to pay full compensation when the compensation law is enforced will not be significantly different from their likelihood to pay full compensation when farmers blockade.

Alternative hypothesis 4 (H4): Concessionaires will be more likely to pay full compensation if the compensation law is enforced than if farmers blockade.

Null hypothesis 5: Concessionaires' likelihood to pay full compensation when there is a threat of third-party litigation will not be significantly different from their likelihood to pay full compensation when farmers blockade.

Alternative hypothesis 5 (H5): Concessionaires will be more likely to fully compensate farmers if there is a threat of third-party litigation than if farmers blockade.

The dependent variable in these hypotheses is *likelihood to pay full compensation*. Also, blockading, third-party litigation and enforcement were treated as three levels of the categorical independent variable, *scenarios*, since the study used a repeated-measures design. Concessionaires' mean likelihood to pay full compensation before conveyance for each of the levels of scenarios are reported in Table 8.5.

Table 8.5 Concessionaires' response to experimental scenarios on compensation payment

Scenarios	**No payment**		**Part payment**		**Full payment**	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Enforcement	2.07	1.11	3.50	1.07	4.30	1.02
Third-party litigation	1.50	0.68	3.20	1.03	4.03	1.45
Blockading	4.47	1.38	2.93	1.48	2.17	1.05

Source: Field Survey, 2016.

The survey revealed that concessionaires are less likely to refuse to pay any form of compensation should the law be enforced or should there be any threat of third-party litigation. Though third-party litigation performed better than enforcement in this regard, both resulted in marked reduction in likelihood not to pay compensation compared to blockading. All three levels, however, performed fairly well in terms of likelihood to pay part of the compensation before conveyance. Nonetheless, blockading performed poorly with regards to full payment. Whereas concessionaires were more likely to pay full compensation to farmers if the law is enforced or if there exists a threat of third-party litigation, blockading only made concessionaires somewhat unlikely to fully compensate farmers.

Subsequent to the results in Table 8.5, a repeated-measures ANOVA was used to test whether the differences observed for full payment were statistically significant. Results from Mauchly's test indicated that the assumption of sphericity has been met ($\chi^2 = 2.314$, $p < 0.314$). With sphericity assumed, the result showed that there are significant differences in likelihood to pay full compensation between the levels of *scenarios* and that the scenarios had a large effect on concessionaires' likelihood to fully compensate farmers (*F*

= 26.238, $p < 0.001$, ω^2 = 0.38).[55] More importantly, the results of the simple contrasts reported in Table 8.6 indicate that mean likelihood for both third-party litigation and enforcement were significantly different from that of blockading.

Table 8.6 Results of tests of within-subjects contrasts

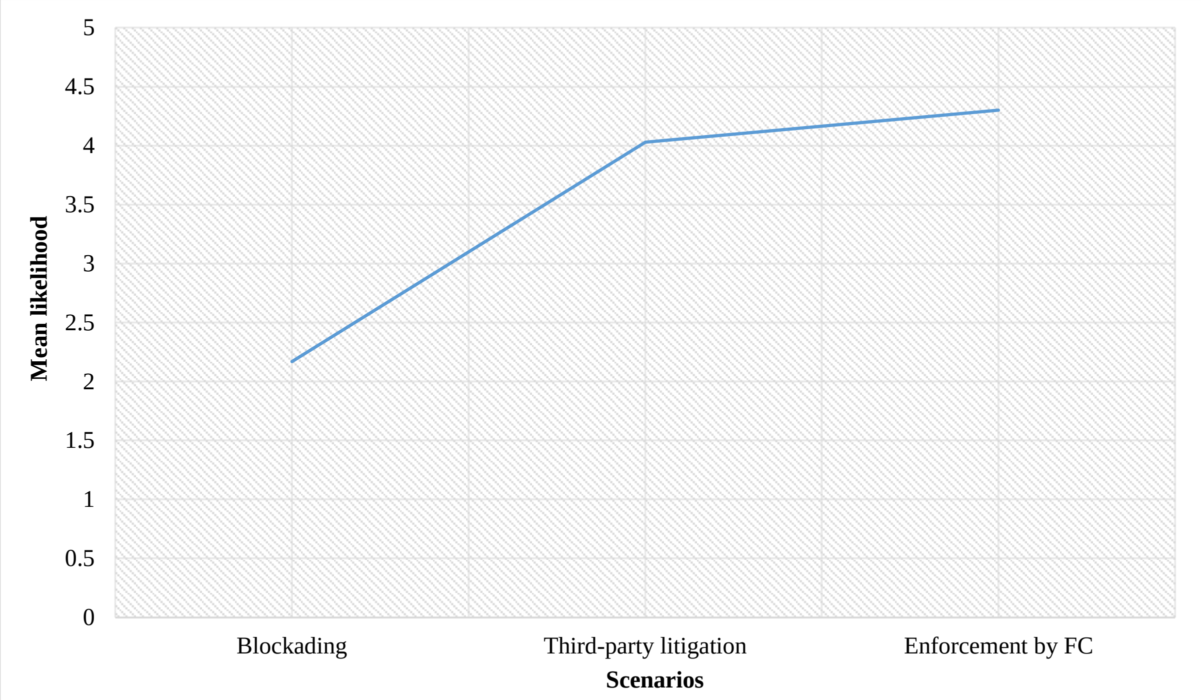
Scenarios	Mean Square	F	Sig.	Effect size (r)
Blockading vs. Third party litigation	104.533	42.418	0.000	0.77
Blockading vs. Enforcement	136.533	47.438	0.000	0.79
Third party litigation vs. Enforcement	2.133	0.543	0.467	0.14

Source: Field Survey, 2016.

It can be observed from Figure 8.2 that mean likelihood to fully compensate farmers was low for blockading but rose sharply with third party litigation and enforcement. This sharp increase yielded very large effect sizes for third-party litigation (r = 0.77) and enforcement (r = 0.79) when each is compared with blockading.[56] Notwithstanding this, Figure 8.2 shows that there was only a narrow increase in mean likelihood between threat of third-party litigation and enforcement. This is evident in Table 8.6 where the difference between these two were not significant and yielded a small effect size (r = 0.14). These results imply that the null hypotheses should be rejected in favour of the alternative hypotheses. That is, the data provide more evidence in support of the alternative hypotheses H4 and H5.

[55] Refer to Appendix B for details of the manual computation of the Omega squared (ω^2). Also, refer to Cohen (1988), Sullivan and Feinn (2012) and Field (2013) for the criteria used in classifying the effect sizes in this study.

[56] Refer to Appendix C for details of the manual computation of these effect sizes (r).



Source: Field Survey, 2016.

Figure 8.2 Mean likelihood for concessionaires to pay full compensation under different experimental scenarios

8.2 Hypothesis on Farmers' Tree Retention Behaviour

This section presents the results from the empirical test of hypothesis relating to farmers' future tree retention behaviour.

8.2.1 Descriptive statistics on willingness to practise the types of cocoa farming

The analysis of the data on tree retention shows that, on average, farmers were more willing to retain both tree types on their farms than to retain only non-timber trees or practice no-shade cocoa farming. However, Table 8.7 shows that farmers' willingness to retain both tree types did not differ much across the hypothetical policy scenarios. With the exception of 'compensation and rights to trees', the average willingness for each of the treatment groups was slightly higher than that of the control group (*status quo*). By contrast, willingness to retain only non-timber trees was relatively lower for all experimental groups. Nevertheless, farmers in the 'enforcement and right to trees' group were less willing to retain only non-timber trees than any other experimental group. Willingness to practice no-shade cocoa farming fluctuated among the experimental groups. The mean willingness to practice 'no-shade' was respectively higher for the 'compensation' and 'compensation and rights to trees' groups than the control group. In all, farmers' willingness to retain both tree types was higher than that of 'non-timber trees only' or 'no-shade' farming for each of the groups (including the control group).

Table 8.7 Farmers' willingness to practice various types of cocoa farming under different scenarios

Type of farming / Treatment groups (Scenarios)	No-shade		Non-timber trees only		Both timber and non-timber trees	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Status quo (control)	1.66	1.30	3.18	1.55	4.46	0.71
Enforcement only	1.32	0.87	2.02	1.42	4.80	0.40
Full compensation only	2.18	1.40	3.08	1.61	4.74	0.83
Right to trees only	1.46	1.03	2.34	1.51	4.82	0.39
Enforcement and full compensation	1.54	1.01	2.66	1.66	4.76	0.43
Enforcement and right to tress	1.08	0.57	1.40	1.05	4.74	0.66
Full compensation and right to trees	1.70	1.11	2.10	1.46	4.44	0.99
Enforcement, full compensation and right to trees	1.30	0.86	1.72	1.09	4.48	0.71
Total	1.53	1.08	2.31	1.54	4.66	0.68

Source: Field survey, 2016.

8.2.2 Results of the mixed-design ANOVA on farmers tree retention behaviour

It was hypothesised from the game models that farmers' willingness to retain both tree types will be significantly higher than their willingness to retain only non-timber trees or practise no shade farming regardless of the tree tenure and compensation situation. This hypothesis was tested by comparing the mean willingness for 'both tree types', 'non-timber trees only' and 'no-shade' within each of the hypothetical policy scenarios. The hypothesis tested is:

> **Null hypothesis 6**: There is no significant difference between the mean willingness to practise 'both tree types' farming, 'non-timber trees only' farming and 'no-shade' farming within each of the hypothetical policy scenarios.
>
> **Alternative hypothesis 6 (H6)**: The mean willingness to practise 'both-tree-types' farming is significantly higher than that of 'non-timber trees only' and 'no-shade' farming within each of the hypothetical policy scenarios.

Mean willingness was measured on a 5-point Likert scale and was used as the dependent variable. *Type of farming* contained three levels, namely 'no-shade', 'non-timber trees only' and 'both tree types'. Also, there were eight treatment groups. These are '*status-quo*' (control), ‘enforcement’, ‘compensation’, ‘enforcement and compensation’, ‘right to trees’, ‘enforcement and right to trees’, ‘compensation and right to trees’, and ‘enforcement, compensation and right to trees’. A mixed-design ANOVA was used to test the hypothesis.

Results from Mauchly’s test indicated that the assumption of sphericity has been violated ($\chi^2 = 53.34$, $p < 0.001$). Therefore, the Huynh-Feldt estimate of sphericity ($\varepsilon = .907$) was used to correct this violation because the Greenhouse-Geisser estimate ($\varepsilon = .887$) was greater than the .75 upper limit (Huynh and Feldt 1976; Girden 1992). Moreover, the Levene’s tests of equality of error variance showed that the assumption of homogeneity has been violated for all three levels of the repeated-measures variable ($F = 10.17$, $p < 0.001$ for no-shade; $F = 10.98$, $p < 0.001$ for non-timber trees only; and $F = 6.34$, $p < 0.001$ for both tree types). Notwithstanding this, the *F-statistic* for the between-subjects effect is still robust because sizes of the sub-samples (n = 50) are large and equal among the scenarios (Glass *et al*. 1972; Field 2013).

That said, the test of between-subjects effects (Table 8.7) showed that mean willingness differed significantly among the treatment groups ($F = 10.20$, $p < 0.001$). Similarly, the ANOVA results revealed that mean willingness was significantly different among the three types of farming ($F = 952.90$, $p < 0.001$). Mean willingness significantly differed among the various interactions between the type of farming and the type of treatment ($F = 5.65$, $p < 0.001$). Table 8.8 reports that even without the effects of the scenarios, willingness to practice ‘both tree types’ farming was significantly higher than that of ‘non-timber trees only’ and ‘no-shade’ farming, respectively.

Table 8.8 Results of tests of within-subjects contrasts

Source	**Type of farming**	**Mean Square**	**F**	**Sig.**
Type of farming	Non-timber trees only vs. No-shade	244.92	88.81	0.000
	Both tree types vs. No-shade	3906.25	2700.05	0.000
	Non-timber trees only vs. Both tree types	2194.92	894.01	0.000
Type of farming × Scenario	Non-timber trees only vs. No-shade	8.43	3.06	0.004
	Both tree types vs. No-shade	7.52	5.20	0.000
	Non-timber trees only vs. Both tree types	21.67	8.82	0.000

Source: Field Survey, 2016.

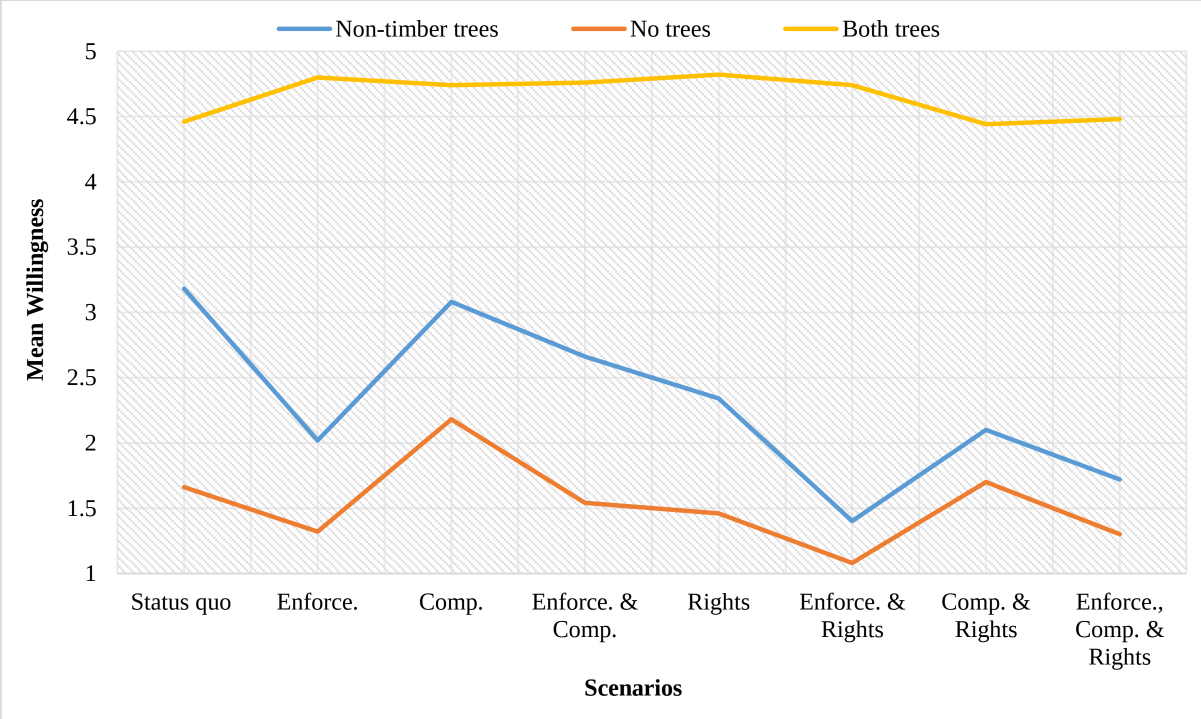
Subsequent to the results in Table 8.8, a post-hoc test was conducted to observe how the mean willingness for the types of farming differed within each scenario. A summary of the results are reported in Table 8.9. Table 8.9 indicates that mean willingness to retain both types of trees was significantly higher than mean willingness to retain only non-timber trees and mean willingness to practise no-shade farming under each hypothetical scenario.

Table 8.9 Summary results of post-hoc tests (pairwise comparison) on mean willingness to practise types of farming under different experimental scenarios

Scenarios	Type of farming (I)	Type of farming (J)	Mean Difference (I-J)	Std. Error	Sig.[b]
Status quo (control)	Both tree types	No-Shade	2.800	0.170	0.000
		Non-timber trees only	1.280	0.222	0.000
Enforcement only	Both tree types	No-Shade	3.480	0.170	0.000
		Non-timber trees only	2.780	0.222	0.000
Compensation only	Both tree types	No-Shade	2.560	0.170	0.000
		Non-timber trees only	1.660	0.222	0.000
Right to trees only	Both tree types	No-Shade	3.360	0.170	0.000
		Non-timber trees only	2.480	0.222	0.000
Enforcement and Compensation	Both tree types	No-Shade	3.220	0.170	0.000
		Non-timber trees only	2.100	0.222	0.000
Enforcement and right to trees	Both tree types	No-Shade	3.660	0.170	0.000
		Non-timber trees only	3.340	0.222	0.000
Compensation and right to trees	Both tree types	No-Shade	2.740	0.170	0.000
		Non-timber trees only	2.340	0.222	0.000
Enforcement, compensation and right to trees	Both tree types	No-Shade	3.180	0.170	0.000
		Non-timber trees only	2.760	0.222	0.000

[b] Based on Šidák adjustments
Source: Field Survey, 2016.

Figure 8.3 gives a clearer illustration of the significant differences between willingness to retain both tree types, on the one hand, and willingness to retain only non-timber trees and willingness to practise no-shade farming, on the other hand. For all scenarios, farmers were more willing to retain both tree types but less willing to practise 'non-timber trees only' or 'no-shade' farming, respectively. Therefore, there is robust evidence from the data to reject the null hypothesis in favour of the alternative hypothesis (H6).



NB: Enforce. = Enforcement; Comp. = Full Compensation; Rights = Right to trees

Source: Field Survey, 2016

Figure 8.3 Mean willingness to practise types of cocoa farming under different scenarios

8.3 Hypotheses on Farmers' Involvement in Illegal Logging

This section presents results on the test of hypotheses on farmers' willingness to engage in illegal logging under the hypothetical policy scenarios.

8.3.1 Descriptive statistics on willingness to engage in illegal logging

Table 8.10 reports the mean willingness to engage in illegal logging for farmers under the various experimental scenarios. It can be observed that farmers in the 'control group' had the highest willingness to engage in illegal logging whereas those in the 'enforcement, compensation and right to trees' group had the lowest willingness to engage in illegal logging. Farmers in the 'compensation' and 'enforcement and compensation' groups showed some willingness to engage in illegal logging whereas those in the 'right to trees', 'enforcement and right to trees' and 'compensation and right to trees' groups were less willing to engage in illegal logging. However, farmers in the 'enforcement' group were indifferent.

Table 8.10 Farmers' willingness to engage in illegal logging under different scenarios

Scenarios	Mean	Std. Dev.
Status quo (control)	4.94	0.31
Enforcement	2.62	1.72
Compensation	3.62	1.68
Right to trees	2.48	1.54
Enforcement and compensation	3.88	1.38
Enforcement and right to tress	1.50	0.86
Compensation and right to trees	2.10	1.04
Enforcement, compensation and right to trees	1.12	0.33
Total	2.78	1.71

Source: Field Survey, 2016.

8.3.2 Results of the factorial ANOVA on willingness to engage in illegal logging

Two hypotheses relating to farmers' willingness to engage in illegal logging emerged from the game models. The first hypothesis was:

> **Null hypothesis 7**: Granting timber rights in addition to enforcing the tree harvesting rule will not significantly affect farmer's willingness to engage in illegal logging
>
> **Alternative hypothesis 7 (H7)**: Granting timber rights in addition to enforcing the tree harvesting rule will significantly reduce farmer's willingness to engage in illegal logging

The second hypothesis was:

> **Null hypothesis 8**: Granting timber rights in addition to enforcing the tree harvesting rule will not significantly affect farmer's willingness to engage in illegal logging
>
> **Alternative hypothesis 8 (H8)**: Farmers' willingness to engage in illegal logging will significantly reduce if they have rights to timber trees, receive agreed compensation and the tree harvesting rule is enforced.

The dependent variable in these hypotheses is *willingness to engage in illegal logging* and this was measured on a 5-point Likert scale. The independent variables include *Strict Enforcement*, *Full Compensation* and *Right to trees* and these were all dichotomous, coded as '0' for the absence of the variable and '1' for the presence of the variable. A 2×2×2 factorial ANOVA was used to determine the relationships between the main and interaction effects of the scenarios on farmers' willingness to engage in illegal logging.

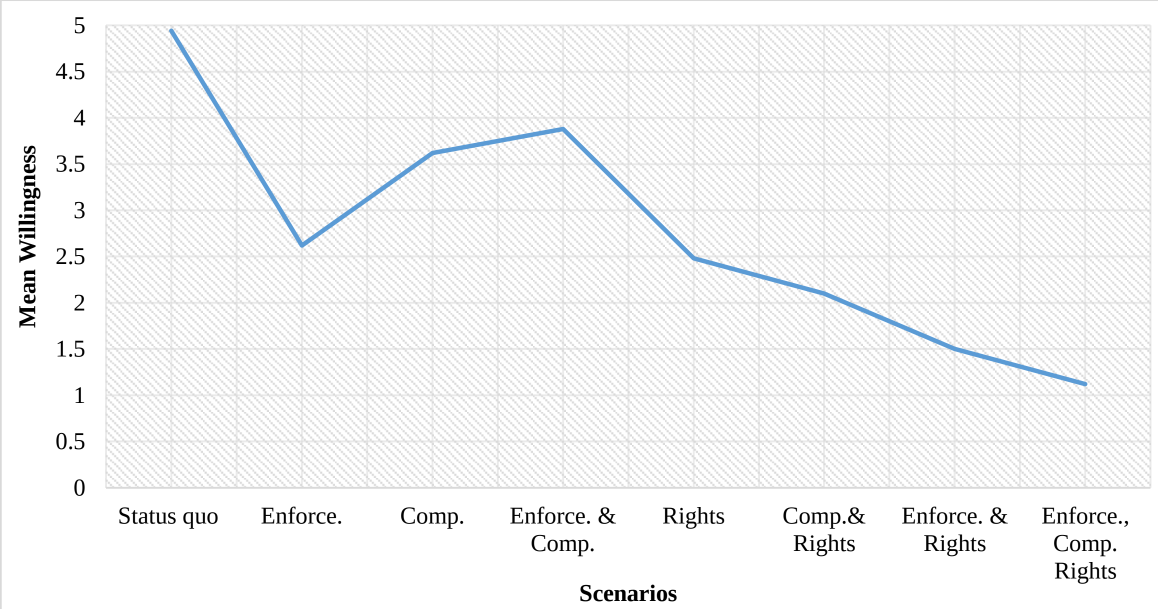
Levene's Test of equality of error variances revealed that the data has violated the assumption of homogeneity (F = 42.313, $p < 0.001$). Nevertheless, the results are robust because sample sizes were large and equal across the treatment groups (n = 50). The results of the ANOVA are reported in Table 8.11. It was found that the main effects of ‘enforcement’ and ‘right to trees’ were significant ($p < 0.001$). Also, the interaction effects, ‘enforcement and full compensation’, and ‘enforcement, full compensation and right to trees’ were significant ($p < 0.001$).

Table 8.11 Result of tests of between-subjects effects on farmers’ willingness to engage in illegal logging

Source	Mean Square	F	Sig.	Omega Squared
Enforcement	101.003	66.833	0.000	0.085
Full compensation	4.203	2.781	0.096	0.002
Right to trees	386.123	255.494	0.000	0.328
Enforcement and full compensation	41.603	27.528	0.000	0.034
Enforcement and right to tress	0.063	0.041	0.839	-0.001
Full compensation and right to trees	3.063	2.026	0.155	0.001
Enforcement, full compensation and right to trees	41.603	27.528	0.000	0.034
Intercept	3096.923	2049.211	0.000	
Corrected Model	82.523	54.605	0.000	

Source: Field Survey, 2016.

The presence of a significant effect for the highest-order interaction (*enforcement* × *full compensation* × *right to trees*) implies that interpreting the significant main and lower-order interaction effects independently from the *enforcement* × *full compensation* × *right to trees* interaction could, at best, be incomplete (Doncaster and Davey 2007; Field 2013; Freund *et. al.* 2010). For the purposes of subsequent analyses, however, it will be necessary to point out that ‘right to trees’ had a substantially large effect on farmers’ willingness to engage in illegal logging (ω^2 = 0.33) than any other factor or combination thereof. Also, enforcement had a medium effect (ω^2 = 0.09) on farmers’ willingness to engage in illegal logging. It can be observed from Figure 8.4 that the mean willingness to engage in illegal logging declined sharply for every group whose scenario included ‘right to trees’. Also, willingness to engage in illegal logging reduced markedly for those in the ‘enforcement’ group.



Source: Field Survey, 2016.

Figure 8.4 Mean willingness to engage in illegal logging under different scenarios

It is interesting to note from Table 8.11 and Figure 8.4 that though willingness to engage in illegal logging reduced to 1.5 for those in 'enforcement and right to trees' group, this effect was not significant.[57] Therefore, the null hypothesis (7) cannot be rejected. This implies that there is not enough evidence from the data to support alternative hypothesis 7 (H7). However, there is enough evidence from the data to support the alternative hypothesis (H8) that farmers' willingness to engage in illegal logging will significantly reduce if they have rights to timber trees, receive agreed compensation and the tree harvesting rule is enforced. Combining all the three treatments significantly reduced willingness to engage in illegal logging to the lowest level ($\bar{x}$ = 1.12, s = 0.33, ω^2 = 0.03). Therefore the null hypothesis is rejected in favour of the alternative hypothesis (H8). Details of the effect of each factor within the interaction are presented in the next section.

8.3.3 Effect of individual scenarios at levels of other treatments

Simple effect analyses were carried out to break down the interaction and examine the effect of each scenario within each level combination of the other two scenarios. Effect sizes were then computed manually (refer to Appendix E). Table 8.12 reports that *enforcement* had a significant and substantial effect on willingness to engage in illegal logging when both *full compensation* and *rights to trees* were absent; when there was *right to trees* but *no full compensation*; and when both *full compensation* and *right to trees* were

[57] Note that the effect would still not be interpretable had it been significant because of the significant higher-order interaction (*enforcement* × *full compensation* × *right to trees*).

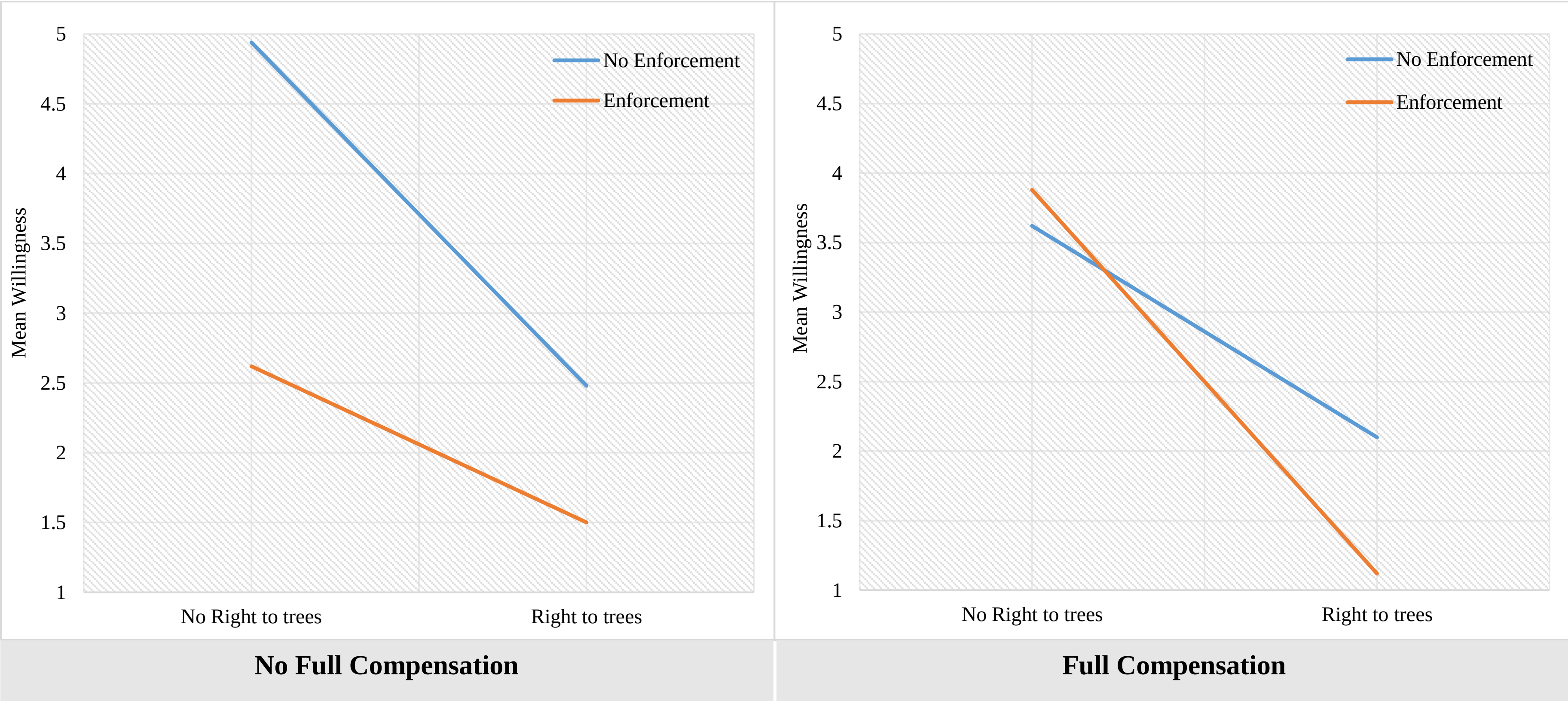
present. The effect of enforcement was not significant when there was *full compensation* without *right to trees*.

Table 8.12 Results of simple effect analysis on contribution of 'enforcement'

Factor-level combinations	Mean Square	F	Sig.	Effect size (r)
No right to trees and no full compensation	134.560	89.037	0.000	0.430
Right to trees but no full compensation	24.010	15.887	0.000	0.197
No right to trees but full compensation	1.690	1.118	0.291	0.053
Full compensation and right to trees	24.010	15.887	0.000	0.197

Source: Field Survey, 2016.

It can be observed from the left panel of Figure 8.5 that the presence of *enforcement* within *no full compensation* and *no rights to trees* reduced the mean willingness to engage in illegal logging from 4.94 to 2.62. This is a substantial decline and the largest contribution made by *enforcement* within the interaction. Next, the presence of *enforcement* reduced willingness from 2.48 to 1.50 when there was *right to trees* but *no full compensation* (left panel) and from 2.10 to 1.12 when both *full compensation* and *rights to trees* were present (right panel). These two effects were the same both in terms of effect size (r = 0.20) and magnitude of reduction in willingness to engage in illegal logging (0.98). Lastly, the right panel of Figure 8.5 indicates that the decrease in willingness to engage in illegal logging when there was *enforcement* within *compensation without right to trees* was not very different from that of *no enforcement* within the same level combination. This explains the non-significant effect reported in Table 8.12.



Source: Field Survey, 2016

Figure 8.5 Interaction graphs of the *enforcement* × *full compensation* × *right to trees* interaction showing the effect of ‘enforcement’

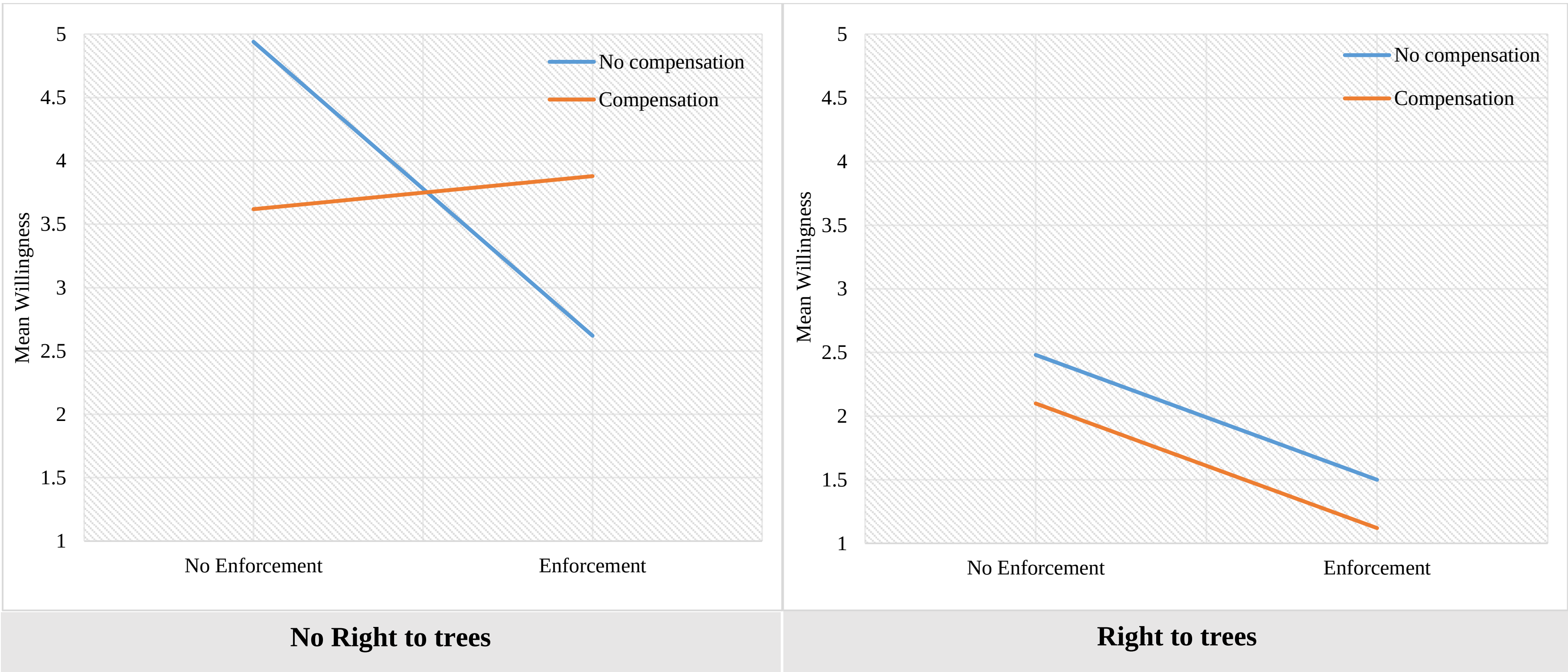
The effects of *full compensation* within each factor-level combination are reported in Table 8.13. The presence of *full compensation* had significant effect when both *enforcement* and *rights to trees* were absent; and when there was *enforcement without right to trees*. However, the effect of *full compensation* was not significant at *right to trees without enforcement*; and *right to trees with enforcement*.

Table 8.13 Results of simple effect analysis on contribution of 'full compensation'

Factor-level combinations	Mean Square	F	Sig.	Effect size (r)
No right to trees and no enforcement	43.560	28.823	0.000	0.262
Right to trees but no enforcement	3.610	2.389	0.123	0.078
Enforcement with no right to trees	39.690	26.263	0.000	0.251
Right to trees and enforcement	3.610	2.389	0.123	0.078

Source: Field Survey, 2016.

As shown in the left panel of Figure 8.6, the presence of *full compensation* significantly reduced farmer's willingness to engage in illegal logging from 4.94 to 3.62 in the absence of any of the other factors (scenarios). By contrast, the presence of *full compensation* significantly increased farmers' willingness to engage in illegal logging from 2.62 to 3.88 when there was *enforcement without right to trees*. The right panel of Figure 8.6 also illustrates the non-significant effect of the presence of *full compensation* whenever there was *right to trees*. The two lines are parallel indicating that both the presence and absence of *full compensation* had the same effect on willingness when there was *right to trees without enforcement*, and when there was both *enforcement and right to trees*.



Source: Field Survey, 2016

Figure 8.6 Interaction graphs of the *enforcement* × *full compensation* × *right to trees* interaction showing the effect of 'compensation'

Finally, Table 8.14 reports that the presence of *right to trees* had a significant effect on willingness to engage in illegal logging at all factor-level combinations. It can be observed that *right to trees* had a relatively large effect on willingness to engage in illegal logging when none of the other factors was present (r = 0.45), and when both of the other factors were present (r = 0.49). Also, *right to trees*, respectively, had substantial effects when there was *full compensation without enforcement* and when there was *enforcement without full compensation*.

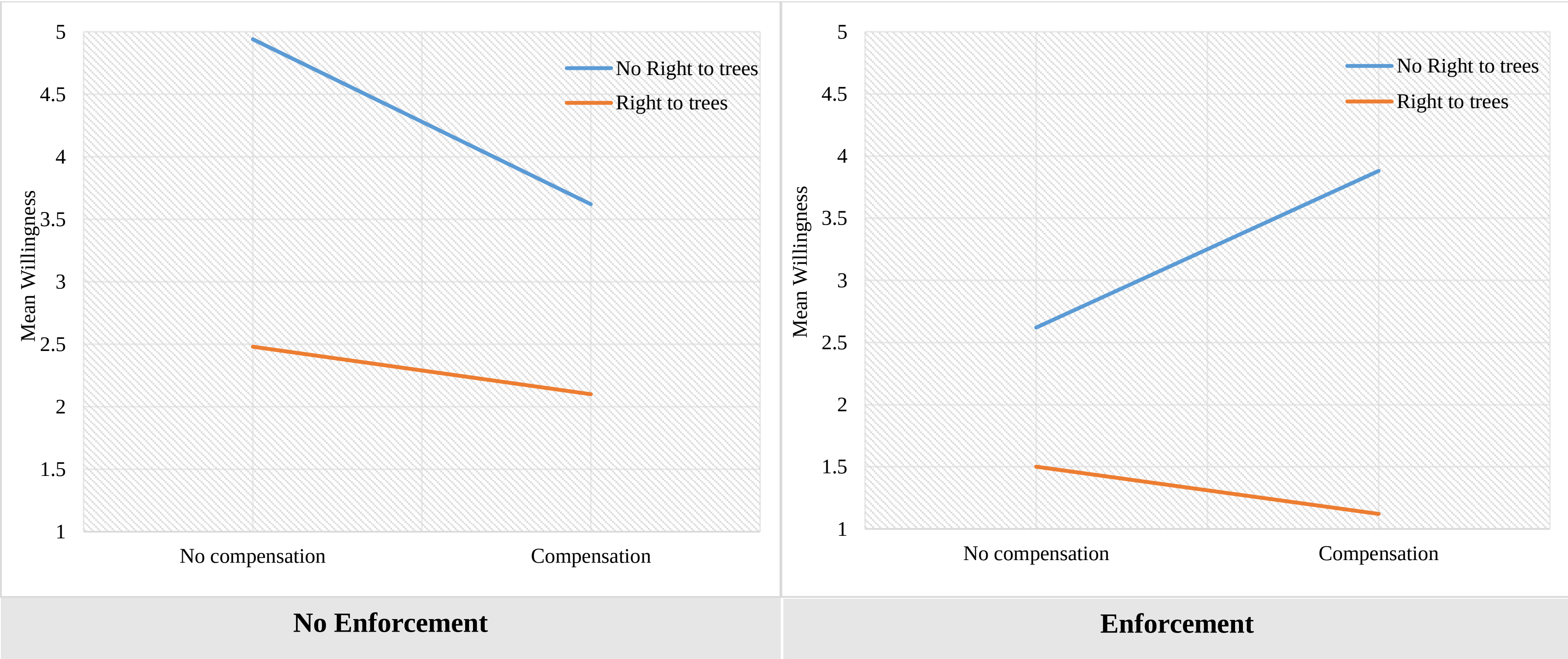
Table 8.14 Results of simple effect analysis on contribution of 'right to trees'

Factor-level combinations	Mean Square	F	Sig.	Effect size (r)
No enforcement and no full compensation	151.290	100.107	0.000	0.451
No enforcement but full compensation	57.760	38.219	0.000	0.298
Enforcement without full compensation	31.360	20.751	0.000	0.224
Enforcement and full compensation	190.440	126.013	0.000	0.493

Source: Field Survey, 2016

The specific effect of *right to trees* on farmers' willingness to engage in illegal logging is illustrated in Figure 8.7. It is notable to observe from the left panel of the interaction graph that mean willingness at *no enforcement and no compensation* significantly dropped from 4.94 when there was *no right to trees*, to 2.48 when there was *right to trees*. Mean willingness at *compensation without enforcement* significantly reduced from 3.62 when there was *no right to trees* to 2.10 when there was *right to trees*. Also, the right panel of Figure 8.7 shows that the reduction in farmers' willingness to engage in illegal logging at *enforcement without compensation* was significantly greater when there was *right to trees* than when there was *no right to trees*.

Overall, however, the largest effect of right to trees on willingness to engage in illegal logging was observed when both of the other factors were present. The right panel of Figure 8.7 shows that at this factor-level, mean willingness reduced from 3.88 when there was *no right to trees* to 1.12 when there was *right to trees*. The above simple effect analysis therefore suggests that *right to trees* significantly and substantially reduced willingness to illegal logging irrespective of the level combination of the other factors. It also explains the large size of the main effect of *right to trees* (ω^2 = 0.33) and demonstrates the substantial influence of the scenario in the *enforcement* × *full compensation* × *right to trees* interaction as well as the model as a whole.



Source: Field Survey, 2016

Figure 8.7 Interaction graphs of the *enforcement* × *compensation* × *right to trees* interaction showing the effect of 'right to trees'

8.4 Conclusion

This chapter has presented empirical results from the tests of hypotheses on the predicted behaviour of farmers and concessionaires under a set of hypothetical scenarios. It was found that there was much support for the hypotheses relating to farmers' likely use of actions to pursue compensation and concessionaires' likelihood to pay compensation. Also, there was enough empirical evidence to support the prediction of the game models with regards to farmers' tree retention behaviour. The results further hint of the high possibility that farmers will intensify sustainable tree retention if they have rights to on-farm timber benefits. Though farmers' willingness to engage in illegal logging under the *enforcement and right to trees* scenario was low, there was little empirical evidence to support the hypothesis that farmers will be less willing to engage in illegal logging if they have rights and the tree harvesting rule is enforced. This notwithstanding, there was much support for the hypothesis that the combination of *enforcement*, *full compensation* and *right to trees* is more likely to reduce farmers' willingness to engage in illegal logging. However, *right to trees* was found to contribute more to the likely reduction in farmer's willingness to desist from illegal logging than any other experimental scenario.

Chapter 9. Optimal Policy Options for Sustaining Off-reserve Forests in Ghana

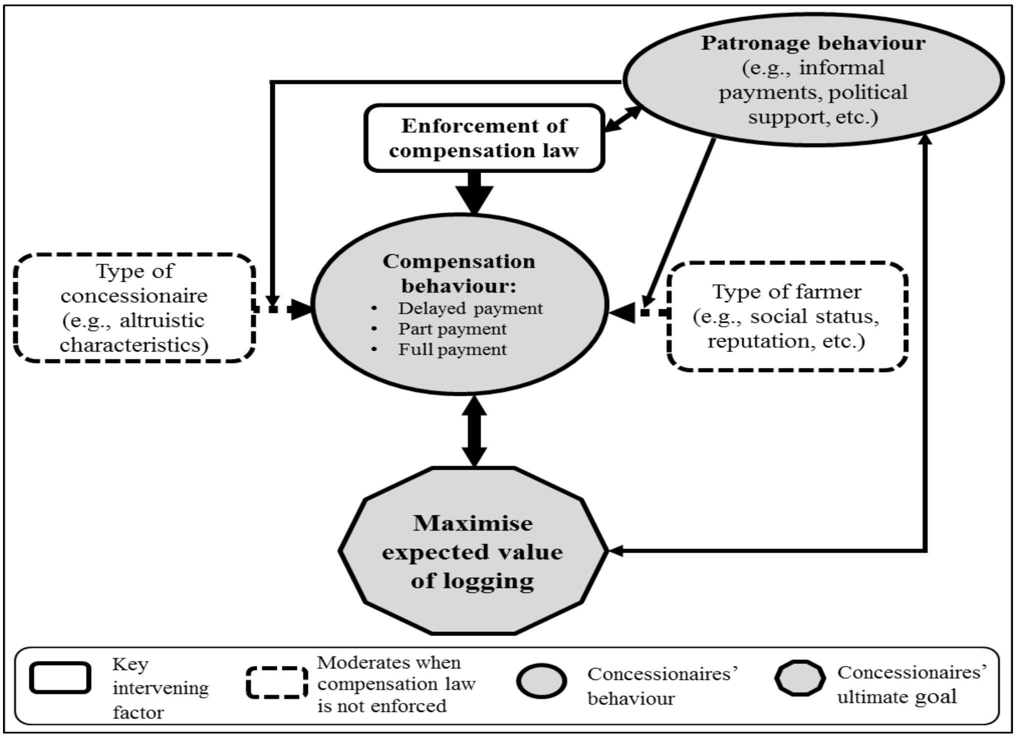
This chapter discusses the results of the study as presented in Chapters 6, 7 and 8. The chapter combines the results of the game-theoretic and empirical analyses to address the central question of the study. It, first, discusses the results on the rationale behind the current behaviour of farmers and concessionaires in the off-reserve forests. The chapter then discusses the results on the hypothetical policy options for resolving the compensation problem. It proceeds to discuss the results on hypothetical policy options for inducing sustainable practices among farmers. These aforementioned discussion sections focus only on the effectiveness of the options in either resolving the compensation problem or sustaining the forests. Hence, the chapter follows this up with an analytical discussion of the optimal option with regards to incentives for long-term sustainability and distributive impacts. This analytical discussion largely relies on existing literature on the subjects.

9.1 Rationale for the current behaviour of farmers and concessionaires

This section briefly discusses the reasons for the current behaviour of farmers and concessionaires in the off-reserve forests from the perspective of the rational choice model. In all, the study found that the current actions of the stakeholders in the off-reserve forests are rational because they aim at maximising their returns from off-reserve interactions.

9.1.1 Rationale for the current behaviour of concessionaires

The empirical results on compensation payment confirm the general consensus in the literature that concessionaires seldom compensate cocoa farmers for crop damage. Results from the game-theoretic analyses revealed that non-payment of compensation stems from concessionaires' desire to maximise their expected value from on-farm logging. This underlying factor is primarily moderated by the enforcement of the compensation law by the FSD (see Figure 9.1). The enforcement of the compensation law alters the cost-benefit calculus of concessionaires in favour of full payment of compensation to all farmers. Typical concessionaires will be better off if they fully and promptly compensate every type of farmer when the compensation law is enforced. Without enforcement, however, typical concessionaires have no rational basis to compensate ordinary farmers (non-leaders). Paying compensation to these farmers when the compensation law is not enforced will reduce concessionaires' expected value of logging. It is therefore discernible that most farmers do not receive full compensation for crop damage, primarily, because there is limited enforcement of the compensation requirement. In fact, the survey revealed that the issue of on-farm logging compensation has been neglected by the FSD. Most concessionaires therefore take advantage of this situation to maximise their expected value of logging by refusing to pay compensation to ordinary farmers.



Source: Author's Construct, 2018

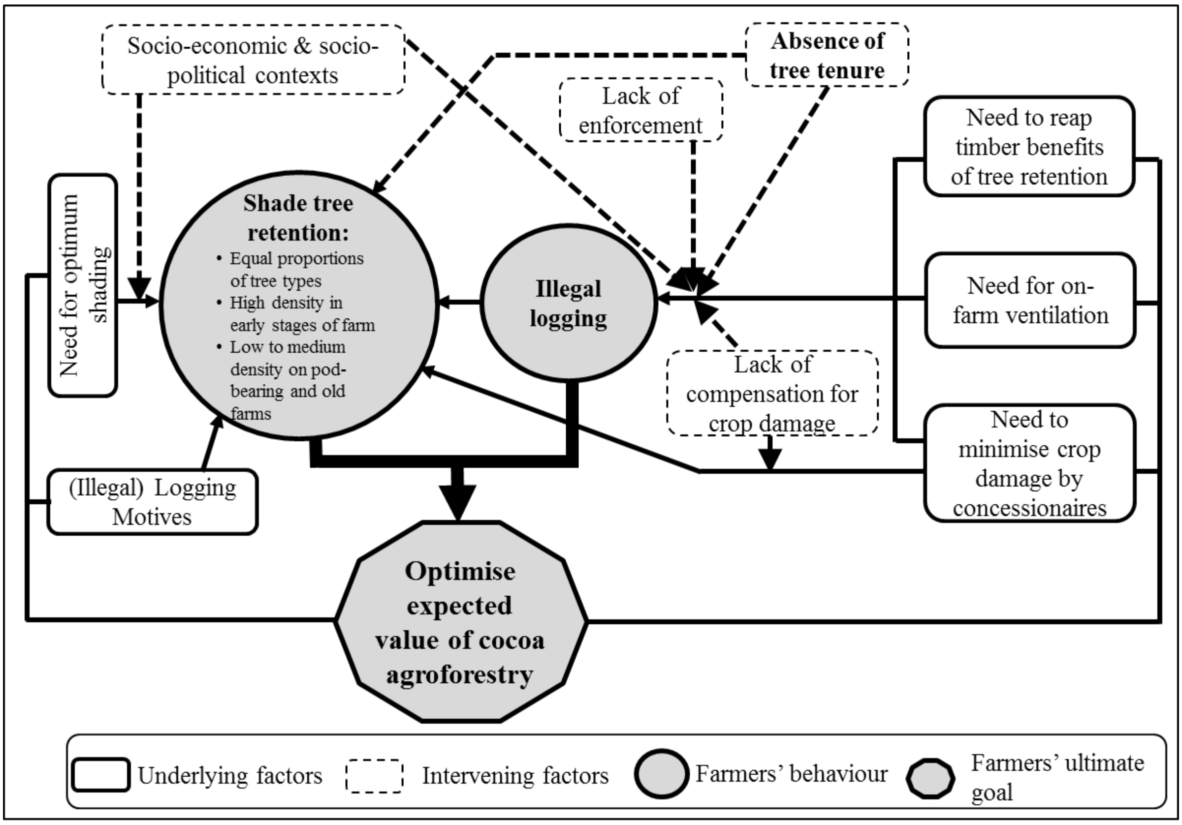
Figure 9.1 Current behaviour of concessionaires explained from a rational choice perspective

Figure 9.1 shows that in the absence of enforcement, the characteristics of the farmer and concessionaire involved in the compensation interaction influence compensation payment. The game-theoretic analyses revealed that the receipt of full compensation by the farmer is more related to the type (or social status) of the farmer. The empirical analyses on receipt of compensation by farmers revealed that full compensation is much more related to leadership position and educational attainment (cf. Marfo *et al.* 2006). Farmers with leadership positions and those with higher educational attainment have higher likelihood of receiving full compensation. As explained in Chapter 6, these are powerful farmers within farming villages and refusing to pay compensation to them will be more deleterious to the concessionaire's expected value of forestry. By contrast, concessionaires will be better off if they refuse to fully compensate farmers without leadership positions in their villages.

It must be noted that since the majority of farmers in farming villages in the off-reserve forests do not occupy leadership positions, the enforcement of the compensation law remains the only major obstacle to the achievement of concessionaires' ultimate goal. As such, concessionaires resort to the use of petty bribes, unofficial payments and political support to compromise law enforcement and other efforts to resolving compensation conflicts in the off-reserve area (cf. Amanor 2005; Katanyal 2008; Marfo and Schanz 2009; Hansen and Lund 2011; Otutei 2012; Ameyaw *et al.* 2016). These compromising mechanisms enable them to obtain Conveyance Certificates to convey logs to sawmills without satisfying the compensation requirement. It is therefore discernible that non-payment of full compensation to ordinary farmers by concessionaires is a rational behaviour. Despite it being illegitimate, this behaviour enables concessionaires to maximise their expected value of logging in the off-reserve forests.

9.1.2 Rationale for the current behaviour of farmers

The empirical results revealed that average shade tree densities on cocoa farms are low compared to the recommended standards by the Cocoa Research Institute of Ghana (CRIG). The CRIG recommends between 15 and 18 shade trees per ha on cocoa farms (Asare 2005). Yet, the average shade density on cocoa farms was around 7 trees per ha. Also, the analysis revealed that shade tree density on farms declines with the age of farm. Further, the survey data shows that farmers are retaining fairly equal proportions of timber and non-timber tree types as shade trees. Illegal logging was also found to be prevalent among farmers. Most farmers also support farmer-driven illegal logging and prefer chainsaw logging to concession logging. The study found that the above behaviour of farmers is rational. Farmers retain equal proportions of timber and non-timber trees, reduce shade density with time, and engage in illegal logging to maximise their returns from cocoa agroforestry. This relationship is captured in Figure 9.2.



Source: Author's Construct, 2018

Figure 9.2 Current behaviour of farmers explained from a rational choice perspective

Figure 9.2 shows that three main factors combine to principally influence shade tree density on cocoa farms. These include the need for optimum shading, the need to minimise anticipated crop damage by concessionaires and illegal logging (motives). As revealed in Chapter 6, cocoa crops are heavily dependent on optimum shading for optimum productivity. The reasons for this high dependence on shade trees are explained in Chapter 6 (Section 6.3.3). Here, it suffices to say that crop yield and the quality of cocoa beans will markedly decline without optimum shade density unless farmers apply complimentary or substitutionary agrochemicals (Duguma *et al.* 2001; Darko-Obiri *et al.* 2007; Gockowski *et al.* 2013). Yet, farmers cannot afford the cost of the complementary or substitutionary quantities of agrochemicals (Barrientos *et al.* 2008; Hansen and Treue 2009; Anglaaere *et al.* 2011; Gockowski *et al.* 2013; Akrofi *et al.* 2015). Being mindful of the above constraints, therefore, farmers maintain high shade density (about 21 trees per ha) during the early ages of farms (below 5 years) when the cocoa crops indispensably require shading, moisture and fertility from shade trees. This ensures optimum pod bearing for the cocoa crops. However, more ventilation is needed on farms when crops start bearing fruits otherwise cocoa crops will shed their pods (Odoom 2005). Also, farmers' cost of damage to farms by concessionaires is expected to be greater on pod-bearing farms than on farms in their early stages (below 5 years). In this case, the more mature the farm, the higher the cost of the expected damage from concession logging and vice versa. Faced with the problems of pod shedding and anticipated extensive crop damage by concessionaires, therefore, the most rational action for farmers is to reduce shade tree density by disposing of some trees. This study argues that the (sharp and later, steady) decline in shade tree density on cocoa farms as revealed by the farmers survey is a rational action by farmers to maximise their agricultural values for tree retention and minimise anticipated crop damage by concessionaires should the Forest Service Division (FSD) grant concessions on farms.

Further, the dependence of cocoa crops on optimum shading and the need to minimise anticipated damage by concessionaires combine to influence farmers' tree selection behaviour. The *t*-test results on types of shade trees revealed that farmers retained almost equal proportions of timber and non-timber trees on farms. It is discernible from Figure 7.2 that this balance was fairly constant throughout all the stages of farming. This behaviour may seem counter-intuitive because farmers revealed during the survey that timber trees have higher compatibility with optimum cocoa production than non-timber trees. Hence, one would intuitively expect significantly more timber trees as shade trees than non-timber trees. However, this was not the case. It can therefore be said that farmers are neither biased towards timber trees nor non-timber trees. This situation is primarily explained by farmers' desire to optimise the agricultural benefits of shade tree retention without compromising the need to protect crops from anticipated extensive damage by future concessionaires. One timber tree logged by concessionaires affects about 80 crops either directly or indirectly (Richard and Asare 1999). Retaining higher proportions of timber trees would mean extensive farm damage during concession logging in the future. On the other hand, retaining higher proportions of non-timber trees would also mean reduction in farm productivity. Thus faced with these two constraints, farmers rationally retain equal proportions of both tree types to balance the maximisation of shading benefits and minimisation of the cost of logging damage by concessionaires. This study concludes that farmers' tree selection behaviour, as revealed by the survey results, is not counter-intuitive when viewed from the perspective of the rational choice model. In fact, the empirical results are consistent with the game-theoretic results in Chapter 6. Combining the theoretical and empirical results, therefore, it can be argued that farmers' decision to retain equal proportions of timber and non-timber trees is to enable them maximise the expected value of on-farm tree retention.

Farmers' hope for economic returns from timber trees (through illegal logging) also influences their tree retention and illegal logging behaviour. Besides shading, farmers retain shade trees with the intention of selling them for a living or harvesting them for domestic construction. About 93.3% of farmers had this intention. These farmers had more trees on their farms (3.5 per ha more) than those who did not have such a motive. Thus, among other things, farmers' desire to obtain timber revenue or lumber products from shade trees influences the shade tree density on their farms. Yet, the prevailing tree tenure regime in the off-reserve forests implies that farmers cannot obtain such timber benefits through legal means. The only possible means to obtain timber benefits is through illegal logging. In fact, the logit model on illegal logging revealed a significant and direct relationship between farmers' hope for timber benefits from tree retention (through illegal logging) and their involvement in illegal logging. Even so, farmers must balance their desire for timber benefit from shade trees and their need for optimum shading. The need to reduce shade density on pod-bearing farms thus offers the right occasion to achieve this balance. In fact, the survey data shows that about 68% of shade trees are quickly disposed of when cocoa crops start bearing pods (after 4 years), mostly through illegal chainsaw logging. Some respondents (including farmers and concessionaires) revealed that at this stage of the farm, the need for reducing shade becomes so compelling that some farmers seek assistance from concessionaires to log some trees when chainsaw operators are not available.

It can therefore be argued that illegal logging is very rampant in the off-reserve forests due, primarily, to farmers' need to recover their investment in tree retention and reduce shade density on mature farms. However, the relationship between the satisfaction of this need and the adoption of illegal logging is moderated, principally, by the exclusionary tenure regime in the off-reserve forests, and to some extent, by the lack of enforcement of the tree harvesting rule and non-payment of compensation for crop damage. It is the prevailing tree tenure regime that makes farmers' quest to obtain timber benefits from shade trees illegal. In addition, the prevailing tree tenure combines with low enforcement, compensation conflicts and farmers' circumstances to facilitate the rate at which farmers engage in illegal logging. Given that illegal logging would be economically and socially profitable even under strict enforcement in the prevailing tenure regime, the activity becomes even more rational for the farmer in the current situation where there is little enforcement of the tree harvesting law. This study concludes that farmers' involvement in illegal logging is a rational activity given the prevailing circumstances. Farmers use illegal logging to maximise their returns from cocoa agroforests: to prevent excessive shading, to reduce anticipated damage by concessionaires and to reap the non-shading benefit of timber tree retention.

9.2 Options for Resolving the Compensation Conundrum

This section discusses results on farmers' likelihood to use actions in the future to independently pursue compensation and the factors influencing their likelihood to use these actions. It then proceeds to discuss results on the effects of farmers' actions and external involvement on concessionaires' likelihood to fully compensate farmers.

9.2.1 Farmers' choice of actions to independently pursue compensation

The theoretical and empirical results showed that farmers are more likely to pursue compensation on their own without formal external intervention. As the game-theoretic models posit, failure to pursue compensation attracts social sanctions. Peers are likely to perceive the affected farmer as a weakling for chickening out of the game. This finding is therefore contrary to that of previous research which indicate that most farmers do not take any action to pursue compensation (Marfo and Schanz 2009). Persuasion was found to be both a universal and foundational action for pursuing compensation independently. As a universal action, almost every farmer, irrespective of social status, is determined to convince the concessionaire to pay the compensation before attempting to convey the logs. As a foundational action, persuasion serves as a springboard for other more intense actions should the conflict continue.

Beyond the point of persuasion, farmers are more likely to use blockading or mediation to pursue compensation. However, likelihood to use any of these actions are lower than that of persuasion. This partly stems from the foundational nature of the latter. It may also signal a loss of interest in the conflict as it intensifies. Moreover, the pursuit of compensation after unsuccessful persuasion and the subsequent use of successive actions are dependent on the socio-political status of the farmer. Both the game-theoretic and empirical analysis showed that farmers with socio-political connections within their respective villages are more likely to use either blockading or mediation to pursue compensation after persuasion has failed. Farmers who do not have these connections are more likely to chicken out of the game after persuasion has been unsuccessful. The finding is therefore consistent with the assertion that there is increasing hopelessness among farmers as compensation conflicts progress through time (Marfo and Schanz 2009).

The above notwithstanding, the study found that farmers are more likely to use blockading than mediation. This finding is rather surprising given the fact that the socio-cultural environment within which conflicts take place influences the choice between mediation and the use of force. Mediation theorists posit that due to the prevailing societal norms within developing countries such as Ghana, there is much social pressure for disputants to opt for mediation over force (Wall and Dunne 2012; Kressel 2014). Off-reserve concession logging takes place within a complex social system involving traditional leaders, local government representatives, farmers and concessionaires. Cooperative actions such as mediation are applauded and defiant actions discouraged in this social milieu. Further, the existence of SRAs is expected to foster social cohesion among these parties and produce conducive environments for mediation in compensation conflicts. Yet, the results from the study is an indication that this is far from being the case. This is because factors affecting participation in mediation transcend social environments to include the perception of disputants (about mediating agents and outcomes) and their attitude towards other alternative strategies (Bercovitch and Houston 1993; Wall and Lynn 1993; Wall and Dunne 2012; Kressel 2014). As revealed in Chapters 3 and 6, studies (e.g., Marfo and Schanz 2009; Ututei 2012) have shown that concessionaires, through several means, have compromised the neutrality of mediators in compensation disputes. This is common knowledge to farmers (Otutei 2012). Therefore, farmers perceive mediators as biased against them. With this perception, farmers' attitude towards mediation as revealed by the empirical analyses is both rational in game-theoretic logic and consistent with mediation theory. Mediation scholars indicate that disputants are not motivated to use mediation if the objectivity, impartiality and neutrality of potential mediators are contested (Isenhart and Spangle 2000; Jehn *et al.* 2010; Dhiaulhaq *et al.* 2015). In short, the prevailing social system rather discourages the use of mediation by farmers.

In addition, farmers are less likely to use mediation because they perceive it to be less successful and more costly in securing full compensation in terms of time, efforts and in-kind gifts to mediators. Kressel (2014) reveals that the choice of mediation is affected by disputants' attitudes towards, and assessment of available alternatives for securing objectives. Parties to a conflict seek mediation because they expect benefit from it (Barton

2005; Bates and Holt 2007). Farmers, as disputants, expect their conflict strategies to secure them full compensation and this is less likely to occur with mediation. As the game models indicate, with the exception of top-level leaders, all other farmers prefer blockading to mediation because they are more likely to lose out should they opt for the latter. Blockading is perceived as a rather effective independent action for securing at least some partial compensation. They also perceive it as less costly, straightforward and not dependent on financial abilities (cf. Burton 2004). Top-level leaders are more likely to choose mediation over blockading because though both are likely to secure them full compensation, blockading comes with a higher socio-political cost regardless of its ability to secure instant payment. In fact, the empirical analyses revealed a significant and inverse relationship between likelihood to blockade and top-leadership position. Hence, it is only in these circumstances that the socio-cultural environment within which a conflict takes place serves to motivate the adoption of mediation over force in off-reserve compensation interactions.

Litigation was the action with the lowest likelihood of adoption by farmers. The game models revealed that farmers are unlikely to use litigation because the expected cost of litigation exceeds the expected benefits. Aside from this, the use of the court system requires financial resources and results in loss of productive hours. Chapter 7 revealed that income levels of farmers are low. Hence, they will not be able to afford legal fees. More importantly, the farmer is relatively powerless against the concessionaire in the legal system and the tendency for concessionaires to influence court ruling in their favour is high (Katanyal 2008; Otutei 2012). With this belief, farmers are more likely to accommodate non-payment after mediation or blockading than to use litigation. This is consistent with the assertion that farmers are unwilling to pursue compensation through the legal system because they are financially and politically under-resourced (Marfo and Schanz 2009; Otutei 2012).

9.2.2 Effect of farmers' actions on concessionaires' likelihood to pay compensation

The empirical results revealed that the concessionaire is less likely to pay full compensation should the farmer use persuasion, mediation or blockading. Though these results are based on the behavioural expectations of concessionaires in relation to farmers' actions, they are, nonetheless, consistent with the findings of Marfo and Schanz (2009). These authors tracked the actual outcomes of the use of strategies in 81 compensation conflicts in five off-reserve forest communities. They report that the ratio of settlement against non-settlement was 0.08 for persuasion and 0.1 for mediation. Blockading performed better in the current study than persuasion and mediation both in terms of concessionaires' likelihood to pay partial compensation and full compensation; and the reduction in likelihood not to pay any form of compensation at all. This confirms farmers' responses during the survey that they believe blockading is more effective in securing at least some compensation from concessionaires. Unlike the other actions, the empirical results revealed that concessionaires are more likely to pay full compensation if farmers win litigation cases. This is consistent with Marfo and Schanz (2009) who found litigation to be the most effective strategy among the set of strategies open to farmers. However, the survey revealed that litigations are rare and mostly unsuccessful due to alleged capture of the court system by concessionaires (cf. Inkoom 1999; Marfo 2006).

It is interesting to note that though mediation is widely linked to higher outcomes in the conflict resolution literature (cf. Landsman *et al.* 2003; Wall and Dunne 2012; Kressel 2014), it performs rather abysmally in compensation conflicts within the off-reserve landscape. This results from the lack of neutrality of mediators and power asymmetries among farmers, concessionaires and mediators. In theory, mediation provides a levelled playing field for disputants to converge and resolve conflicts regardless of the extent of power differentials (Bercovitch 1996; Dhiaulhaq *et al.* 2015). However, this is not the case in the compromised social system within which compensation conflicts occur in the off-reserve landscape. Mediation in off-reserve compensation conflicts can be classified as emergent mediation (as opposed to contractual mediation) because mediators are not contracted by the disputants but rather they have 'enduring ties' with them (cf. Kressel 2014). Farmers are the subjects or electorates of mediators, whereas concessionaires become allies and benefactors of mediators. Concessionaires combine the opportunities provided by these ties and their high politico-financial powers to influence mediators in their favour (cf. Marfo and Schanz 2009). Both the concessionaire and the mediator become co-winners if mediation agreement favours the former. Hence, mediators are more likely to deploy their socio-cultural powers to influence outcomes in favour of the more powerful (concessionaires) to serve their own vested interests (cf. Mulcahy 2000; Della Noce 2001; Evans 2001; Kay 2009). These findings support the assertion in the literature that mediation is not a silver bullet in conflict resolution and that outcomes may depend on several factors, including contexts (Wall and Dunne 2012; Kressel 2014; Coleman *et al.* 2015).

The above empirical results on concessionaires' behaviour may seem contradictory to some of the game-theoretic results in Chapter 6. Upon further analyses, however, it becomes obvious that the empirical results are consistent with the theoretical results. For instance, the game models revealed that farmers who will use mediation are more likely to be top-leaders, and mediation is more likely to be successful for this type of farmers. Yet, the empirical analyses revealed that concessionaires are less likely to fully compensate farmers if they use mediation. But, it should be noted that rational concessionaires believe that in the real world, top-leaders do not get to use mediation because they are more likely to receive prompt compensation. Therefore, their potential contenders in mediation processes are more likely to be less powerful farmers. Out of frustration, these farmers may turn to their leaders for mediation though they (farmers) know that the strategy is sub-optimal. With this belief, concessionaires are more likely to participate in mediation processes, publicly accept mediated agreements and afterwards refuse to comply. Likewise, the theoretical results revealed that blockading is optimal for connected non-leaders and sequentially optimal for lower-level leaders. However, since lower-level leaders are more likely to receive prompt and full compensation, concessionaires are more likely to expect blockading from non-leaders. Concessionaires are also aware that these types of farmers cannot blockade for longer periods because of the existence of social pressure from their leaders to withdraw. Therefore, blockading becomes an incredible threat, and insofar as it remains so it will be less likely to secure full compensation (cf. Burton 2004). The empirical analyses revealed that concessionaires are more likely to seek for mediation during blockading to convey logs with the incredible promise that they will pay after conveyance. These are consistent with the game-theoretic predictions in Chapter 6.

9.2.3 The need for and impact of external interventions on concessionaires' behaviour

The above discussion points to the conclusion that the compensation problem is not likely to be resolved should farmers pursue compensation using their own strategies. This is because few farmers are powerful within forest villages and the use of litigation is less likely. Also, the power of concessionaires and the mutually beneficial alliances between them and mediators and other higher powers will make the use of blockading and mediation ineffective. It is interesting to note that despite their empirical evidence suggesting the ineffectiveness of mediation, Marfo and Schanz (2009) argue for its adoption as the primary strategy for resolving compensation conflicts. To these scholars, mediation can be effective if actors in the conflict are empowered through capacity building, provision of bargaining platforms, neutral mediators and legalisation of mediated agreements.

The above recommendation is laudable considering the superior ability of mediation to achieve outcomes in many settings (cf. Wall *et al.* 2001; Wall and Dunne 2012; Kressel 2014; Coleman *et al.* 2015; Zhang and Chen 2017). However, the recommendation is less likely to be legitimate, effective and feasible in the logging compensation context for two main reasons. Firstly, underlying the compensation problem is non-compliance by concessionaires due to non-enforcement of the compensation law by the Forest Service Division (FSD) of the Forestry Commission (FC). Therefore, any option for resolving the compensation situation that fails to tackle the root of the problem implicitly serves to legitimise non-compliance and non-enforcement. Secondly, chiefs and local government representatives are still recommended as potential mediators who need to be empowered and their capacities built to remain impartial in the mediation process (Marfo and Schanz 2009). Though the proposal for the continuous use of these mediators is in order and consistent with both theory and practice (Wall and Dunne 2012), their neutrality cannot be guaranteed regardless of how trained or empowered they may be. This is because the prevailing culture within which mediation takes place serves to dictate the behaviour of the mediator (Wall and Dunne 2012). The pre-logging and logging interactions between the concessionaire and community leaders will continue to inextricably establish enduring ties between these two groups of actors and compromise their neutrality and partiality in the process. Influenced by their vested interests and enduring ties with concessionaires, they are more likely to continue to use their powers to favour concessionaires and socially coerce farmers to accept unfavourable agreements (cf. Mulcahy 2000, 2001; Gerami 2009; Shapira 2009). It is therefore doubtful if outcomes of recommended mediation processes will be any different from the *status quo*.

The foregoing discussion indicates that options which transcend village boundaries to address the root of the problem and circumvent compromised village leaders are needed. Both the game-theoretic models and the empirical results revealed that concessionaires are more likely to promptly pay compensation to the farmer should the State enforce the compensation law. They will have no other option than to fully compensate farmers if District Forest Officers comply with the Manual of Procedures and withhold Conveyance Certificates from them until they have duly paid full compensation to farmers. In fact, this was the best performing option in terms of increasing concessionaires' likelihood to pay full compensation. Likewise, the study found that concessionaires are likely to pay full compensation to farmers if there is an advocacy group that can credibly threaten a court action against the State and the concessionaire for non-payment of compensation to the farmer. Concessionaires will promptly compensate farmers to avoid any bad publicity and extra-logging expenses in court that will result from non-payment of compensation. These results demonstrate that a more *legitimate* and *effective* solution to the compensation conundrum is more likely to lie primarily with the Forestry Commission as an enforcer and with the intervention of other capable third-party advocates. These findings therefore seem to provide evidence to support the call for strengthened enforcement of the compensation law by some researchers and some donor partners such as the European Union (Owubah *et al.* 2001; EU and GoG 2009; Amoah and Boateng 2014). However, the game models showed that the FC is less likely to enforce the compensation law. Therefore, third-party advocacy appears to be the best option to addressing the on-farm logging compensation conundrum.

9.3 Options for Inducing Sustainable Practices among Farmers

Sustaining the off-reserve forests requires that farmers maintain high shade tree density with sustainable tree diversity and desist from illegal chainsaw logging. These two issues (especially illegal chainsaw logging) have become the centre of the debate to rescue the off-reserve landscape from degradation. It is therefore incontrovertible that the effectiveness of any policy option to sustain the forests is to be measured by how much it motivates farmers to sustainably intensify tree retention on farms and stop engaging in illegal logging. Based on this premise, the study sought to theoretically and empirically evaluate the effectiveness of hypothetical policy options in addressing these issues. The findings are discussed in this section.

9.3.1 Intensification of sustainable tree retention

Both the game-theoretic results and the empirical results revealed that farmers are more willing to retain both tree types on their farms regardless of the hypothetical policy scenario. The primary explanation for this findings is that the retention of both tree types is indispensable to cocoa farming in the off-reserve landscape due to reasons explained earlier. Suffice it to say that since optimum production under 'non-timber trees only' and 'no-shade' farming is heavily dependent on agrochemicals which farmers cannot afford, the most rational choice for them is to retain both tree types regardless of the circumstances. The second reason is farmers' intention to engage in illegal logging when trees are matured. Farmers are more willing to retain optimal shade density with fairly equal proportions of timber and non-timber trees because they intend to engage in illegal logging in the future. However, this by no means suggests that shade tree density and or shade tree diversity will remain the same as in the *status quo* when issues relating to tree-tenure and compensation are addressed. For instance, the empirical results showed that farmers' willingness to retain both tree types is higher for every hypothetical policy option compared with the *status quo*. In addition, excepting the provision of *full compensation* and *full compensation plus right to trees*, the differences in farmers' willingness to retain both tree species on the one hand, and their willingness to retain only non-timber trees or practice no-shade farming, on the other hand, under the remaining hypothetical policy options were greater than that of the *status quo*.

It must be noted that recognising farmers' right to trees (by providing them with 40% of timber revenue) appears to be an important motivation for farmers to intensify tree retention on their farms. This is because *rights to trees* produced the highest willingness to retain both tree types. Moreover, *right to trees,* whether alone or combined with other options, resulted in substantial and significant differences between farmers' willingness to retain both tree types, on the one hand, and their willingness to practice 'non-timber tree only' or 'no-shade' farming, on the other hand. Again, the results showed that granting right to trees plus enforcing the tree harvesting rule is the most effective incentive for farmers to be more willing to retain both tree types and at the same time reduce their willingness to either retain only non-timber trees or practice no-shade farming. This finding provides empirical evidence in support of the position of some scholars that revising the existing timber benefit sharing arrangement to include farmers is more likely to motivate them to increase shade tree density on their farms (Richards and Asare 1999; Owubah *et al.* 2001; Acheampong *et al.* 2014; Oduro *et al.* 2015; Dawoe *et al.* 2016). Such a recognition of rights to timber benefits is more likely to provide farmers a sense of ownership of on-farm trees and motivate them to retain more trees compatible with cocoa.

9.3.2 Controlling farmer-driven illegal chainsaw logging

The biggest threat to the sustainability of the off-reserve forests is illegal chainsaw logging aided by farmers. The study found that only a policy mix option that concurrently combines rights to trees (40% of stumpage revenue), full compensation for crop damage and strict enforcement through a collaboration of the FSD and village residents can effectively control the illegal logging menace and sustain the off-reserve forests. It was found that any policy option that tackles only one of the underlying issues or combines any two of them may be less likely to reduce illegal chainsaw logging to a sustainable level. The details of these findings are discussed below:

The necessity but insufficiency of forest rule enforcement

Both the theoretical and empirical results showed that strict enforcement alone, even with the use of local enforcers from respective forest villages, is less likely to control illegal logging by farmers. The game-theoretic results revealed that farmers are less likely to desist from illegal logging because the results of their cost-benefit calculus proves the activity to be financially and socially rewarding even under strict enforcement. Further, the empirical results showed that enforcement within the current off-reserve regime will only make farmers indifferent towards illegal logging. This is because strict enforcement will reinforce the perceived unfairness within the off-reserve landscape. Therefore, farmers are expected to constantly be on the look-out for opportunities to outwit local enforcers to maximise their returns from on-farm tree retention. This finding is consistent with the situation in the Ecuadorian Amazon where smallholders engage in illegal logging because they find the net-benefit of illegal sale of timber to be higher than the deterrence cost (Perry *et al.* 2007; Amacher *et al.* 2009; Vasco *et al*. 2017).Therefore, the study presents evidence from outside the communal property regime (CPR) to lend credence to the theory that authorised entrants to a forest resource 'engage in a game with rule enforcers, seeking to gain as much as possible' (Schlager and Ostrom 1992, p. 257).

The above findings on the singleton application of strict enforcement runs contrary to the focus on enforcement as a panacea for arresting illegal logging by the Government of Ghana and some scholars (EU and GoG 2009; Boakye 2015). Efforts by the government at the on-farm level have achieved abysmal results judging from the rather high rate of farmer-driven illegal logging revealed by the study (cf. Hansen 2011; Ramcilovic-Suominen and Hansen 2012; Franck and Hansen 2014; Ramcilovic-Suominen and Epstein 2015). The study demonstrates that these efforts have been ineffective and that other novel enforcement strategies such as the one considered in this study are less likely to be effective because proponents have missed the fact that the sole reliance on enforcement without concurrently addressing other root causes of illegal logging is less likely to control the phenomenon (cf. Marfo 2010; Hansen 2011; Ramcilovic-Suominen and Hansen 2012;

Ramcilovic-Suominen *et al.* 2013; Franck and Hansen 2014; Hajjar 2015a; Ameyaw *et al.* 2016).

Using the favourable cost-benefit calculus of illegal loggers discussed above as a justification, some scholars argue that the existing sanctions are not enough to deter farmers from illegal logging (e.g., Derkyi 2012; Boakye 2015). They therefore call for higher sanctions by the State to reduce the attractiveness of illegal chainsaw logging in Ghana. However, experiences elsewhere show that this is more likely to aggravate the illegal logging situation. For instance, the lone enforcement of forest laws in Bangladesh has been found to trigger a vicious circle of illegal logging' by forest dwellers (Mukul *et al*. 2014). The poor culprits of illegal logging, in many cases, have to continue engaging in illegal logging to be able to raise enough money for legal fees and court fines and, at the same time, cater for the needs of their households (Mukul *et al*. 2014). This shows that the solution to illegal chainsaw logging is less likely to lie in the application of higher sanctions.

Of course, the above does not suggest that deterrence has nothing to contribute to the fight against illegal chainsaw logging in the off-reserve landscape. Rather, this study stresses the insufficiency of the approach in improving forest conditions on its own. In fact, the results revealed that the strict enforcement of the tree-harvesting rule makes substantial contributions in reducing farmers' willingness to engage in illegal logging within the policy mix. As shown in the game models, granting rights to timber benefits without enforcing the tree-harvesting rule may prove counterproductive. It is enforcement that serves to reduce farmers' net-benefit in engaging in illegal logging after their rights have been recognised by markedly altering the cost side of farmers' internal cost-benefit calculus. This demonstrates the indispensability of enforcement in efforts to salvage the off-reserve forests from illegal loggers and provide evidence to indicate that appropriately enforcing the law is not illusory as some scholars seem to suggest (e.g., Hansen *et al*. 2009; Hansen 2011). Enforcement becomes illusory only when it is applied solely and inappropriately. For instance, statist enforcement has become ineffective because it continues to rely solely on the sporadic and limited monitoring of the scattered on-farm timber resources by urban-based forest guards and Task Forces. By contrast, the approach prescribed here is more likely to be effective because apart from being a part of a policy mix, it also uses paid local residents as enforcers. These paid residents will be more able to monitor forest use at the on-farm level in forest communities, thereby surmounting problems posed to the FSD staff by the scattered nature of the off-reserve timber resources. Though this may be costly, its contribution in combatting illegal logging cannot be overemphasised.

The finding on the necessity of local enforcement in sustaining the off-reserve forests is consistent with those from other settings such as communal forests and protected areas (PAs). For instance, based on the results of their multi-country analysis of factors conducive to the successful management of communal forests, Gibson *et al.* (2005, p. 274) have long concluded that the monitoring and enforcement of forest rules are ‘necessary (but not sufficient) for the long-run protection of local resources’. Similarly, Chhatre and Agrawal (2008) reveal from their multi-country study on local enforcement and forest conditions that enforcement is critical for the sustainability of the forest commons. Outside the commons, Robinson *et al.* (2014a) has revealed that the involvement of local people in the enforcement of laws regulating the use of Protected Areas in Tanzania is more likely to reduce illegal harvesting among forest dwellers. This study therefore provides additional theoretical and empirical evidence from outside CPR and PA settings to reinforce the seemingly general consensus that enforcement through local enforcers, though insufficient on its own, is a necessary condition underlying the sustenance of forest resources (cf. Kaimowitz 2003; Gibson *et al.* 2005; Chhatre and Agrawal 2008; Singh *et al.* 2011; Bouriaud *et al.* 2014; Coleman and Liebertz 2014; Robinson *et al*. 2014a). In the case of the off-reserve landscape, the effectiveness of enforcement is contingent on its combination with other important measures.

The paradox of compensation

The study found that the payment of full compensation to farmers will have a negligible impact on their willingness to desist from illegal logging. When assessed on its own, the receipt of full compensation was found to have the least effect on farmers’ willingness to comply with the tree-harvesting rule despite its role in breeding non-compliance (refer to Chapter 7). Combining compensation and enforcement was found to even perform worse due to two main reasons. Firstly, the full payment of negotiated compensation is inadequate to cover the damage caused by concessionaires. Chapter 7 revealed that farmers are not satisfied with the compensation they received because concessionaires employ their powerful agencies to marginalise farmers in compensation negotiations, thereby leaving farmers with no option than settling for low compensation amounts (cf. Kantayel 2008; Hansen *et al.* 2009; Hansen 2011). Similarly, others have observed that the extent of damage to the farm goes beyond cultivated crops to include damaged saplings and loss of shade protection from the felled trees (Richards and Asare 1999). Also, farmers indicated during the survey that the mere sight of a farm damaged extensively by a concessionaire is unbearable regardless of the amount of compensation paid.

Secondly, farmers would still engage in illegal chainsaw logging even if compensation fully covered their nominal, agro-ecological and psychological losses. This is because they would still need to meet their (illegal) logging intention for tree retention. Also, the full and just compensation is less likely to erode the perception of unfairness of the tree-harvesting rule, thereby serving to fuel their need to log trees illegally to obtain timber benefits from tree retention. Insufficient compensation, illegitimate forest law and the quest to achieve (illegal) logging intentions for retaining trees will unite to render the combination of only compensation and enforcement counterproductive thereby undermining efforts to sustain the off-reserve forests. This shows the incongruity of the focus of the FLEGT on the enforcement of the tree-harvesting and compensation laws in Ghana (EU and GoG 2009). Any policy option combining only enforcement and compensation may not produce the desired outcomes as long as the central issue of tree tenure is not addressed (cf. Hansen 2011; Hajjar 2015a). This is because, ‘there will always be someone whom the farmer can find to chop down some trees illegally because it would be to their advantage to do so’ (Hajjar 2015a, p. 15).

The study also found that combining right to trees and compensation without enforcement is less likely to be effective. Farmers will still seek for opportunities to maximise their gains from on-farm tree retention if the tree-harvesting law is relaxed. This finding therefore provides empirical evidence to reveal the likely weakness in the call for incentives and compensation to address the pervasiveness of illegal chainsaw logging in the High Forest Zone (HFZ) of Ghana (Amoah and Boateng 2014). It also provides evidence for the veracity of the assertion that ‘no control measure can be effective without’ the rigorous monitoring, detection and sanctioning of culprits by the Forestry Commission (Odoom 2005, p. 64).

Paradoxically, the study found that no policy option can be effective without compensation regardless of how negligible its contribution may be. The simple effect analyses found the effect of compensation to be statistically insignificant when both right to trees and enforcement are present. Yet, it is this insignificant contribution that tightens the grip of the policy mix on illegal logging. Considering the fact that the compensation problem is peculiar to the HFZ, the results indicate that the effective application of both equitable distribution of rights and enforcement in forest conservation is much more dependent on the context within which they are applied. This study therefore reiterate the theoretical assertion that contextual factors, such as compensation payment in the off-reserve area, influence compliance by acting as catalysts or inhibitors (Vatn 2005, 2009; Ramcilovic-Suominen and Epstein 2012). In this case, compensation for crop damage will inhibit efforts to reduce illegal logging if it is not addressed concurrently with tenure reforms. Addressing the compensation problem is a necessary catalyst for inducing compliance among cocoa farmers in the off-reserve landscape.

The centrality but inadequacy of tenure reforms

The absence of tree-tenure in the off-reserve forests has been found to be the major factor underlying farmer-driven illegal logging. Based on this, several scholars have called for a revision of the current benefit sharing arrangement to grant a ‘competitive’ proportion of on-farm timber revenue to farmers to incentivise them to desist from illegal logging (refer to Table 3.1). However, the results of this study show that granting timber revenue to farmers *alone* is less likely to control the illegal logging menace. Both the game-theoretic and experimental results showed that farmers are more likely to continue to engage in illegal logging should the State grant them a competitive percentage of on-farm timber revenue without law enforcement and full compensation. They will seek to maximise their value from agroforestry through illegal logging when the law is relaxed. Additionally, farmers’ will continue to sell strategically located trees to illegal loggers to avoid extensive damage to cocoa crops by concessionaires without full compensation. This shows that tenure reforms alone in Ghana may be ineffective in addressing illegal logging (cf. Hajjar 2015a). The results also support the assertion in the commons literature that tenure alone is not sufficient in ensuring sustainable forest behaviour (Ostrom and Nagendra 2007).

Despite the ineffectiveness of the sole application of right to timber benefits, this study found that it is the most important element both on its own and in combination with other measures. In fact, it is the driving force behind the effectiveness of the policy mix found in this study. Providing farmers with 40% of stumpage revenue was found by this study to be the key motivator of farmers to desist from illegal logging when the law is enforced and full compensation is paid. In the game models, for example, it was found that every optimal action that induced compliance from farmers included right to trees. It was found to be the only action in the model by which compliance is triggered and subsequently consolidated by either the addition of enforcement or enforcement and compensation. Likewise, right to trees produced the strongest contribution in the policy mix option revealed by the empirical model on illegal logging. It was also found to produce substantial and significant effect at every factor-level combination of the other measures. This shows the inevitability of equitable tenure reform in any genuine policy option to arrest illegal chainsaw logging and sustain the off-reserve forests.

Granting farmers' right to timber benefits contributes to arresting farmer-driven illegal logging by means of addressing both the normative and instrumental causes of the problem. On the normative side, providing farmers a share of timber revenue will erode perceptions of unfairness among them: a perception found by numerous studies to be a rallying point for farmer-driven illegal logging (e.g., Amanor 1996, 2004, 2005; Marfo 2010; Hansen 2011; Amoah and Boateng 2014). The reduction in the perception of unfairness will secure legitimacy for the tree-harvesting law that will more likely alter attitudes of majority of farmers with regards to illegal logging. It may also influence peer behaviour towards compliance and reduce the acceptability of the activity among farmers. This will have the dual effect of reducing farmers' willingness to engage in illegal logging due to the presence of both social and legal sanctions, and at the same time motivating farmers to voluntarily partner with paid local enforcers to monitor and detect illegal activities (cf. Marfo 2010; Ramcilovic-Suominen and Epstein 2015). In fact, extensive research has shown that forest dwellers are incentivised to voluntarily monitor forests when granted at least user rights to forest resources (Ostrom and Nagendra 2006; Chhatre and Agrawal 2009; Coleman 2009; Coleman and Steed 2009).

On the instrumental side, granting of rights to farmers serves to reduce farmers' value of illegal logging. Farmers will now be able to obtain timber benefits from tree retention—a principal need that was found by this study to partly breed non-compliance with the tree-harvesting law (cf. Marfo 2010; Osafo 2010; Hajjar 2015a). Thus, an equitable tenure reform is more likely to prepare a fertile ground for law enforcement to deter farmers from engaging in illegal logging since rules are likely to be complied with when they distribute benefits fairly (Ostrom 1990; Nielsen 2003). However, as this study shows, legitimacy of the law and economic incentives may count for little without effective enforcement. With effective enforcement, the provision of rights to timber revenue is more likely to produce incentives for farmers to sacrifice relatively inferior, illicit and highly risky gains from illegal logging for superior benefits from FC-regulated logging.

The findings on rights to trees thus provide a non-CPR evidence to lend credence to the theoretical assertion that granting higher levels of property rights to forest dwellers is likely to promote compliance with conservation rules (Schlager and Ostrom 1992). In the case of the off-reserve forests, granting farmers a substantial percentage of on-farm timber revenue will be a formal recognition of farmers as part-owners of on-farm timber resources. Though farmers cannot directly enjoy harvest rights for commercial purposes, they will benefit from the sale of timber resources by the FC. This, to some extent, will bestow proprietorship rights on farmers. It will, then, motivate them to desist from illegal logging because they are more likely to gain more from concession logging without any deterrence costs.

It should be noted, however, that granting rights to trees plus law enforcement without full compensation may not be sufficient in combatting illegal logging. This is because the results of the study on the effectiveness of this combination was inconclusive. Whereas the game models found this option to be optimal in curtailing farmer-driven illegal logging, there was not enough evidence from the empirical results to support this theoretical prediction. Therefore, there is little or no support from the study to support the claim by some authors that combining right to trees and enforcement will induce compliance among farmers (cf. Ramcilovic-Suominen and Hansen 2012; Ramcilovic-Suominen *et al.* 2013; Franck and Hansen 2014).

9.3.3 Synthesis: a policy mix

Putting together the intensification of tree retention and reduction of illegal logging, it can be argued that the off-reserve forests are more likely to be sustained only when issues of tree-tenure, compensation for crop damage and enforcement are addressed simultaneously and appropriately. Though other options can equally or better increase the motivation of farmers to increase shade tree density and diversity, they are less likely to incentivise them to desist from illegal logging when trees are harvestable. Considering the fact that the intensification of tree retention and reduction in illegal logging are inseparable conditions for the sustenance of the off-reserve forests, a viable option is one that can achieve both conditions. This study reveals that a policy mix that combines all three measures is more likely to achieve such a dual objective. This policy mix should include a provision of 40% of stumpage revenue to farmers (property rights); strict enforcement of the tree harvesting law using FC-farmer partnerships (command-and-control); and full payment of compensation by concessionaires through third-party litigation (community pressure). Each of these measures plays a complementary role in motivating farmers to retain more shade trees and desist from illegal logging. Right to trees serves as the propeller of sustainable farmer practices; compensation as the catalyst; and appropriate enforcement as the regulator of activities. Thus, any policy option that trivialises or neglects any of these three underlying factors is less likely to be effective in sustaining the forests.

The above findings provide empirical evidence from a rather unique forest setting to support the argument that in most cases, a combination of policy approaches is the most efficient way to resolve environmental problems (Cato 2011). As demonstrated in this chapter, a complex array of economic, social, political and institutional factors underlie forest conflicts and shape individuals' forest behaviour (cf. Mercer and Miller 1998; Campbell *et al.* 2001; Otsuka *et al.* 2001; Irimie and Essmann 2009; Kijazi and Kant 2011; Xie *et al.* 2013; Robinson *et al.* 2014b). For this reason, effective approaches to forest conflict resolution and for inducing sustainable behaviour are more likely to be those that combine a set of devices that are able to tackle the major sources of conflicts and degradation, starting with the issue of property rights (Poteete *et al.* 2010; Yin *et al.* 2016). The findings of this study demonstrate the above assertion.

9.4 Distributive Impact and Comparative Effectiveness of the Policy Mix

This section discusses the implications of the policy mix for the beneficiaries of the current benefit-sharing scheme for on-farm timber revenue. It also draws on existing studies and experiences from other countries to discuss the superiority or otherwise of the policy mix to complete devolution with regards to long-term sustainability of the off-reserve forests.

9.4.1 Distributive impacts: equity and fairness

Every forest management policy generates costs and benefits and these need to be distributed fairly (Bagnoli *et al.* 2008). Scholars have long pointed out that the prevailing off-reserve regime is based on an unfair tenure system. The policy option advanced by this study implies an alteration of the deeply entrenched system and this will create winners and losers. Farmers will be the greatest winners because they will enjoy a reward for their investment in tree retention and receive full compensation for crop damage. The option is also more likely to create employment in forest villages through the recruitment and training of locals as paid forest guards. As revealed by the survey, income levels of farming households are low. Part of the reasons is that they do not benefit from off-reserve timber revenue despite their substantial investments in on-farm tree retention (Hansen *et al.* 2015). Income levels and farmers' livelihood are expected to improve markedly when they are in receipt of timber benefits.

Many stakeholders will be negatively affected by the policy mix option. A revision of the current benefit sharing scheme implies a reduction in the share of timber revenue received by at least one of the *status qu*o beneficiaries such as the FC, DAs, the OASL, the TCs and stool landowners (chiefs). The likely changes in the benefit sharing scheme are presented in Table 10.1. Either of two sharing options is likely to apply under the policy mix option. The first option seeks to stick to both the constitutional provision and the existing Ministerial directive. The other seeks to embrace a new sharing system based on the constitution and a revised ministerial directive. In both options, farmers are expected to receive 40% of stumpage revenue as their management fee, *de jure*, and ownership benefits, *de facto*.

Table 9.1 Proposed timber revenue benefit-sharing schemes based on the policy mix

Stakeholder	Current Scheme (%)	Proposed Sharing Scheme 1 (%)	Proposed Sharing Scheme 2 (%)
Farmers	0.0	40.0	40.0
Forestry Commission (FC)	50.0	30.0	10.0
OASL	5.0	3.0	5.0
District Assemblies (DAs)	24.7	14.8	24.7
Traditional Council	9.0	5.4	9.0
Stool landowners	11.3	6.2	11.3
Total	100.00	100.0	100.0

Notes: Computed using the constitutional formula and current benefit scheme presented in Chapter 3.
Source: Author's Construct, 2017.

In Proposed Sharing Scheme 1, the FC will deduct 50% of the remaining stumpage revenue after deducting the farmers share in accordance with the existing ministerial directive. Thereafter, the remaining revenue will be released to the OASL to distribute to the other beneficiaries according to the constitutional formula. In Proposed Sharing Scheme 2, however, the farmer's share will be deducted from the original 50% received by the FC thereby reducing the FC's share to 10% whiles the shares of the other stakeholders remain unchanged. Either option will lead to loss of revenue for the FC, but the FC's loss will be greater in Proposed Sharing Scheme 2. This study considers Proposed Scheme 2 as more equitable and fair than Proposed Sharing Scheme 1. The FC has little legal and practical mandate in the off-reserve forests. Therefore, 10% of the stumpage revenue may be a justifiable payment for its limited regulatory activities in these forests. This is also consistent with the 10% proposed by the multi-stakeholder consultancy report (MLNR 2016b). Though the remaining stakeholders do not play active roles in managing the off-reserve forests, they have customary or jurisdictional stakes in the forestland either as custodians or statutory administrators. They are thus entitled to their existing share of the off-reserve timber to finance their customary or administrative activities. Proposed Sharing Scheme 2 is also likely to be more feasible than Sharing Scheme 1. It may reduce anticipated opposition to the revision of the benefit sharing scheme to only that of the FC. The remaining stakeholders can easily invoke constitutional arguments to oppose any 'unfavourable' revision to the current timber benefit sharing scheme, as in Proposed Sharing Scheme 1 (cf. Amanor 2004). Legally, the FC cannot make such arguments since its share is not directly backed by law. It is only fixed arbitrary by the Minister in charge of forestry in consultation with the FC.

Beyond tenure reform, the optimal option prescribed by this study is more likely to negatively affect chainsaw operators and their accomplices. Chainsaw operators will have to search for alternative sources of livelihood should the tree-harvesting law be strictly enforced. Also, rural residents who are employed by operators to assist in carrying sawn beams are more like to lose their jobs. Farmers will have to forego the free lumber and other SRA benefits enjoyed from chainsaw operators and put up with the extensive farm damage caused by on-farm concession logging. Likewise, enforcing the harvesting law is expected to negatively affect chainsaw owners, chainsaw mechanics, urban-based financiers of illegal logging and lumber marketers, wood-workers and so on (Hansen *et al.* 2015). These are expected to lose substantial revenue or, at worst, stay out of business. Again, enforcing the tree-harvesting law is expected to halt informal payments made by illegal loggers to FSD officials, the police and the military. Likewise, the profits of concessionaires will reduce when on-farm compensation is paid and this will subsequently affect the 'kick-backs' received by FSD officials. In sum, the policy mix option is expected to benefit farmers and local enforcers but will negatively affect stakeholders who have, hitherto, benefited from the current system unjustly or illegally.

Notwithstanding the above, the prescribed option is mutually beneficial to major stakeholders in the off-reserve forests. Farmers get rewarded and compensated for managing the forests and for losing crops respectively; concessionaires stay in business but their gains are legitimately reduced by the cost of compensating farmers; and the State (FC, DA, OASL) retains its control over timber resources with marked, but justifiable, reduction in its share of timber revenue. Other beneficiaries such as stool landowners and the Traditional Council will continue to receive their share of timber royalties. All legitimate actors also benefit from the reduction in the loss of resources to illegal loggers due to the strict enforcement of the law. Displaced beneficiaries of the illegal logging menace may be safeguarded by the government's intention to implement artisanal milling. As such, little opposition is anticipated from the beneficiaries of the current benefit-sharing scheme. Such a mutually beneficial but effective policy option will be much more equitable in the off-reserve area than a complete imposition of a Statist tenure (PA) or devolution of rights to on-farm timber trees to individual farmers.

9.4.2 The policy mix, complete devolution and incentives for long-term sustainability: a comparative analysis

It is anticipated that the prescribed policy mix will more likely receive severe criticisms from proponents of complete devolution (refer to Table 3.1).[58] Proponents of devolution in the off-reserve area have been highly critical of any proposed option that is centred on the revision of the existing timber benefit sharing arrangement (such as the policy mix). They do not regard the revision of benefit sharing arrangement as a viable option for sustaining the off-reserve forests. Their argument is summarised by Boateng (2009, p. 52) as follows:

> It is widely believed that extending the benefit sharing arrangement to include farmers will ensure better management of trees but it is also known that sharing of user rights does not necessarily ensure conservation, rather sharing of power and authority is a more effective conservation strategy […..]. Therefore, an improved benefit sharing that takes care of farmers but still leaves decision making in the hands of the FC will not be a very effective option of managing trees on farms. It is liable to State abuses and manipulations that result in weak controls and eventual demise of the resource. Decentralisation of decision making to the lowest level (the individual farmer) is the ultimate condition for better control.

[58] Devolution is used by these authors to refer to the transfer of the ownership, sale rights, management responsibilities and tree-harvest decision-making power from the FC to individual farmers (cf. Katila 2008, p. 11). There would be no tree harvesting law to enforce and compensation would not be deemed important.

To them, the sustenance of the off-reserve forests is contingent on complete devolution of rights to timber trees to individual farmers. This is because it 'unlocks the value of resources and attracts investments, especially from actors naturally bound to the resource' (Boateng 2009, p. 52). It will also 'introduce a hitherto absent incentive to produce rather than exploit dwindling stocks of timber' and 'carries a much greater likelihood of […] combating illegal logging, deforestation and forest degradation because it would enhance the resource base' (Hansen *et al.* 2015, p. 420). This section of the thesis therefore evaluates the above argument by comparing the policy mix with complete devolution with regards to incentives for the long-term sustainability of the off-reserve forests.

Incentives for increasing tree density

The proponents of devolution have not provided empirical evidence from the off-reserve area in Ghana to support their claims. However, there is much theoretical support for their claim that completely devolving rights to timber trees to individual farmers is more likely to lead to increased investment in forest conservation than mere revision of the current benefit-sharing scheme (e.g., Demsetz 1967; Hardin 1968; Umbeck 1981; Anderson and Hill 1990; Hart and Moore 1990; Larson and Bromley 1990; Pearse 1990; Deacon 1994; Mendelsohn 1994). In theory, individual farmers will be more willing to invest in tree retention on their farms since they are assured of fully recovering their investments. In addition to the theoretical support, there is ample empirical evidence from other countries such as the Philippines (Martin *et al*. 2012), Taiwan (Koo 2011), Ethiopia (Ali *et al*. 2011) and China to support the devolution claims. The Chinese case is of particular interest here because it is closer to the devolution advocated by proponents in the off-reserve area. Beginning from 2003, the Chinese government has devolved forest lands previously held as collective property to individual households to plant and own trees and sell, mortgage or bequeath them (Yin *et al.* 2013; Lu *et al.* 2016; Xie *et al*. 2016). Though impacts vary across provinces and groups (Xie *et al.* 2013, 2014), there is substantial evidence that this reform has motivated individuals to increase investments in tree planting on household forest plots thereby leading to increased forest cover (Xu 2010; Xie *et al.* 2016). These may provide some evidence to support the assertion that complete devolution of tree tenure in the off-reserve forests may be superior to the policy mix option (*centred on competitive incentive*) prescribed by this study in terms of promoting farmer investment in on-farm tree retention.

Incentives for increasing tree diversity

It should be noted that the above conclusion on farmer investment in tree retention grossly overlooks other aspects of forest conditions such as forest composition and the age structure of trees. It can be argued that though devolution may prove superior in terms of standing volume of trees, it is more likely to be inferior to the policy mix option in terms of tree diversity. This is because farmers' economic motivations to increase future returns from tree retention is more likely to induce bias towards the selective retention of valuable timber species at the expense of non-timber trees and other less valuable trees. This has been one of the major downsides of individualisation of forest plots in China (especially, the Miao Area of Guizhou), where tree diversity and species richness on households forests have significantly fallen below those of collective forests and State-owned forests (Lu *et al.* 2016). In particular, household forests are predominantly *C. lanceolata* and *P. massoniana* plantations: two highly valuable timber species planted by households as a response to the reform 'to [maximise] the economic value of the forests under their control' (Lu *et al.* 2016, p. 199). In contrast to devolution, however, the policy mix option featuring competitive incentives to farmers is more likely to reduce such biases to a sustainable level because farmers are expected to retain non-timber tree species on farms to at least reduce crop damage by concessionaires and loss of agro-ecological services from logged trees.

As already indicated, each tree logged by concessionaires is likely to affect up to 80 cocoa crops either directly through crop damage or indirectly through loss of agro-ecological services of the logged tree (Richards and Asare 1999). This can reduce crop yield by a third (Richards and Asare 1999). On the average, the farmer has to spend between 5 to 10 years to raise a new shade tree to replace the logged tree and return crops to normal yield (Richards and Asare 1999). Considering all this, farmers are more likely to mix timber species and non-timber species under the policy-mix option to balance their economic motivations (profit maximisation) with the need to protect crop productivity from concession logging (cost minimisation). In this case, the on-farm concession logging within the policy mix will serve as an inhibiting factor preventing farmers from overly retaining timber species on their farms. This is expected to help in maintaining species diversity at a relatively sustainable level. In sum, the policy mix option prescribed by this study is more likely to induce increased tree density and tree diversity at the same time: an essential requirement for sustainable forests (Henry *et al.* 2009; Dawoe *et al.* 2016).

Ability to control overharvesting by farmers

Beside tree diversity, there is little guarantee that the forests will be sustained after shade density has been increased by devolution. Per the demands of the proponents of devolution (see Section 5.3.2), there would be no quota system [annual allowable cuts (AAC)] and harvestable diameter restrictions from the FC under devolution. Likewise, there will be no regulation of logging in accordance with scientific methods for sustainable forestry under devolution. Without these harvest restrictions by a higher authority such as the FC, and considering their low income levels, farmers may be more likely to engage in unsustainable sale of trees to cater for their economic needs (cf. Adam and Duah-Gyamfi 2009). Farmers may be more likely to over-harvest trees or even harvest under-aged trees to supplement their low incomes when pressed by the persistent economic hardships between the lean and major cocoa seasons (May to October). Though this high possibility cannot be demonstrated with empirical data by this study, it is much supported by experiences from other forest settings. For instance, Chattre and Agrawal (2008) report from their multi-country study of the forest commons that forests with higher commercial values can only be sustained when there is high levels of enforcement of forest rules. Similarly, in an extensive review of empirical research on forest tenure devolution, Yin *et al.* (2016) reveal that in the presence of strong market incentives such as high log prices and high demand for lumber, devolution is more likely to induce over-harvesting of forests thereby leading to degradation (cf. Yin and Newman 1997). By contrast, the policy mix option prescribed in this study has the capacity to control over-harvesting and ensure sustainable logging practices through strict enforcement and regulation by the FC using local enforcers.

Granted that farmers will not overharvest trees during the productive years of farms under devolution, they will still be more likely to engage in mass sale of trees when they are about to abandon farms to fallow. As argued by Gibson *et al.* (2005), if an individual greatly values the resource, it can be assumed that that individual will be more likely to sustain it. Farmers retain trees primarily for their agricultural benefits and trees are greatly valued so long as they serve this purpose. Thus, they are more likely to conserve harvestable trees as far as they depend on them for higher farm productivity. However, this dependency completely ends when farms are abandoned to fallow. Farmers will have no rational basis for conserving the trees after abandoning farms because the trees do not have agricultural values to them. Chapter 7 revealed that an aspect of this problem is already felt in the current tenure system where shade tree density is found to reduce from 21 per ha on young farms to seven (7) on pod-bearing farms because more ventilation is needed.

To further compound the problem of diminished agricultural value, fallow lands under leasehold or sharecropping automatically transfer to the landowner who may decide to renegotiate with the farmer for replanting on the terms of the landowner or lease it to a different but more cooperative farmer. Thus without harvest restrictions, these farmers will speedily sell trees to chainsaw loggers to avoid potential conflicts with landowners or succeeding farmers after the fallow period. Hence, devolution has a higher likelihood of over-harvesting leading to deforestation in the long term. A way of overcoming this problem under devolution is for the FC to provide technical assistance and regulate farmer-harvesting to ensure sustainability. However, such regulation will defy the form of devolution demanded by proponents. Also, experiences from Ecuador indicate that official regulation under devolution seem to be counterproductive because the presence of harvest restrictions and bureaucracies associated with the acquisition of harvest permits serve to frustrate smallholders thereby resulting in illegal logging (Vasco *et al.* 2017).

Ability to control chainsaw milling

A more serious downside of devolution with respect to the sustainability of the off-reserve forests is the high likelihood for farmers to deal more with chainsaw loggers than conventional loggers (concessionaires). This was evident in the survey (refer to Chapter 7). The survey revealed that about 88% of farmers prefer chainsaw loggers on their farms to concessionaires due to reasons revealed in Chapter 7. However, studies show that the environmental impacts of chainsaw milling is more destructive than concession logging (Adam *et al.* 2007a; Adam and Duah-Gyamfi 2009; Marfo 2010). Chainsaw milling has been found to cause larger and wider forest disturbances at the felling site in terms of plant damage and soil disturbance than conventional logging (Adam and Duah-Gyamfi 2009). Further, chainsaw milling has no regard for felling limits. The conventional minimum felling diameter is 70 cm and chainsaw millers have been found to harvest trees with diameter smaller than 50 cm (Adam *et al.* 2007a). This affects the capacity of the tree to regenerate (Adam and Duah-Gyamfi 2009). Chainsaw loggers (in collaboration with farmers) also harvest restricted species due to their limited knowledge on endangered tree species (Adam and Duah-Gyamfi 2009). More importantly, chainsaw loggers engage in intensified harvesting that quickly depletes the resource base. It has been found that the harvesting intensity of chainsaw loggers is 7 trees per ha compared with 2 to 3 trees per ha by concessionaires (Adam and Duah-Gyamfi 2009). With this, devolution is more likely to be deleterious to the sustainability of the off-reserve forests. By contrast, the policy mix is more likely to overcome problems associated with unsustainable harvesting. Only concession (or conventional) logging will be permitted by the FC on farms and the FC will use the quota system to minimise over-harvesting. Additionally, the FC will regulate logging activities in accordance with scientific practices to prevent harvesting of trees below felling limits. It will also protect endangered species.

Ability to control 'outsider' illegal logging[59]

The policy mix will better sustain the forest because it is expected to have a tighter control over 'outsider' illegal logging than devolution. Proponents of devolution assume that farmers will have the incentive to protect trees from these illegal loggers (Hansen and Treue 2009; Hansen *et al.* 2015). Though this may be true in the theoretical sense, farmers lack the capacity to independently exclude illegal loggers. Since on-farm trees would be privately owned, collective monitoring is less likely to occur automatically. Farmers would need to be successfully organised to achieve this. Further, monitoring would be risky and life-threatening for these unarmed farmers because these types of illegal loggers operate in the night, are heavily armed and are found to attack, maim and kill those who stand in their way (Marfo 2004b; Marfo *et al.* 2009a, 2009b; Nutakor and Marfo 2009). Even when they are able to detect illegal loggers, farmers would still need State institutions such as the police and the courts to arrest and prosecute offenders. Individual farmers do not have the financial capacity to pursue such cases on their own and would probably lose out if they did, considering the connivance of chainsaw operators with the police and the alleged corruption in the judicial system of Ghana (Marfo *et al.* 2009a, 2009b). The FC would be less concerned with such cases because it has no vested interest in them. Moreover, the customary system would not be appropriate for sanctioning illegal loggers because perpetrators are more likely to come from far away villages. In short, this type of illegal logging will continue unabated under devolution. By contrast, the policy-mix is expected to reduce the activities of these illegal loggers because it will use trained and armed local enforcers and forest guards who will be able to apprehend these offenders. Also, the FC will readily prosecute offenders because it has a vested interest in the sustenance of the off-reserve forests.

[59] This type of illegal logging is carried out by operators not known to farmers (outsiders). They come from outside the respective community to steal trees from farms at night.

The above analysis shows that devolution may be superior to the policy mix in terms of incentives to invest in tree retention. However, it becomes inferior in sustaining the forests in the long-run. Unlike the policy mix prescribed by the study, devolution cannot guarantee the sustenance of the forest cover. This shows that devolution may have many downsides and its success in sustaining forests may depend on other contextual factors. Based on their findings from China, therefore, Lu *et al.* (2016) have called for a balanced system that is capable of providing improved forest conditions together with subsistence resources, commercial resources and economic opportunities for forest dwellers. This is in harmony with the policy mix prescribed in this study because it is more likely to promote intensification of shade trees, tree diversity, protection from over-harvesting and illegal logging, timber revenue for farmers and compensation for crop damage. In sum, the policy mix option appears superior to devolution because it is capable of achieving the two inseparable elements of sustainability considered in this study: intensified sustainable tree retention and control of illegal logging.

9.5 Conclusion

The chapter has presented a detailed discussion of the findings of the study in response to the central research question. The chapter argues that ordinary farmers are less likely to receive full compensation from concessionaires if they continue to pursue compensation independently. Yet, the government is less likely to enforce the compensation law. Therefore, third-party advocacy through litigation by civil society groups is needed. The most optimal option to sustain the off-reserve forests appeared to be a policy mix that concurrently allocates a competitive percentage (40%) of stumpage revenue to farmers, pays prompt and full compensation for crop damage and strictly enforces the tree-harvesting law using local enforcers as collaborators. Moreover, the chapter reveals that this policy mix is superior to complete devolution with regards to long term sustainability of the forests because it safeguards the forests from low tree diversity, unsustainable harvesting and chainsaw milling. Further, it distributes costs and benefits equitably.

Chapter 10. Conclusion and Practical Implications

This study aimed at examining policy scenarios to induce sustainable behaviour among farmers in the off-reserve forests in Ghana. Three specific research questions were raised to address this aim. The first of these research questions was: what is the rationale behind the current behaviour of concessionaires and farmers in the off-reserve forests in Ghana? The second research question was: under what policy interventions are concessionaires likely to fully and promptly compensate farmers for crop damage? The last of these questions was: under what policy interventions will farmers intensify sustainable tree retention on farms and desist from illegal logging in the off-reserve forests? The study formally analysed the behaviour of the major actors in the off-reserve forests using game-theoretic modelling. Experimental data was collected through cross-sectional surveys to test the predictions of the game models. Chapters 6 to 8 have presented the results of the study and Chapter 9 has presented a discussion of these results in relation to the central research question of the study. This chapter summarises the major findings of the study. The findings have been organised under the three research objectives. The chapter then proceeds to summarise the key contributions of the study to the current literature. This is followed by a discussion of the practical implications of the findings for forest policy and governance and civil society activism. The chapter also presents the limitations of the study and some suggestions for further research.

10.1 Summary of the Major Research Findings

This section presents a summary of the major findings of the thesis in response to the key research question.

10.1.1 Rationale for the current behaviour of farmers and concessionaires

The decline in tree density and pervasiveness of illegal logging in the off-reserve area in Ghana are mainly the results of the rational actions of individual actors. Concessionaires and farmers behave the way they behave because of the need to maximize their returns from their off-reserve interactions. Details of this finding are given below:

Rationale for the current behaviour of concessionaires in the off-reserve forests

The study revealed that the underlying reason behind non-payment of compensation by concessionaires is their desire to maximise the expected value of logging. The enforcement of the compensation law was found to be the primary moderating factor between this desire and non-payment of compensation to farmers. The enforcement of the compensation law influences the cost-benefit calculus of concessionaires. Concessionaires are worse off if they do not fully compensate farmers when the compensation law is enforced. Most concessionaires are more likely to be better off by not paying compensation when the compensation law is not enforced.

The 'type' of the farmer in on-farm logging compensation interactions influences compensation outcome when the compensation law is not enforced. For instance, the social status of farmers influences the time and amount of compensation paid by concessionaires when the law is not enforced. Farmers who occupy leadership positions in forest villages are more likely to receive full and prompt compensation for crop damage. Refusal to fully compensate these farmers comes with huge social costs and the rational concessionaire will do as much as possible to avoid these costs. However, non-leaders are less likely to receive full compensation from concessionaires. The empirical analyses also revealed that farmers with at least senior secondary education are more likely to receive full compensation for crop damage.

Rationale for the current behaviour of farmers in the off-reserve forests

Cocoa farms depend on timber and non-timber trees for shading, soil fertility, soil moisture and protection from pest and diseases. The productivity of cocoa farms will be markedly reduced if farmers do not retain optimum shading on farms, regardless of the variety of cocoa cultivated. Without optimum shading, farmers would have to apply substantial quantities of agrochemicals: which quantities they cannot afford. Hence, it will be irrational for farmers not to retain optimum and fairly equal proportions of timber and non-timber tree species on their farms. Farmers also intend to sell or harvest some of the timber tree species among the shade trees. However, the current tree tenure in the off-reserve forests poses a challenge to the achievement of this objective. This challenge is further aggravated by the anticipated loss of cocoa crops, inter-planted food crops, and saplings during future concession logging; and the need to reduce shade density to improve farm ventilation and prevent pod shedding on pod-bearing farms. But the farmer, being sequentially rational, has devised a strategy *a priori* to solve this puzzle.

The strategy is: *retain high shade density with fairly equal proportions of timber and non-timber trees at the early stage of farming and collude with chainsaw loggers to harvest desired quantities of trees at latter stages of farming*. Though timber trees are the most compatible with cocoa crops, farmers strategically retain equal proportions of timber and non-timber trees to both optimise the agricultural value of shade trees, reduce the extent of damage by concessionaires in the future and recover investments in tree retention. This strategy optimises farmers' total value from the off-reserve forests. Alternative options such as 'no-shade' farming, 'timber trees only' farming and 'non-timber trees only' farming would be sub-optimal. This thesis argues that farmers continue to retain on-farm trees and engage in illegal logging not because they are clueless of available alternatives or oblivious of the environmental consequences of chainsaw logging but that this is the most rational strategy to maximise their returns from cocoa agroforestry given the prevailing tenure and compensation system in the off-reserve forests.

10.1.2 Impacts of hypothetical policy interventions on concessionaires' likelihood to fully compensate farmers

On average, farmers are less likely to be compensated for crop damage should they continue to pursue compensation independently. Concessionaires are more likely to pay full and prompt compensation for crop damage if the compensation law is enforced by the Forest Service Division (FSD) or if there is a credible threat of litigation from third-party advocates. Details of these findings are provided below:

Actions likely to be used by farmers to independently pursue compensation

Until the time of conveyance, every farmer is less likely to accommodate non-payment of compensation. Almost all farmers are highly likely to use persuasion to pursue compensation from concessionaires until the latter attempt to convey logs to sawmills. However, the choice of action is dependent on the social status of the farmer when the conflict moves beyond the point of persuasion. Farmers without leadership positions and socio-political connections in the forest villages (unconnected non-leaders) are more likely to accommodate non-payment and allow the concessionaire to convey the logs. Non-leaders with some form of socio-political connections in the forest villages (connected non-leaders) and lower-level leaders are more likely to blockade conveyance of logs should the concessionaire attempt to convey logs without paying full compensation. For non-leaders, the cost of pursuing compensation after concessionaires have refused to pay during or after conveyance far outweighs the benefits. Therefore, it is irrational for them to pursue compensation further. This explains why a substantial number of farmers currently accommodate non-payment of compensation by concessionaires. However, top-level leaders (chiefs, local government representatives and religious leaders) are more likely to opt for mediation than blockading should the concessionaire refuse to pay full compensation and attempt conveyance.

Impacts of farmers' actions on concessionaires' likelihood to pay full compensation

Concessionaires are less likely to compensate ordinary farmers (non-leaders) should they continue to use their own actions to pursue compensation. Though mediation is regarded to be highly successful in the conflict resolution literature, it is less likely to resolve on-farm logging compensation conflicts in the off-reserve forests in Ghana. The mediation environment in the off-reserve area is not conducive for successful mediation. The study revealed that concessionaires are more likely to participate in mediation processes in the compromised village environment, publicly accept mediated agreements and later fail to comply with the mediated agreements. Blockading of conveyance of logs is also less likely to ensure full payment of compensation. This action is usually an incredible threat and concessionaires are more likely to seek for mediation during blockading to convey their logs without paying the compensation in question.

In all, the likelihood to pay compensation to farmers in the future without any external intervention is expected to continue to be dependent on the type of farmers involved in the conflicts. Non-leaders are less likely to be compensated by concessionaires should they pursue compensation independently. Most concessionaires have little to lose should they refuse to compensate non-leaders for crop damage. Concessionaires are more likely to continue to pay full and prompt compensation to farmers who occupy leadership positions in their respective villages because refusing to pay will be highly costly. Yet, many farmers do not hold leadership positions in their respective villages. Thus, this thesis argues that ordinary farmers (non-leaders) are less likely to be compensated should they rely on their own actions to pursue compensation. External interventions are therefore needed.

Impacts of external inventions on concessionaires' likelihood to pay full compensation

The hypothetical external inventions considered in this study are enforcement of the compensation law by the FSD and compensation litigation by a third-party advocate. Both interventions are highly likely to induce cooperative behaviour among concessionaires. The enforcement of the compensation law by the FSD is more likely to have more impact on concessionaires' likelihood to fully compensate farmers. However, the game-theoretic models revealed that enforcing the compensation law will be sub-optimal for the State. This leaves third-party litigation as the most optimal option to resolve compensation conflicts in the off-reserve forests. It is interesting to note that the mere (credible) threat of litigation will induce compliance with the compensation law. Hence, this thesis argues that full and prompt payment of compensation for crop damage will more likely hinge on direct third-party advocacy than calls for statist enforcement or reliance on independent actions by farmers.

10.1.3 Impact of hypothetical policy interventions on farmers' behaviour in the off-reserve forests

Two forest-specific behaviours of farmers were considered in this study. These are tree retention and illegal chainsaw logging. Only one of the eight hypothetical scenarios examined in this study was found to be more likely to motivate farmers to sustainably intensify tree retention and minimise farmer-driven illegal logging. The study found that farmers' are more likely to be motivated to conserve and protect the forests if they are in receipt of a competitive proportion of stumpage revenue from the government, fully compensated and the tree harvesting law is strictly enforced. Details of these findings are provided below.

Impact of hypothetical policy options on farmers' willingness to retain both timber and non-timber trees on their farms

The study found that farmers are willing to retain both timber and non-timber trees on their farms regardless of the hypothetical policy scenario. Retaining both timber and non-timber trees is indispensable for optimum productivity of cocoa crops in Ghana. Hence, it will be irrational for farmers to solely retain either or none of the two types of shade trees. Yet, the study revealed that farmers' willingness to retain both timber and non-timber trees is more likely to be higher if issues of tree tenure, compensation and forest law enforcement are addressed. The provision of 40% of timber revenue to farmers (right to trees) appeared to be a key motivation for farmers to intensify tree retention on their farms. However, combining right to trees and the enforcement of the tree harvesting law produced the highest effect on farmers' willingness to retain both timber and non-timber trees. In sum, all other hypothetical policy scenarios are likely to promote sustainable tree retention among farmers but granting right to trees together with strict enforcement of the tree harvesting law is likely to be the most effective.

Impact of hypothetical policy options on farmers' willingness to engage in illegal chainsaw logging

Unlike tree retention, only the combination of right to trees, full compensation and strict enforcement of the tree harvesting law using FC-farmer partnerships appears to significantly minimise farmers' willingness to engage in illegal logging. All other options were found to be less likely to motivate farmers to desist from illegal harvesting of trees on their farms. It was observed that the sole enforcement of the tree harvesting law is less likely to deter farmers from illegal logging. This is because strict enforcement, without addressing the fundamental issues of tenure and compensation, would reinforce perceptions of unfairness of the tree tenure regime in the off-reserve area: a perception largely blamed for the pervasiveness of the illegal logging menace in Ghana. Also, ensuring full compensation for crop damage, without addressing issues of tree tenure and forest law enforcement, is less likely to reduce farmers' willingness to engage in illegal logging. This is because farmers will need to meet their non-shading intentions for retaining shade trees. In addition, full compensation will not erode the perception of unfairness of the off-reserve tenure. The combination of strict enforcement and full compensation is also less likely to reduce illegal logging among farmers.

The sole provision of 40% of timber revenue to farmers (right to trees) was found to be less likely to control illegal logging among farmers. Farmers are likely to seek to maximise their returns from cocoa agroforestry if the law is relaxed under this scenario. They are also likely to seek to log strategically located trees on the farms to avoid extensive damage from concessionaires without full compensation. Likewise, combining right to trees and full compensation was found to be less likely to minimise farmer-driven illegal logging. However, the results on the likely effect of right to trees plus strict enforcement was inconclusive. The theoretical analyses found this option to be optimal in controlling illegal logging among farmers. Yet, the empirical data did not support this theoretical prediction.

Optimal policy option to induce sustainable forest practices among farmers

For the off-reserve forests to be sustained, a policy option must concurrently achieve the twin-objective of intensifying sustainable tree retention and controlling farmer-driven illegal logging. The previous sections indicate that the most optimal and mutually beneficial option to achieve this twin-objective is a policy mix that provides 40% of stumpage revenue to farmers (right to trees), ensures full and prompt payment of compensation (through a credible threat of third-party litigation) and strictly enforces the tree harvesting rule using FC-farmer partnerships (strict enforcement). It was found that any option that trivialises any of the three elements of the policy mix is less likely to be effective in inducing sustainable behaviour among farmers.

Each of the elements of the policy mix plays a complementary role in inducing sustainable behaviour among farmers. The study found that granting rights to timber benefits plays a central role in this option. It provides special motivation for farmers to retain more trees and desist from illegal logging because it will help them achieve their non-shading motives for tree retention and erode their perception of unfairness of the off-reserve tenure. Strict enforcement is found to be indispensable in deterring farmers from illegal logging. Without this, farmers are more likely to continue to engage in illegal logging regardless of any receipt of timber revenue from the government. The policy mix is likely to be less effective without full compensation though this element appeared to have a negligible effect on farmers' willingness to engage in illegal logging. In sum, right to timber benefits in the policy mix is expected to serve as the propeller of sustainable farmer practices; compensation as the catalyst; and appropriate enforcement as the regulator of farmers activities.

Expected distributive impacts of the policy mix

The above policy mix is argued to be more equitable and feasible. It distributes timber benefits more equitably than the current benefit sharing scheme. The current scheme is not based on beneficiaries' contribution to the sustenance of the off-reserve forests. It is based on their custodianship, regulatory or administrative roles. This anomaly in the current scheme is addressed by the policy mix. Farmers will be equitably rewarded for the enormous role they play in sustaining the forests. This study prescribes a revised timber benefit sharing scheme that maintains the share of the other beneficiaries, provides 40% of the stumpage revenue to farmers and reduces that of the FC to 10%. The reduction in the FC's share is justifiable because it contributes little to the management of the off-reserve forests. The policy mix is also more politically feasible than complete devolution. The potential amount of timber revenue to be lost by government agencies under complete devolution is halved under the policy mix. Also, the 40% stumpage payment to farmers is demonstrably feasible because the government is currently implementing a similar scheme under the Modified Taungya System in degraded forest reserves. More importantly, the prescribed benefit sharing scheme does not require any constitutional amendments. Hence, it is likely to face less delay and less opposition by *status quo* beneficiaries compared to complete devolution of right to tress to farmers.

Incentives for long-term sustainability of the off-reserve forests: the policy mix versus complete devolution

A comparative analysis of the policy mix and complete devolution to farmers using secondary sources revealed that the policy mix has a higher potential for long-term sustainability of the off-reserve forests. Devolution of trees to farmers may better incentivise farmers to intensify tree retention than the policy mix. However, tree diversity is not guaranteed under devolution. Farmers are more likely to be biased towards timber tree species at the expense of non-timber tree species. But the presence of concession logging in the policy mix is more likely to rationally ameliorate this problem. Farmers will be more likely to engage chainsaw loggers under devolution because they perceive them to be more compatible with cocoa farming and favourable to their cocoa-based livelihoods than concessionaires. Chainsaw logging is unsustainable and this is more likely to degrade the forest environment even under complete devolution. This potential of degradation is less likely to occur under the policy mix because only regulated concession logging will be allowed. Lastly, farmers lack the capacity to exclude heavily armed ‘outsider’ illegal loggers (squatters) under complete devolution. In contrast, the FC-farmer partnership prescribed under the policy mix has a higher potential to exclude squatters because the capacities of local enforcers will be built and the FSD will be in a better position to prosecute such offenders.

10.2 Contribution to the Current Literature

This section of the chapter summarises the contributions of the thesis to the current literature on game-theoretic application in forest management, forest resource management and the off-reserve forest problem.

10.2.1 Contribution to game-theoretic applications in tropical forest management

This study has made a number of contributions to the application of game theory to forest management problems in developing countries. First, it has extended game-theoretic analyses in forest management to a unique forest setting: the off-reserve forests. It has added to the increasing evidence that game theory can be used to successfully explain and predict behaviour in several strategic interactions in forest management. Second, the study has demonstrated the usefulness of behavioural willingness and expectations in testing game-theoretic predictions. It shows that such proximal antecedents to behaviour could be combined with formal theoretical analyses to evaluate the efficacy of hypothetical scenarios, especially where scenarios present opportunities and benefits hitherto absent in past or prevailing behavioural settings.

Third, the study goes beyond the sole use of monetary costs and benefits in most forest-based game-theoretic studies to incorporate non-pecuniary parameters into the models to reify the game-theoretic approach in a third world setting. For instance, the incorporation of the rent-seeking interests of State actors in the games led to an interesting revelation: the fact that the State is less likely to enforce the compensation law even when the condition of forests is of high priority to the government. This made it possible for the consideration of an alternative external involvement. Such an insight would have been missed had the analyses ignored the rent-seeking interests of the State. The findings highlight the enormous potential to reduce discrepancies between game models and realities when parameters about essential socio-political preferences of players are incorporated in model specifications. The author is convinced that the inclusion of these non-pecuniary incentives underlie the successful predictions of the game models as confirmed by the empirical analyses. This provides evidence to support the position that the reification of a model is more likely to depend on its ability 'to grasp what is essential' (Forgó *et al.* 1999, p. xii).

10.2.2 Contribution to the literature on forest management

Evidence from a rather unique forest tenure has been provided by the study to support several theoretical assertions regarding forest sustenance. First, there is a general consensus in the commons literature that the provision of enforceable property rights is essential for the sustenance of forest resources (Agrawal 2001, 2007; Ostrom 2001; Zhang and Owiredu 2007; Hayes and Persha 2010; Schroeder and Castillo 2013; Adhikari *et al.* 2014; Robinson *et al.* 2014b). This has been demonstrated in this study to be true even in the off-reserve forests. Granting farmers right to timber benefits was found to be central to their willingness to behave sustainably. In addition to this assertion in the literature, this study demonstrates that forest dwellers adapt to whichever type of property regime they find themselves to optimise their gains from forest interactions. The legality or otherwise of the strategies they adopt in this optimisation contest is directly related to the level of *de jure* rights they hold to the forest resources. The more expansive the right they hold, the more legal their forest practices are and vice versa.

Second, it is largely agreed in the literature that enforcement is a necessary prerequisite for sustainable forest management (Kaimowitz 2003; Gibson *et al.* 2005; Chhatre and Agrawal 2008; Singh *et al.* 2011; Bouriaud *et al.* 2014; Coleman and Liebertz 2014; Robinson *et al*. 2014a). The universality of this assertion is demonstrated by the findings of the study. Thirdly, the findings of the study demonstrate the veracity of the assertion that law enforcement alone is not sufficient to induce sustainable behaviour among forest dwellers in any forest regime (Gibson *et al.* 2005).

Fourth, it is well documented in the literature that a complex array of factors affect individual forest behaviour (Mercer and Miller 1998; Campbell *et al.* 2001; Otsuka *et al.* 2001; Irimie and Essmann 2009; Kijazi and Kant 2011; Xie *et al.* 2013; Robinson *et al.* 2014b). Based on this, it has been posited that the most effective options to induce sustainable behaviour are those that tackle the major sources of unsustainable behaviour through a combination of a set of policy devices (Poteete *et al.* 2010; Yin *et al.* 2016). This study has provided the theoretical and empirical evidence to demonstrate the veracity of this assertion. In particular, the study found that inducing sustainable behaviour among forest dwellers lie beyond the singleton application of the major forms of policy approaches (command-and-control, property rights, incentive based, etc.). It is therefore needful that forest policy researchers undertake thorough analyses of the major factors affecting behaviour in a particular forest context and address them accordingly. The findings on compensation payment reveal that contextual sources of forest conflicts are equally important and need to be tackled in order to achieve desired changes in behaviour (cf. Vatn 2005, 2009; Ramcilovic-Suominen and Epstein 2012). In other words, this study shows that the success of conventional policy approaches proposed in the literature may be contingent on how effective they address contextual factors.

10.2.3 Contribution to the literature on the management of the off-reserve forests in Ghana

The major contributions of this study to the current literature on the off-reserve problem in Ghana include the following. First, using the revised framework of property rights proposed by Galik and Jagger (2015), this study is the first to accurately capture cocoa farmers' alteration right and distinguish it from their access rights. The right to alteration was added to the original Schlager-Ostrom framework to improve its sufficiency and appropriateness to specific circumstances. Alteration right is defined as the right to convert a particular resource from one land-use to another (Galik and Jagger 2015). In this thesis, farmers' distinct right to alter the off-reserve landscape from natural or secondary forests to agroforests has been identified and captured in the analysis of off-reserve property rights for the first time, thanks to the above revision. Prior to this thesis, studies that have relied on the original Schlager-Ostrom framework have either overlooked farmers' right of alteration, conflated it with their access rights, or both (e.g., Hansen 2011; Dumenu *et al.* 2014; Lambini and Nguyen 2014; MLNR 2016b). By so doing, this study has provided a clearer picture of the tree tenure regime in the off-reserve forests of Ghana.

Second, the thesis has provided a rational choice perspective on the prevailing off-reserve tenure and compensation situation. Specifically, it has provided a novel evidence that the situation in the off-reserve forests can be adequately and successfully conceptualised as a strategic game played by rational actors: a perspective long-ignored in the literature. The findings exemplify the specific insights game theory can provide into the behaviour of self-interested actors in the off-reserve area. The study departs from the current literature to argue that the current behaviour of farmers go beyond just being the unfortunate consequences of the tenure system or coping strategies. Also, the current behaviour of farmers are not the direct result of farmers' adoption of highly profitable sun-tolerant cocoa varieties like the hybrid *Amazonia* as argued by some scholars and policy makers (e.g., Ruf 2011; MLNR 2016a). In fact, the study did not find any evidence to support this assertion as the ANOVA results did not show any significant differences in shade tree density among the three varieties of cocoa cultivated. Rather, the study found that farmers' actions are a composite part of the game stakeholders play in the forests. Not only are farmers' behaviour rational responses to rational strategies of other players in the off-reserve forests but they are also the basis for the rational strategies of these other players. Such an insight has been missed or ignored by the numerous studies on the off-reserve conflicts. Yet, this perspective offers a unique appreciation of the conflicts and supplies a key to altering farmers' behaviour.

Third, the study brings a different dimension to the debate in the literature on farmers' selective retention of trees in response to the prevailing tenure and compensation conflicts. The study has revealed that farmers rationally retain fairly equal proportions of timber and non-timber tree types as shade trees on their farms. This behaviour was found to be constant throughout all the ages of the farm. This finding deviates from the situation reported in the current literature. There appears to be a lack of consensus in the current literature regarding farmers' shade tree selection behaviour in response to the tenure and compensation conflicts. Some researchers claim that farmers are biased towards the retention of timber trees due to the hope for economic returns from the illegal sale or harvest of trees (e.g., Dumenu 2010; Gockowski *et al.* 2013). The majority of the researchers, however, argue that farmers are biased towards the retention of non-timber trees as a result of tree tenure and compensation conflicts (e.g., Owubah *et al.* 2001; Lambini *et al.* 2005; Otutei 2012; Acheampong *et al*. 2014; Dawoe *et al.* 2016). However, the findings of the study do not support either side of the debate in the literature. Though the overall average proportion of timber trees on farms was slightly higher than non-timber trees, there was no indication from the game-theoretic and *t*-test results that farmers are retaining higher proportions of any tree type at the expense of the other. The study therefore finds little or no evidence to support the oft-repeated claim in the literature that non-timber trees have become the dominant shade trees on cocoa farms in the off-reserve forests due to tree tenure and compensation conflicts.

Fourth and more importantly, the study has contributed to addressing a critical research gap in the literature on the off-reserve forest problem. It has gone beyond the current literature to theoretically and empirically evaluate options for resolving the problem to induce cooperative and sustainable behaviour among concessionaires and farmers. By so doing, it has furnished the much needed academic evidence to inform and influence policy making in Ghana. It has also laid the foundation and opened the gateway for other scholars with similar interests and objectives to undertake further analyses on other alternatives for inducing sustainable behaviour in the off-reserve forests. Lastly, the study has developed a novel model for understanding, predicting and prescribing behaviour in the off-reserve forests that can be extended to similar forest management situations in the tropics.

10.3 Practical Implications

The study findings have several implications for forest policy and governance. This section discusses the implications for State policy, civil society activism and advocacy.

10.3.1 Implications for policy-making

The findings of the study point to the urgent need for on-farm tree tenure reforms by the government and a restructuring of forest law enforcement to involve local farmers. The government has not followed through previous proposals for reforms because such demands may be viewed as unrealistic. It is envisaged by the current author that proposals for reforms may be more feasible if they are more sensitive to the government's vested interest in off-reserve timber revenue and are equitable to the current beneficiaries of on-farm timber revenue. As the study reveals, granting 40% of the stumpage revenue to farmers is more likely to be enough to induce cooperative and sustainable behaviour from farmers. It is also likely to be mutually beneficial, feasible, and equitable. This may be able to generate the needed political will and reduce anticipated opposition from vested interests.

To achieve its forest conservation goals, the government needs to go beyond its current action of commissioning studies and endless consultations to expediting actions to reform tenure. This study provides both theoretical and empirical evidence that sustaining the forests hinges on timely and effective reform of the existing tree tenure to provide some incentives for cocoa farmers to protect the off-reserve forests. Therefore, the enactment of legislations to revise the current timber benefit-sharing arrangement (as proposed in the Forest and Wildlife Policy) should be treated as a matter of urgency. Further, there needs to be a restructuring of the timber contract allocation process. Some scholars favour devolution over revision of the current benefit-sharing scheme because they fear the latter will be subject to the current abuse of the timber system by the government (Boateng 2009; Hansen and Treue 2009). It is said that the Forest Commission engages in discretionary allocation of timber rights instead of competitive bidding, and decisively charges low forest fees thereby reducing stumpage revenue (Hansen and Lund 2011). This may affect the value of timber benefits eventually received by farmers. To ensure transparency and accountability in timber rights allocation, it is imperative that the government enforces the *Timber Resources Management (Legality) Regulation* of 2012 (L.I. 2184) that seeks to enhance transparency through competitive bidding and continuous auditing of the timber allocation process. A direct legislation on transparency and accountability in the forest sector, as proposed by the 2012 Forest and Wildlife Policy, is also needed. A Unit can be established under the Forest Service Division to specifically oversee the disbursement of stumpage revenue to farmers. This needs to be subjected to continuous and rigorous external auditing to ensure accountability.

Recent efforts by the government to control illegal logging have either been ineffective (e.g., the use of task force) or completely missed the underlying causes of illegalities (e.g., artisanal milling). As found in this study, the best option to circumvent the budgetary and spatial challenges of enforcement is to motivate farmers in general and provide extra incentives for some selected farmers to assist the Forestry Commission (FC) in monitoring off-reserve logging activities. Farmers live in the off-reserve forests and can better detect illegal logging activities in forest villages both at night and during the day. Though monitoring is equally needed at the domestic lumber market (Franck and Hansen 2014), the current author believes that more monitoring efforts are needed at the source of the problem: the farm level. An HFZ-wide project on FC-farmer partnership in forest law enforcement is urgently needed. This is likely to provide a better chance for the FC to apprehend illegal loggers. However, the effectiveness of enforcement will be complete only when offenders are sanctioned strictly according to existing laws. Both farmers and operators in the particular illegal operation need to be sanctioned to deter farmers from engaging in illegal logging. However, a mechanism to provide free lumber to farmers should be incorporated in the design of artisanal milling as an SRA activity. This will ensure cheap and easy access to lumber for farmers who may need wood for domestic construction.

The timing of on-farm timber concessions is very critical to the expected effectiveness of the policy mix. Since farmers urgently need to reduce shade tree density when crops start bearing cocoa pods, it will be imperative for the FSD to grant on-farm concessions during this stage of cocoa farms. Any delay on the part of the FSD in granting concession logging on pod-bearing farms is expected to result in illegal logging. Farmers would have no choice than to engage in nocturnal illegal logging to reduce shade and improve farm ventilation. They are likely to blame such illegal activities on ‘outsiders’. For this reason, the FSD should grant salvage permits on cocoa farms immediately the crops start bearing pods.

10.3.2 Implications for third-party advocacy

The study has demonstrated the effectiveness of third-party advocacy in resolving compensation conflicts in the off-reserve area. Local Civil Society Organisations (CSOs) and the Ghana Cocoa Board (Cocobod) can take up this advocacy role.[60] They have the potential for advocating for farmer’s rights to compensation in the off-reserve landscape because they are more likely to possess the financial and legal resources to match concessionaires in compensation litigations. They can also use the media to expose the injustices meted out to farmers by concessionaires and the FSD. CSOs need to closely and

[60] The Ghana Cocoa Board (Cocobod) is the State agency for overseeing the production and marketing of cocoa beans in Ghana

constantly monitor on-farm logging compensation and take on non-compliant concessionaires.

Further, CSOs need to extend their activities to building the capacities of farmers in compensation negotiations. Cocoa farmers are already organised into cocoa marketing groups called *Societies*. Currently, these Societies are only concerned with the marketing of cocoa beans and, to some extent, the distribution of government-supplied agrochemicals to members. The CSOs can use these Societies as conduits for building the capacities of farmers. They can organise farmers within the existing Societies to present formidable fronts to fight for farmers' rights to veto on-farm logging and their rights to give written consent to logging. The Societies can also be organised and trained to effectively advocate for better and prompt compensation for farmers and to pull resources together to litigate on behalf of a group of affected farmers when mediations fail. Above all, CSOs need to advocate for separate compensation standards for on-farm logging from the government.

The Cocobod can also play the third-party advocacy role as part of its corporate social responsibilities. The Cocobod can roll-out a special initiative to address issues of on-farm logging and compensation through advocacy, funding of CSOs and setting of compensation standards. It should take the resolution of on-farm logging as part of its mission and advocate for farm-compatible logging practices from loggers. It needs to laisse with the FSD to design and pilot technical logging specifications and instructions that are more benign to cocoa agroforestry. This will reduce the extent of damage to cocoa farms during concession logging. The Cocobod is also the right institution to partner with the Land Valuation Division to set compensation standards for the various varieties and ages of the cocoa crop. This can end the problem of discretionary, arbitrary, and unsatisfactory compensation rates offered by concessionaires.

10.4 Limitations of the Study

Some limitations of the current study need to be highlighted. First, the formal theoretical analyses considered only the three key stakeholders in the off-reserve forests. However, there are other stakeholders such as stool landowners and illegal chainsaw loggers who can influence the outcomes of the game. For instance, the actions of illegal loggers could alter farmers' decision even when they are in receipt of formal timber benefits from the State and the tree-harvesting law is enforced. Yet, these stakeholders were not included in the analyses because of the need for simplicity and to focus on what is essential. The confirmation of the predictions of the games by the empirical tests, however, goes to affirm the validity of the outcomes of the game despite the exclusion of some stakeholders.

Second, the theoretical analyses relied on hypothetical *commitments* by the government. These commitments are in no way representative of the government's actual decisions or sanctions and should not be treated as so. However to promote realism, they were formulated based on government intentions as reported in official documents such as the 2012 Forest and Wildlife Policy, REDD+ documents, VPA and consultancy reports. The certainty of the commitments cannot be guaranteed. Nonetheless, they may be probable considering the recent increase in government, donor and civil society interests in tree tenure reforms and forest law enforcements in the off-reserve landscape (cf. Hajjar 2015b).

Third, the author acknowledges that the use of self-reported data on illegal logging activities could bias responses because farmers could respond strategically to conceal socially-undesirable behaviour or avoid potential repercussions (Nuno and St. John 2015). To reduce strategic behaviour, multiple questions were purposefully and strategically placed in the questionnaire to measure illegal logging activities. This was to cross-check the reliability of farmers' responses and obtain accurate data on illegal logging activities (cf. Babbie 2013; Nardi 2014). Further, farmers in the survey considered their illegal tree harvesting as socially acceptable (in forest villages) and coupled with perceived weak enforcement, they were willing to reveal their illegal practices and freely share their views on on-farm illegal logging. This is confirmed by the high levels of illegal logging activities reported by farmers during the survey (cf. Ramcilovic-Suominen and Epstein 2015). Despite all these measures, it is acknowledged that strategic behaviour could still occur.

The nature of the study necessitated the use of behavioural antecedents such as willingness and likelihood instead of actual behaviour. Thus, actual future behaviour could deviate from the proximal antecedents used in this study. As pointed earlier, several studies have revealed a high correlation between these antecedents and actual behaviour (Gibbons and Gerrard 1997; Armitage and Conner 2001; Ajzen and Fishbein 2005; Pomery *et al.* 2009). Therefore, there is high possibility that the empirical results will reflect actual behaviour of farmers and concessionaires should the conditions of the scenarios be present. Also, the comparative analyses on complete devolution largely relied on empirical studies from other countries. This may or may not reflect the actual behaviour of farmers when there is devolution in the off-reserve area in Ghana. Nevertheless, the conclusions made in this comparative analysis are valid considering the compelling evidence in the literature.

10.5 Suggestions for Further Research

Following are some suggestions for further research. The first set of recommendations relate to the models developed in this study. The forest management games assumed complete information for equilibrium analyses. Future research could attempt to introduce some uncertainties in the payoff structure of the game to observe how players, especially farmers, may react to such situations. For more complex analyses, future studies could introduce chainsaw operators into the model to observe how these may react to the government's attempt to grant timber benefit to farmers. Alternative benefit-sharing options could be introduced into the game and tested empirically to ascertain how farmers will react to each proportion of stumpage revenue proposed.

The second set of recommendations relate to the extension of game-theoretic modelling to other forest-related issues in Ghana. These include the management of national parks and game reserves, management of forest reserves with admitted settlements and farms, collaborative forest management regimes, Community Resource Management Areas (CREMAs), forest woodlands in the Savannah, and the management of sacred groves. The application of game theory in these areas has a high potential of unveiling the rationale behind the behaviour of many stakeholders. This will contribute immensely to the development of viable options for resolving the numerous challenges militating against the successful management of these forest systems in Ghana. Further studies are also needed to analyse farmer-concessionaire negotiations during on-farm logging compensation interactions using bargaining models. Such studies have the potential of providing more insights into the dynamics of compensation negotiations and their outcomes.

Thirdly, detailed empirical studies are needed to ascertain the political feasibility of options prescribed in this study. Scholars hint of a patronage system that impedes every attempt to reform tree tenure in the forestry industry in Ghana (cf. Amanor 2004; Hansen and Lund 2011; Lund *et al.* 2012). Future studies can investigate the extent to which the alleged patronage system can actually hinder the proposed revision by the study; and to subsequently evaluate effective mechanisms for breaking this system. Future studies are also needed to ascertain the prospects and challenges for FC-farmer partnerships in forest law enforcement in the off-reserve area.

10.6 Conclusion

This study comes at a time when stakeholders and activists in the off-reserve forests are unanimous about the necessity for reforms but lack consensus and evidence on the nature of the needed reforms. It provides the information required to achieve consensus on the nature of reforms needed. The study underscores the need for realistic and equitable reforms that are likely to reduce opposition from vested interests. Thus, it has been argued that a more efficient, effective, equitable, and feasible tenure-reform option is one that revises the current tree-tenure to provide 40% of on-farm stumpage revenue to the farmer without changing the constitutional formula for the distribution of stool land revenue. However, the effectiveness of tenure reforms in Ghana may well be contingent on full compensation for crop damage and collaborative forest law enforcement. This stresses the need for ongoing forest management initiatives in the High Forest Zone in Ghana to adopt multidimensional approaches in tackling unsustainable practices in the off-reserve forests.

Appendices

Appendix A. Ethics Approval Letter

THE UNIVERSITY of ADELAIDE

RESEARCH BRANCH
OFFICE OF RESEARCH ETHICS, COMPLIANCE AND INTEGRITY

LEVEL 7, 115 GRENFELL STREET
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CRICOS Provider Number 00123M

10 December 2015

Dr J Suh
School of Social Sciences

Dear Dr Suh

ETHICS APPROVAL No: H-2015-269

PROJECT TITLE: **Sustaining off-reserve forests in Ghana: a game-theoretic approach**

The ethics application for the above project has been reviewed by the Low Risk Human Research Ethics Review Group (Faculty of Arts and Faculty of the Professions) and is deemed to meet the requirements of the *National Statement on Ethical Conduct in Human Research (2007)* involving no more than low risk for research participants. You are authorised to commence your research on **10 Dec 2015**.

Ethics approval is granted for three years and is subject to satisfactory annual reporting. The form titled *Annual Report on Project Status* is to be used when reporting annual progress and project completion and can be downloaded at http://www.adelaide.edu.au/ethics/human/guidelines/reporting. Prior to expiry, ethics approval may be extended for a further period.

Participants in the study are to be given a copy of the Information Sheet and the signed Consent Form to retain. It is also a condition of approval that you **immediately report** anything which might warrant review of ethical approval including:

- serious or unexpected adverse effects on participants,
- previously unforeseen events which might affect continued ethical acceptability of the project,
- proposed changes to the protocol; and
- the project is discontinued before the expected date of completion.

Please refer to the following ethics approval document for any additional conditions that may apply to this project.

Yours sincerely

PROFESSOR RACHEL A. ANKENY
Co-Convenor
Low Risk Human Research Ethics Review Group (Faculty of Arts and Faculty of the Professions)

ASSOCIATE PROFESSOR VERONICA SOEBARTO
Acting Co-Convenor
Low Risk Human Research Ethics Review Group (Faculty of Arts and Faculty of the Professions)

Appendix B. Calculation of Omega Squared (ω^2) for the Repeated-Measures ANOVA on Concessionaires' Likelihood to Pay Full Compensation

The values for the parameters in Equation 5.4 and the results of their computation are reported in Table B.1.

Table B.1. Values for parameters and results of the computation of the Omega Squared for the repeated-measures ANOVA.

	Sum of Squares	df	Mean Square	F	Sig.	Omega Squared
Model	81.067	2	40.533	26.238	0.000	0.3791
Residual (error)	89.600	58	1.545			
Grand Variance						2.2978
Total Sum of Squares						204.5042
Between-Subjects Sum of Squares						33.8372
Between-Subject Mean Squares						1.1668

NB: k = 3; N = 30

Appendix C. Calculation of Effect Sizes for Contrasts in the Repeated-Measures ANOVA on Concessionaires' Likelihood to Pay Full Compensation

Table C.1. reports the values for the parameters in Equation 5.8 and the computed effect sizes

Table C.1. Inputs for and results from the computation of effect sizes of simple contrasts in the repeated-measures ANOVA.

Scenarios	**Mean Square**	**F**	**Sig.**	**Effect size (r)**
Blockading vs. Third party litigation	104.533	42.418	0.000	0.77
Blockading vs. Enforcement	136.533	47.438	0.000	0.79
Third party litigation vs. Enforcement	2.133	0.543	0.467	0.14
df (for each contrast)				1
df for Residual the same for each constant				29

Appendix D. Calculation of Omega Squared (ω^2) for the Main and Interaction Effects of the Factorial ANOVA on Farmers' Willingness to Engage in Illegal Logging

The inputs for Equation 5.9 together with their computed values are reported in Table D.1.

Table D.1. Inputs for and results from the computation of Omega squared for factorial ANOVA

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Estimated Variance ($\hat{\sigma}^2$)	Omega Squared (ω^2)
Corrected Model	577.658	7	82.523	54.605	.000		
Intercept	3096.923	1	3096.923	2049.211	.000		
Enforcement only	101.003	1	101.003	66.833	.000	0.2487	0.0849
Compensation only	4.203	1	4.203	2.781	.096	0.0067	0.0023
Right to trees only	386.123	1	386.123	255.494	.000	0.9615	0.3283
Enforcement and compensation	41.603	1	41.603	27.528	.000	0.1002	0.0342
Enforcement and right to tress	.063	1	.063	.041	.839	-0.004	-0.001
Enforcement and compensation	3.063	1	3.063	2.026	.155	0.0039	0.0013
Enforcement, compensation and right to trees	41.603	1	41.603	27.528	.000	0.1002	0.0342
Error (or residual)	592.420	392	1.511				
Total	4267.000	400				1.4177	
Corrected Total	1170.078	399					
Sum of variance components + mean residual ($\hat{\sigma}^2_{total}$)						2.9287	

NB = a = 2; b = 2; c = 2; n = 50.

Appendix E. Calculation of Effect Sizes for Simple Effect Analyses of the Enforcement × Compensation × Right to trees Interaction in the Factorial ANOVA on Farmers' Willingness to Engage in Illegal Logging

The F-Statistic of the contrasts, the degrees of freedom and resultant effect sizes of the simple effect analyses are reported in Table E.1.

Table E.1. Inputs for and results from the computation of effect sizes for the *enforcement* × *compensation* × *right to trees* interaction.

Factor-level combinations	**Mean Square**	**F**	**Sig.**	**Effect size (r)**
Effect of Enforcement				
No right to trees and no compensation	134.560	89.037	.000	0.430
Right to trees but no compensation	24.010	15.887	.000	0.197
No right to trees but full compensation	1.690	1.118	.291	0.053
Full compensation and right to trees	24.010	15.887	.000	0.197
Effect of Compensation				
No right to trees and no enforcement	43.560	28.823	0.000	0.262
Right to trees but no enforcement	3.610	2.389	0.123	0.078
Enforcement with no right to trees	39.690	26.263	0.000	0.251
Right to trees and enforcement	3.610	2.389	0.123	0.078
Effect of Right to trees				
No enforcement and no compensation	151.290	100.107	0.000	0.451
No enforcement but full compensation	57.760	38.219	0.000	0.298
Enforcement without compensation	31.360	20.751	0.000	0.224
Enforcement and compensation	190.440	126.013	0.000	0.493
df (for each contrast)	1			
df for Residual the same for each constant	392			

Appendix F. Farmers' Survey Questionnaire

CODE…………

School of Social Sciences

Geography, Environment and Population (GEP)

FARMERS' SURVEY QUESTIONNAIRE

PhD Research Topic: Sustaining off-reserve forests in Ghana: a game-theoretic approach

Name of Researcher:
Emmanuel Otutei

Name of Farmer's Community……………………………………………………

Forest District………………………………………………………………….

Region…………………………………………………………………………….

A. FARMING CHARACTERISTICS AND FOREST MANAGEMENT ISSUES

A1. For how many years have you been farming? ………………………………………….

A2. How old is your (main) farm (in years)?...

A3. What is your total farm size (acres)……………………………………………………..

A4. What was your total cocoa yield (bags) during the previous season?……………….

A5. What crop arrangement do you practice? 1. Own farm [] 2. Abunu [ ] 3. Abusa []

A6. What is the main variety of cocoa cultivated?

1. Tetteh Quarshie (*Almenado*) [ ] 2. *Amazonia* [ ] 3. Hybrid *Amazonia* [ ]

A7. How many timber trees (both young and mature) are on your farm(s)?……………….

A8. How many non-timber trees (both young and mature) are on your farm(s)?…………

A9. How many of these trees did you nurture as saplings or coppices?..............................

A10. How many of the trees on your farm did you retain purposely for cultural reasons?.....

A11. How many trees have been harvested on your farm (both contractors and operators)?..

A12. Apart from shading, what are your reasons for retaining trees on your farm (***Select as many as applicable***)

a. To harvest them for construction [ ] b. To sell them for a living [ ] c. For religious/cultural purposes [ ] d. Others (e.g., medicine and fruits) []

A13. One of the main reasons for farmers to retain and nurture timber trees on farms is to use the wood for their buildings instead of buying them from the market? Please indicate the sources of wood for the construction of the following?

Actions	1. Wood from farm	2. Wood from farm of a relative/friend	3. Wood from the lumber market	4. No answer	5. Not applicable
a). Your house					
b). Your storage hat/barn					
c). Shelter for your domestic animals					

A14. Do you know of any farmer(s) who was/were not compensated for damaged crops?

1. Yes [ ] 2. No [ ] 3. Refused to answer [ ]

A15. Do some farmers in your community use wood from their farms to build their houses?

1. Yes [ ] 2. No [ ] 3. Refused to answer [ ]

A16. Please indicate your level of agreement or disagreement with this statement: "Farmers who have retained and tended timber trees on their farms can harvest a tree on their farms for their buildings instead of buying them from the lumber market".

1. Strongly disagree [ ] 2. Somewhat Disagree [ ] 3. Neither agree nor disagree [ ] 4. Somewhat Agree [ ] 5. Strongly Agree [ ]

A17. Do people report chainsaw activities in your community to the Forestry Commission?

1. Yes [ ] 2. No [ ] 3. Don't Know [ ]

A18. Are chainsaw operators sanctioned when arrested by the Forest officers?

1. Yes [ ] 2. No [ ] 3. Don't Know [ ]

B. ON-FARM LOGGING ACTIVITIES

B1. Has any timber contractor harvested any tree on your farm before?

1. Yes [ ] 2. No [ ] (***Skip to Q. B11***)

B2. If Yes to ***Q. B1,*** did the contractor who logged on your farm consult you before logging? 1. Yes [ ] 2. No [ ]

B3. If Yes to ***Q. B1,*** **w**hich of these forms of consent did you give before the contractor started logging?

1. Verbal Consent [ ] 2. Written Consent [] 3. I did not consent to logging on my farm [ ]

B4. . If Yes to ***Q. B1,*** were you able to make an agreement on compensation for crop damage? 1. Yes [ ] 2. No [ ]

B5. If Yes to ***Q. B1***, what was the extent of compensation payment made by the recent contractor?

1. Full payment as agreed between you and the contractor [ ]

2. Part of the agreed amount [ ] 3. Not at all [ ]

B6. If you were fully or partially paid compensation, what was the time of payment?

1. Before conveyance [ ] 2. At the time of conveyance [ ] 3. After conveyance [ ]

B7. How much compensation (in Gh¢) did you receive for each of the following crops (as applicable)?

a. Cocoa: Gh¢……… b. Oil palm: Gh¢…………………….
c. Plantain: Gh¢…………… d. Other food crops (please specify)……….

B8. Please indicate your level of satisfaction or dissatisfaction with the compensation paid by the contractor? 1. Highly dissatisfied [ ] 2. Somewhat Dissatisfied [ ]

3. Neither satisfied nor dissatisfied [ ] 4. Somewhat satisfied [ ] 5. Highly satisfied [ ]

B9. Are you aware of any standard compensation rates set by the government?

1. Yes [ ] 2. No [ ]

B10. If Yes in B10, what are the standard compensation rate for each of the following crops?

a. Cocoa: Gh¢…………… b. Oil palm: Gh¢……………………….

c. Plantain: Gh¢…………………... d. Other food crops (please specify)……

B11. How many of the following crops were damaged on your farm by the recent contractor?

a. Cocoa:…………………… b. Oil palm:……………………….

c. Plantain:…………………... d. Other food crops (please specify)……

B12. Did the contractor pay for any tree-tending fee apart from compensation?

1. Yes [ ] 2. No [ ]

B13. If Yes in ***Q. B12***, how much was paid per tree? Gh¢……………………………….

B14. How would you rate timber contractors in terms of compensation payment?

1. Very Poor [ ] 2. Poor [ ] 3. Fair [ ] 4. Good [ ] 5. Very Good [ ]

B15. Has any of the trees on your farm(s) been harvested by a chainsaw operator before?

1. Yes [ ] 2. No [ ] (***Skip to Q. B19***)

B16. Did the operator(s) pay for the tree logged? 1. Yes [ ] 2. No [ ]

B17. If yes in ***Q. B16***, how much was paid? Gh¢…………………………………………

B18. Did the operator provide you with sawn wood?

1. Yes [ ] 2. No [ ] 3. Don't Know [ ]

B19. Please indicate your level of agreement or disagreement with the following statements about chainsaw operators.

Statement	1. Strongly Disagree	2. Somewhat Disagree	3. Neutral	4. Somewhat Agree	5. Strongly Agree	Don't Know
a). Chainsaw operators cause less damage to farms than contractors.						
b). Chainsaw operators pay less compensation than contractors.						
c). Chainsaw operators provide farmers with firewood from tree branches.						
d). Chainsaw operators assist farmers in removing unwanted stumps.						
e). Chainsaw operators provide free lumber boards to farmers.						

B20. Which of these would you prefer to log on your farm?

1. Operators [ ] 2. Contractors [ ] 3. Don't Know [ ]

C. SATISFACTION WITH TREE TENURE ARRANGEMENT

C1. Please indicate your level of agreement or disagreement with the following statements?

Statement	1. Strongly Disagree	2. Somewhat Disagree	3. Neutral	4. Somewhat Agree	5. Strongly Agree	Don't Know
a). The current tree harvesting rule for on-farm trees in the off-reserve forest is fair to farmers						
b). The current arrangement where farmers are ousted from the sharing of timber revenue is unfair to farmers						

D. NO INTERVENTION SCENARIO (GROUP H)

D1. Currently, you are not allowed to harvest trees on your farm and loggers seldom compensate farmers for crop damage. If the current tree tenure and compensation situation continues to persist, how willing or unwilling are you to do each of the following activities in the table below?

Activities	1. Extremely Unwilling	2. Somewhat Unwilling	3. Indifferent	4. Somewhat Willing	5. Extremely Willing	Don't Know
a). Retain only non-timber trees on your farm						
b). Retain any tree-specie compatible with cocoa trees on your farm						
c). Retain no tree at all on my farm						
d). Allow an operator to fell a tree on your farm, considering the tree payment they make						

D. STRICT ENFORCEMENT *ONLY* SCENARIO (GROUP A)

D1. Currently, you are not allowed to harvest trees on your farm. Suppose that the government wants to tighten the monitoring of forest activities in the off-reserve forest. As such, the government intends to contract some people from your community to actively monitor logging activities in the community. Anybody found felling a timber tree without the permit of the Forestry Commission will be immediately prosecuted.

Suppose that you are uncertain of receiving compensation from loggers for crop damage but the government contracts some people from your community to monitor logging activities in your community as described above, how willing or unwilling are you to do each of the following activities in the table below.

Activities	1. Extremely Unwilling	2. Somewhat Unwilling	3. Indifferent	4. Somewhat Willing	5. Extremely Willing	Don't Know
a). Retain only non-timber trees on your farm						
b). Retain any tree-specie compatible with cocoa trees on your farm						
c). Retain no tree at all on your farm						
d). Allow an operator to fell a tree on your farm, considering the tree payment they make						

D. FULL COMPENSATION *ONLY* SCENARIO (GROUP B)

D1. Currently, you are not allowed to harvest trees on your farm and loggers seldom compensate farmers for crop damage. Suppose that you are certain that loggers will fully compensate you for crop damages after logging on your farm, how willing or unwilling are you to do each of the following activities in the table below.

Activities	1. Extremely Unwilling	2. Somewhat Unwilling	3. Indifferent	4. Somewhat Willing	5. Extremely Willing	Don't Know
a). Retain only non-timber trees on your farm						
b Retain any tree-specie compatible with cocoa trees on your farm						
c). Retain no tree at all on your farm						
d). Allow an operator to fell a tree on your farm, considering the tree payment they make						

D. MTS *ONLY* SCENARIO (GROUP C)

D1. Currently, you are not allowed to harvest trees on your farm and loggers seldom compensate farmers for crop damage. The government is implementing the Modified Taungya System (MTS) where farmers who interplant trees with their crops in forest reserves and tend them to canopy level are paid 40% of the stumpage value of each tree. Suppose that you are uncertain of receiving compensation from loggers for crop damage but the government rolls out this MTS to the off-reserve forest when a logger permitted by the Forestry Commission (FC) fells any tree on your farm. In such a scenario, how willing or unwilling are you to do each of the following activities in the table below.

Activities	1. Extremely Unwilling	2. Somewhat Unwilling	3. Indifferent	4. Somewhat Willing	5. Extremely Willing	Don't Know
a). Retain only non-timber trees on your farm						
b). Retain any tree-specie compatible with cocoa crops on your farm						
c). Retain no tree at all on your farm						
d). Allow an operator to fell a tree on your farm, considering the tree payment they make						

<u>D. STRICT ENFORCEMENT & FULL COMPENSATION SCENARIO (GROUP D)</u>

D1. Currently, you are not allowed to harvest trees on your farm. Suppose that the government wants to tighten the monitoring of forest activities in the off-reserve forest. As such, the government intends to contract some people from your community to actively monitor logging activities in the community. Anybody found felling a timber tree without the permit of the Forestry Commission will be immediately prosecuted.

Suppose that you are certain that loggers will fully compensate you for crop damages after logging on your farm and the government contracts some people from your community to monitor logging activities in your community as described above, how willing or unwilling are you to do each of the following activities in the table below.

Activities	1. Extremely Unwilling	2. Somewhat Unwilling	3. Indifferent	4. Somewhat Willing	5. Extremely Willing	Don't Know
a). Retain only non-timber trees on your farm						
b). Retain any tree-specie compatible with cocoa crops on your farm						
c). Retain no tree at all on your farm						
d). Allow an operator to fell a tree on your farm, considering the tree payment they make						

<u>D. STRICT ENFORCEMENT & MTS *ONLY* SCENARIO (GROUP F)</u>

D1. Currently, you are not allowed to harvest trees on your farm. Suppose that the government wants to tighten the monitoring of forest activities in the off-reserve forest. As such, the government intends to contract two people from your community to actively monitor logging activities in the community. Anybody found felling a timber tree without the permit of the Forestry Commission will be immediately prosecuted.

The government is implementing the Modified Taungya System (MTS) where farmers who interplant trees with their crops in forest reserves and tend them to canopy level are paid 40% of the stumpage value of each tree. Suppose that you are uncertain of receiving compensation from loggers for crop damage but the government rolls out this MTS to the off-reserve forest when a logger permitted by the Forestry Commission (FC) fells any tree on your farm. Suppose also that in addition to rolling out the MTS, the government contracts some people from your community to monitor logging activities in your community as described above, how willing or unwilling are you to do each of the following activities in the table below.

Activities	1. Extremely Unwilling	2. Somewhat Unwilling	3. Indifferent	4. Somewhat Willing	5. Extremely Willing	Don't Know
a). Retain only non-timber trees on your farm						
b). Retain any tree-specie compatible with cocoa crops on your farm						
c). Retain no tree at all on your farm						
d). Allow an operator to fell a tree on your farm, considering the tree payment they make						

D. FULL COMPENSATION AND MTS *ONLY* SCENARIO (GROUP E)

D1. Currently, you are not allowed to harvest trees on your farm and loggers seldom compensate farmers for crop damage. The government is implementing the Modified Taungya System (MTS) where farmers who interplant trees with their crops in forest reserves and tend them to canopy level are paid 40% of the stumpage value of each tree. Suppose that the government rolls out this MTS to the off-reserve forest when a logger permitted by the Forestry Commission (FC) fells any tree on your farm. Suppose also that you are certain of receiving compensation from loggers for crop damage, how willing or unwilling are you to do each of the following activities in the table below.

Activities	1. Extremely Unwilling	2. Somewhat Unwilling	3. Indifferent	4. Somewhat Willing	5. Extremely Willing	Don't Know
a). Retain only non-timber trees on your farm						
b). Retain any tree-specie compatible with cocoa crops on your farm						
c). Retain no tree at all on your farm						
d). Allow an operator to fell a tree on your farm, considering the tree payment they make						

D. STRICT ENFORCEMENT, FULL COMPENSATION & MTS SCENARIO (GROUP G)

D1. Currently, you are not allowed to harvest trees on your farm. Suppose that the government wants to tighten the monitoring of forest activities in the off-reserve forest. As such, the government intends to contract two people from your community to actively monitor logging activities in the community. Anybody found felling a timber tree without the permit of the Forestry Commission will be immediately prosecuted.

D2. The government is implementing the Modified Taungya System (MTS) where farmers who interplant trees with their crops in forest reserves and tend them to canopy level are paid 40% of the stumpage value of each tree. Suppose that the government rolls out this MTS to the off-reserve forest when a logger permitted by the Forestry Commission (FC) fells any tree on your farm. In addition, the government contracts some people from your community to monitor logging activities in your community as described above. Suppose also that you are certain of receiving compensation from loggers for crop damage, how willing or unwilling are you to do each of the following activities in the table below?

Activities	1. Extremely Unwilling	2. Somewhat Unwilling	3. Indifferent	4. Somewhat Willing	5. Extremely Willing	Don't Know
a). Retain only non-timber trees on your farm						
b). Retain any tree-specie compatible with cocoa crops on your farm						
c). Retain no tree at all on my farm						
d). Allow an operator to fell a tree on your farm, considering the tree payment they make						

E. STRATEGIES FOR FUTURE COMPENSATION PROBLEMS

E1. How likely or unlikely are you to use each of the following strategies to pursue compensation when a contractor fails to pay full compensation for crop damage?

Actions	1. Very Unlikely	2. Somewhat Unlikely	3. Indifferent	4. Somewhat Likely	5. Very Likely	Don't Know
a). Take no action to pursue compensation						
b). Try to persuade the contractor to pay the compensation						
c). Seek for mediation from community leaders, DCE or forestry officials (if persuasion fails)						
d). File a law suit against contractor (if mediation fails)						
e.) Blockade conveyance of logs						

E2. Logging affects your farm through damage to crops and saplings and reduction in the yields of the other crops that enjoyed shading, fertility, moisture and protective benefits from the trees felled by logging companies. Considering all these, what is the minimum amount you are willing to accept for each of the following damaged crop to feel satisfied that you have been adequately compensated for your crop damage (***as many as applicable***).

a. Cocoa: Gh¢…………………… b. Oil palm: Gh¢……………………….

c. Plantain: Gh¢…………………... d. Other food crops (please specify)……

F. SOCIO-DEMOGRAPHIC CHARACTERISTICS

F1. What is your age (in years)?………………………………..

F2. Sex 1. Male [ ] 2. Female [ ]

F3. What is your highest level of education?

1. No formal education [ ] 2. Primary education [ ] 3. Middle School/JHS [ ]

4. Secondary education (SHS/Voc/Tech) [ ] 5. College/Tertiary [ ] 99. Refused to answer [ ]

F4. Are you the head of your household? 1. Yes [ ] 2. No [ ]

F5. How many dependents do you have (including yourself)?..................................

F6. What is your marital status?

1. Never married [ ] 2. Divorced/Separated [ ] 3. Married [ ] 4. Other Union [ ] 5. Widowed [ ] 99. Refused to answer [ ]

F7. Ethnicity (please select only one)

1. Akan [ ] 2. Northern [ ] 3. Ewe [ ] 4. Ga Adangbe [ ] 5. Guans [ ]

99. Refused to answer [ ]

F8. How long (years) have you lived in this village?..

F9. What is the highest position you have ever held in this community?

1. Chief/Caretaker [ ] 2. Abusuapanyin Family head [ ] 3. Unit committee member [ ]

4. Assembly-member [ ] 5. Religious leader (Pastor/Elder/Priest) [ ]

6. Community member [ ] 7. Leader of a youth group, religious group, farmers' association or NGO [ ]

8. Other (specify)……………………………...[ ] 99. Refused to answer [ ]

F10. Does any of your close relatives or friends occupy any of the positions from **(1)** to **(8)** listed in Q.G9? 1. Yes [ ] 2. No [ ] 99. Refused to answer [ ]

F11. What is your residency status? 1. Native [ ] 2. Migrant [ ] 99. Refused to answer [ ]

F12. Please state your monthly income for each of the applicable sources of income in the table below.

Income source	Amount (Gh¢)
Non-farm paid job	
Business (trading or artisanal work)	
Remittances	
Farm produce apart from cocoa (annual)	
Others (specify)	

Appendix G. Loggers’ Survey Questionnaire

CODE…………

School of Social Sciences

Geography, Environment and Population (GEP)

SURVEY QUESTIONNAIRE FOR LOGGING CONCESSIONAIRES

PhD Research Topic: Sustaining off-reserve forests in Ghana: a game-theoretic approach

Name of Researcher:
Emmanuel Ututei

Location of company………………………………………………………………………….

Forest District………………………………………………………………………….

Region………………………………………………………………………………

A. LOGGING PROFILE

A1. Off-reserve operational areas (districts)………………………………………………

A2. How long has your company been logging off-reserve?......................................(years)

A3. Total area of concessions/contracts or permits (hectares)…………………………..

A4. What is the duration of your timber contract in your current operational area?...............

A5. How many employees does you company have?..

B. OFF-RESERVE COMPENSATION PAYMENT TO FARMERS

B1. Have you encountered any compensation problems with any farmer before?

1. Yes [ ]   2. [ ]

B2. If yes, what were the problems about? (***Select as many as are applicable***)

a. Disagreement over compensation amount [ ]   b. Delayed payment [ ]

c. Partial payment [ ]   d. Non-payment of compensation [ ]

B3. Are you aware of any standard compensation rates set by the government?

1. Yes [ ]   2. No [ ]

B4. If Yes in ***Q. B3***, what are the standard compensation rate for each of the following crops?

a. Cocoa: Gh¢……………………   b. Oil palm: Gh¢…………………

c. Plantain: Gh¢…………………...   d. Other food crops (please specify)…

……………………………………………………………………………………..

B5. Farmers suffer more damages beyond the actual crops and saplings that are destroyed during logging. Since they use the trees as shade trees, there is a medium-term impact on the yield of the cocoa crops that benefited from the shades of the removed trees. These removed trees provided shading, improved soil fertility, improved soil moisture, regulated farm temperature, controlled pests and diseases and protected crops from bushfires and precarious weather. However, these losses are not easily and visibly quantifiable. As such, farmers can be compensated in part by offering acceptable payment for the actual crops that are damaged during logging.

Considering this, please indicate the highest amount you are willing to pay per each of the following crop:

a. Cocoa: Gh¢ …………………….........
b. Oil palm: Gh¢ ……………………….
c. Plantain: Gh¢ ………………………..
d. Other food crops such as cocoyam and yam: Gh¢ ………………………………

C. FUTURE MEASURES BY GOVERNMENT TO CURB COMPENSATION PROBLEMS

C1. Please indicate your level of agreement or disagreement with the statement that: "the government should set compensation standards for each crop instead of leaving it to farmers and contractors to negotiate".

1. Strongly Disagree [ ] 2. Somewhat Disagree [ ] 3. Neither agree nor disagree [] 4. Somewhat Agree [ ] 5. Strongly Agree [ ]

C2. How important to you is timely conveyance of logs to the sawmill?

1. Not important at all [ ] 2. Somewhat not important [ ] 3. Neutral [ ]
4. Somewhat Important [ ] 5. Very Important [ ] 6. Don't Know [ ]

C3. Currently, farmers are complaining that they seldom receive compensation from contractors for damages to crops during logging. Suppose that the Forest Service Division (FSD) restrains you from conveying your logs to the sawmill until you have fully paid farmers their due compensation. In such a scenario, how much do you agree or disagree with each of the following statements in the table?

Actions	1. Strongly Disagree	2. Somewhat Disagree	3. Neutral	4. Somewhat Agree	5. Strongly Agree	Don't Know
a). I am expected by my superiors to deliver the logs to the sawmills before paying compensation, thus I will not be able to pay before conveying the logs.						
b). I will pay part of the compensation and negotiate with both the FSD and farmers and come to pay later						
c). I will pay farmers the full compensation due them before conveying the logs						

C4. The government is concerned about the frequent compensation complaints from farmers. Suppose that a third party private agency takes charge of the compensation negotiation and payment process on behalf of the farmers. This agency has the ability to pursue compensation payment through persuasion and the legal system. The affected farmers will bear 10% of their entitlements as service fee of the private agency. However, if the logging company fails to pay compensation before conveying its logs, every cost associated with the pursuit of payment by the private agency will be borne by the logging company. In such a scenario, how willing or unwilling are you to take each of the following actions in the table below?

Activities	1. Extremely Unwilling	2. Somewhat Unwilling	3. Indifferent	4. Somewhat Willing	5. Extremely Willing	Don't Know
a). Pay full compensation to farmers before conveying logs						
b). Pay part of the compensation before conveying logs						
c). Convey logs to sawmill first before deciding on what to do.						

D. RESPONSES TO FUTURE ACTIONS BY FARMERS REGARDING COMPENSATION ISSUES

Supposed that you have not paid full compensation to farmers, but farmers are determined to pursue their compensation. Please answer the following questions relating to each of the strategies of farmers.

D1. How likely or unlikely are you to do each the following if a farmer uses persuasion to convince you to settle the compensation?

Actions	1. Very Unlikely	2. Unlikely	3. Indifferent	4. Likely	5. Very Likely	Don't Know
a). Pay part of the compensation due to usual budgetary constraints						
b). Convey the logs to the sawmill first, for my superiors to confirm before settling any outstanding compensation						
c). Pay the full compensation after persuasion.						

D2. How likely or unlikely are you to do each of the following if a farmer seeks the assistance of a chief, forest official or a local government official (DCE, Assemblyman) to pursue compensation for crop damage?

Actions	1. Very Unlikely	2. Unlikely	3. Indifferent	4. Likely	5. Very Likely	Don't Know
a). Pay part of the compensation due to usual budgetary constraints						
b). Convey the logs to the sawmill first for my superiors to confirm before settling any outstanding compensation						
c). Pay the full compensation immediately after the mediation process						

D3. How likely or unlikely are you to do each of the following if a court of law orders you to pay the compensation due a farmer within a specified time period?

Actions	1. Very Unlikely	2. Unlikely	3. Indifferent	4. Likely	5. Very Likely	Don't Know
a). Make a one-off full payment within the period specified by the court						
b). Pay the full compensation in instalments within the specified by the court.						
c). Pay part of the compensation within the specified period due to budgetary constraints.						

D4. How likely or unlikely are you to do each of the following if a group of aggrieved farmers blockage your attempts to convey your logs because you have not paid them the full compensation due them?

Actions	1. Very Unlikely	2. Unlikely	3. Indifferent	4. Likely	5. Very Likely	Don't Know
a). Pay part of the compensation and seek the support of opinion leaders to persuade farmers to accept later payment						
b). Seek the support of opinion leaders to persuade farmers for full payment after conveying the logs						
c). Pay the full compensation before conveying the logs.						

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