INTEGRATED FARM MANAGEMENT FOR SMALL HOLDINGS IN LOMBOK (INDONESIA)

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DECLARATION

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma in any university. To the best of my knowledge and belief, no material described herein has been previously published or written by another person except when due reference is made in the text.

Abdoerrahman

SYNOPSIS

The main problems of small farmers in Lombok Island particularly, are the small size of farm, lack of capital and low capabilities of managerial skill. These problems cause low outputs and incomes. Serious efforts are being made to overcome them. The Indonesian Government has paid a lot of attention to small farmers in an effort to increase their income through increasing food production, and to overcome their inertia in order that they are also able to play a role in the ongoing programme of agricultural development.

The problems of these farmers are the precarious marginality of their enterprise, with average incomes so low as to lift them only slightly above subsistence levels.

As expected from the small size of their holdings, these farmers concentrate on the production of staple food crops, especially rice, but also corn and/or peanuts and soybean, with little variation. The alternative typical crop rotations usually practised by the farmers of this region in a year, are: Rice-Rice-Corn, Rice-Rice-Mixed Crops, Rice-Rice-Peanut, and Rice-Rice-Soybean. The type of crop rotation as Rice-Rice-Soybean was practised more widely than the others. At the same time , small farmers possess some livestock, particularly cattle or buffaloes as draft animals for soil cultivation activities. Farmers cultivate the soil as well as possible, constrained by capital availability.

The performances of poorer farmers are hindered by a lack of capital to purchase the optimal quantities of inputs. The remedies would appear to lie in further extension of credit to poor farmer or in other measures to make the distribution of income more even.

In the effort to increase the small farmers' output, it is also necessary to look for appropriate technologies which are affordable by the farmers.

The integration between livestock production and food crop production, will prove more beneficial when the farmers, as decision makers, have abilities not only in technical areas, but also in managerial ones , because integrated farming systems have a more complex management process.

In the sampled villages farming involves mainly loosely integrated mixed farming systems where most farmers engage in the production of food crops, cattle, and/or catch fish from the ponds. Integration of livestock into food crop production occurs not only when livestock are used as draft animals for soil cultivation, but also as livestock producing manure which is used as fertilizer for food crops (organic fertilizer). To increase the farmers' output, the quality

of farming practices must be considered. For this purpose a survey was done to collect data from farmer respondents, incorporating the results from interviews and questionnaires used.
The aim of the survey was to find out whether a number of farming practices can be improved.

The survey for this study was conducted in 1991 in six sampled villages of three regencies in Lombok island (West, Central and East Lombok), but only two villages of West Lombok were analysed for detailed consideration because of limitations of time. The sample used comprised 121 respondents, consisting of 58 farmers who had livestock and 63 farmers who did not.

In this survey data was collected not only on number and age of farmers, their educational levels and other personal data (relationships, etc.), but also on farming practices, i.e.: details of cropping pattern, livestock, inputs (amounts and values), outputs and gross margins of farming.

Furthermore, from the results of the survey we looked at farmers who have livestock compared to farmers who do not in terms of their inputs, outputs, gross margins, crop rotations, use of inorganic fertilizer and manure (organic fertilizer). and also the educational levels of the farmers.

In this study seven farm models were used based on crop rotation: (1) Rice-Rice-Corn, (2) Rice-Rice-Mixed Crops (With Livestock), (3) Rice-Rice-Mixed Crops (Without Livestock), (4) Rice-Rice-Peanut (With Livestock), (5) Rice-Rice-Peanut (Without Livestock), (6) Rice-Rice-Soybean (With Livestock), and (7) Rice - Rice - Soybean (Without Livestock).

Basically, farmers use inorganic fertilizer for their food crops, such as Urea, Triple Super Phosphate and Potassium Chloride, while manure (waste of livestock) is occasionally used for fertilizer of secondary crops (corn, peanut, soybean, sweet potatoes, and cassava).

The quality of these farming practices might be affected not only by the availability of capital, but also the levels of education of farmers themselves. In the sampled villages, most farmers (48.8 percent) attended primary school, while 36.4 percent did not have a formal education.

From the results of data analysis, it can be concluded that farmers with livestock have a statistically-significant higher gross margin than those without livestock. The reason for this appears to be that those with livestock are generally richer farmers, who are not faced with the same constraints of capital. Consequently they apply higher levels of inputs than those without livestock, and this is what appears to give rise to the higher gross margins.

In the year referred to in the survey (1990), some farm-models (rotation patterns) were better than others. The results showed that a farm model with rotation pattern Rice-Rice-Peanut had a significantly higher output and gross margin than other rotations patterns. This is partly because in 1990 the price of peanuts was higher than could have been expected from past prices. When the expected 1990 price of peanuts was used instead of the actual 1990 price, the expected gross margin was still higher than that of corn and soybean.

All farmers apply recommended levels of inorganic fertilizer for the rice crops, according to government policy, while for secondary crops farmers used less than the recommendation. However, manure was not used by the farmers as a fertilizer for rice, and only in small amounts for secondary crops. The analysis in that part of the thesis attempts to explain why farmers use so little manure, and derives a value for manure. The value of manure per Tonne implied by its nutrient content is approximately Rp.9,300, or Rp.9.3 per kilogram. An alternative measure based on its value in enhancing soybean yield gives Rp.5.3 per kilogram. Another result is that the use of manure was not related to distance from manure production site to the nearest field of farmers. A cost-benefit analysis of manure usage is undertaken, and shows that the cost of gathering, storing and spreading manure is worthwhile, and is likely to add 0.7 to 2.7 percent to gross margins.

Farmers' formal education levels were not significantly related to gross margin. By this, it can be understood that educational level is a factor which influences the output and/or gross margin only indirectly. It appears that improving the techniques or managerial skills of adult farmers can be achieved by informal education through agricultural extension activities.

The conclusions of the thesis relate to three areas of farming practice.

First, it appears that the performances of poorer farmers are hindered by a lack of capital to purchase the optimal quantities of inputs. The remedies would appear to lie in further extension of credit to poor farmers, or in other measures to make the distribution of income more even.

Second, at current relative prices, farmers should be encouraged to grow more peanuts relative to soybeans. However, care needs to be taken in this area, because if all farmers in Indonesia undertook such advice in the same year, it would almost certainly result in the collapse of peanut prices and a large increase in soybean prices. For that reason, and to diversify farmer's crops (and hence reduce their exposure to risk) it is suggested that soybean farmers plant <u>some</u> peanuts as well. The result that significantly higher gross margins would accure to peanut farming rather than soybean production comes not only from the survey using the 1990 price and yield data, but was also sustained when <u>expected</u> 1990 price data was used. The 1990 peanut prices were higher than expected and resulted in gross margins for rice-rice peanuts being 26 % higher than for rice-rice-soybean. But even when actual gross margins were replaced by expected gross margins, based on the price expected in 1990 on the basis of 1985-1989 prices, the expected gross margin for rice-rice-peanuts was 16 to 18 percent higher than for rice-rice-soybean. Thus it is clear that even on this basis, farmers would be a lot better off with peanuts (or a peanut-soybean mix) rather than soybean alone.

In addition to the possibility of a change in emphasis on crop rotation choice, it should also be possible, as production of rice continues to outstrip population growth, to phase down the production of secondary starch crops such as sweet potatoes and cassava, and to use that acreage for protein crops (soybean and peanut).

Third, a case has been made for a large-scale extension effort, concentrating on encouraging the use of natural manures on secondary crops.

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ABBREVIATIONS USED IN THIS THESIS

IROUT_HA : Outputs of Irrigated Lowland (sawah) per Hectare, per Year
IRINP_HA : Total Inputs of Irrigated Lowland (Sawah) per Hectare, per Year
ICLAB_HA : The Amount of Labour used in Soil Cultivation of Irrigated Lowland (Sawah) per Hectare, per Year
ICLS_HA : The Number of Livestock (Cattle) used in Soil Cultivation of Irrigated Lowland (Sawah) per Hectare, per Year
IFERT_HA : The Amount of Inorganic Fertilizer used for Food Crops on Irrigated Lowland (Sawah) per Year, per Hectare
IWAST_HA : The Amount of Manure (Waste) used for Food Crops on Irrigated Lowland (Sawah) per Year, per Hectare
EDC1 : The Educational Level of Farmers
UPOUT_HA : Outputs of Upland (Lahan Kering) per Hectare, per Year
UPINP_HA : Total Inputs of Upland (Lahan Kering) per Hectare, per Year
UCLAB_HA : The Amount of Labour Used in Soil Cultivation of Upland (Lahan Kering) per Hectare, per Year
UCLS_HA : The Number of Livestock (Cattle) Used in Soil Cultiovation of Upland (Lahan Kering), per Hectare,per Year
UFERT_HA : The Amount of Inorganic Fertilizers Used for Food Crops on Upland (Lahan Kering), per Hectare, per Year
UWAST_HA : The Amount of Waste (Manure) Used for Food Crops on Upland (Lahan Kering), per Hectare, per Year
SCLABHA : The Amount of Labour Used in Soil Cultivation per Hectare, per Year
COSCLBHA : Costs of Soil Cultivation Using Labour per Hectare, per Year
SCLSHA : The Number of Livestock (Cattle) Used in Soil Cultivation per Hectare, per Year
COSCLSHA : Costs of Soil Cultivation Using Livestock (Cattle) per Hectare, per Year
SEEDHA : The Value of Seeds per Hectare,, per Year
PLANLBHA : The Amount of Labour in Planting per Hectare, per Year
COPLANHA : Costs of Planting per Hectare, per Year
FERTHA : The Value of Inorganic Fertilizers per Hectare, per Year
WASTEHA : THe Value of Manure per Hectare, per Year
FERTLBHA : The Amount of Labour in Fertilizing per Hectare, per Year
COFERTHA : Costs of Fertilizing per Hectare, per Year

WEEDLBHA	:	The Amount of Labour in Weeding per Hectare, per Year
COWEEDHA	:	Costs of Weeding per Hectare, per Year
PESTICHA	:	The Value of Pesticides per Hectare, per Year
SPRALBHA	:	The Amount of Labour Used in Spraying per Hectare, per Year
COSPRAHA	:	Costs of Spraying per Hectare, perr Year
COHARVHA	:	Costs of Harvesting per Hectare,per Year
IRRINPHA	:	Total Inputs in Irrigated Lowland (Sawah) per Hectare, per Year
IROUTHA	:	Output of Irrigated Lowland (Sawah) per Hectare, per Year
GROSSMHA	:	Total Gross Margin per Hectare per Year
COSCLTOT	:	Total Costs of Soil Cultivation per Hectare, per Year
EFFICNCY	:	Efficiency

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

After decades of modern agricultural research, the small farmer in most developing countries is still poor, and is still operating with largely traditional technology at little above subsistence level (Bay et al 1985).

The problems which are faced by the small farmer have been regarded as important not only by the countries themselves but also by international agencies such as the United Nations Food and Agricultural Organization (FAO). The reason is that small farmers number more than half of all the farmers in the world, and for that reason alone they are very significant to world food crop production policy. Wharton (1969) suggests that 60 percent of all farmers in the world are small farmers and that they account for approximately 40 percent of all agricultural outputs.

According to Dillon et al (1980), in Indonesia as a whole, about 70 percent of all farms are less than one hectare in size and these constitute 27 percent of the total farmed area.

Furthermore, according to the Indonesian Department of

Agriculture West Nusa Tenggara Province (1989), 71.24 percent of all farm families in Lombok, which is the subject of this study, hold less than one hectare.

Farm production contributes importantly to regional income. In 1988 approximately 51.77 percent of the Regional Domestic Product (RDP) in West Nusa Tenggara was from the agricultural sector, consisting of food crop production 34.31 percent, livestock production 7.54 percent, fisheries 5.3 percent, plantation 3.74 percent and forestry 0.86 percent (Zaelani et al 1990).

Food crop production is a dominant enterprise on either irrigated lowland or upland areas. Therefore, the Government has an interest from the national food stability view in increasing food crop productivity. In food crop production particularly, the farmers utilize crop rotations such as: rice - rice - secondary food crop; rice - rice - cash crop; rice - secondary food crop - secondary food crop, and other crop rotations depending on the condition of the region.

West Nusa Tenggara farming involves mainly loosely integrated mixed farming systems where most farmers engage in the production of food crops, cattle, and/or catch fish from the ponds.
Even though this is implemented by the use of simple methods such as independent collection of crops and animals, livestock production especially is still an enterprise which can have an important role for crop production.

At the same time as producing crops, more than half West Nusa Tenggara farmers possess some livestock such as cattle and buffaloes.

Zaelani et al (1990) show that the population of livestock in West Nusa Tenggara has been increasing significantly in recent years (Table 1.1).

Table 1.1

The Number of Livestock in West Nusa Tenggara

LIVESTOCK	1984	1985	1986	1987	1988	INCREASE (% per year)
CATTLE	188379	196523	205467	210003	224342	4.48
BUFFALOS	138326	147437	152291	149385	153753	2.31
TOTAL	326705	343960	356758	359388	378095	3.74

Source: The Livestock Office, West Nusa Tenggara Province, Indonesia (1989).

Farmers consciously diversify the use of their resources to provide food for consumption and some of them to increase their income.

Carangal et al (1986) argued that there is interaction of the various activities not only within the cropping and animal components but also between them and other enterprises or activities in the farm. Certainly, farming systems are very complex especially in areas where the environment is favourable for producing more crops and animals. Hence, farming systems need to consider not only cereal production but also animal production. Better integration in this case would involve the improved combination of food crop in one system with livestock in the other system to become one bigger system (Figure 1.1), each system utilizing the waste products of the other.

Figure 1.1

Integrated Farming Systems

```
                    (1st  system)

   +-----------------> CROP--------------------+
   !                 PRODUCTION                !
   !                                           !
   !                                           !
fertilizer                                    feed
 (manure)                                   (waste)
   !                                           !
   !                                           !
   !                                           !
   +----------------LIVESTOCK <----------------+
                    PRODUCTION

                   (2nd  system)
```

The utilization of waste resources as factors of production would then help small farmers (especially) who have inadequate capital for their farming. Cost savings are likely to be small but of significance for small farmers in the effort to improve their income.

There are some factors which can change the output of farming. The relationships between these factors and outputs will be examined in the other chapters, to show which factors have significantly influenced output.

The strategies of Indonesian integrated agricultural development, known as 'Trimatra Pembangunan Pertanian' consists of three components (Department of Agriculture , 1986), are:

(1) Integrated Farm; an approach which aims to make optimum use of the factors of production by integrating farm and non-farm activities, with the objective of improving farmers' welfare.

(2) Integrated Commodity; an approach which aims to stimulate a balanced and harmonious vertical linkage (production, processing, and marketing) of a commodity as well as balanced development among various commodities.

(3) Integrated Area; an approach which aims to integrate agricultural development at regional or local level (provinces, regencies, districts, and villages).

1.2 Aims of the Study

In order to study the region, a comprehensive survey was conducted in 1991 of farming practices in six villages in Lombok.

According to the success of the agricultural development strategy, the result of this survey should contribute to making decisions as to what kind of enterprises should be integrated, and also what type of crop rotation will be recommended in the integrated farming systems development, in an effort to increase the farmer's income, particularly in Lombok.

In more detail, the aims of the study, are:

1. To provide a basis for recommending improvements to Indonesian farm management, particularly on Lombok.

2. To identify and discuss the general resources which are available to Lombok farmers and the general social and economic context in which the farmers must operate.

3. To identify the factors affecting the increase of small holdings' output in Lombok in relation to integrated farming systems.

4. To examine the effect of selected explanatory variables on influencing the increased output of small holdings.

5. To contribute the results of this research for use by agricultural extension workers in West Nusa Tenggara. This would give practical value to the thesis.

1.3 Outline of Study

1.3.1 Source of the Data

This study used two kinds of data. They are:

1. Primary data, which are the survey data (mentioned in section 1.2) from farmer respondents , incorporating the results from interviews and questionnaires used.

2. Secondary data, which are the data found from other sources such as the Agricultural Department West Nusa Tenggara Province, The Livestock Office of the Province, The Agricultural Office Regencies in Lombok and Rural Extension Centre, and references in textbooks, journals of agriculture, magazines , and others.

1.3.2 Study Area

The field study was conducted in the three regions of Lombok: West Lombok, Central Lombok, and East Lombok, West Nusa Tenggara Province, Indonesia, in 1991.
Those regions involve three districts, six villages (two per district), and 329 respondents who were randomly selected. However, due to time constraints, in the analysis only the data from West Lombok regency involving 121 respondents were used.

1.3.3 Sampling Methods

In this study, multistage sampling was used to represent the various districts and villages of the regions. Samples were drawn of districts within the region, then of villages in the sampled districts, then finally of the farmers in the sampled villages.

1.3.4 Method of Analysis

a. Variables used in the Analysis

The variables which are used in this study can be divided into four groups. They are :

(1). **Characteristics of the farmer respondent**, consisting of:

1. sex, 2. place and date of birth, 3. status, 4. the number of children, 5. number of family members, 6. education of the farmer, 7. occupation, 8. income per year.

(2). **Enterprises**, consisting of: 9. farm size, 10. kind of area, 11. variety of crops, 12. crop rotation pattern, 13. the number of livestock, 14. the benefits of livestock.

(3). **Inputs**, consisting of: 15. the amount of labour used in soil cultivation per year, 16. the number of livestock used in soil cultivation per year, 17. the kind and the amount of each fertilizer used per year.

(4). Economic variables, consisting of: 18. the cost of inputs per year, 19. the outputs per year, 20. gross margin per year.

A copy of the questionnaire is found in Appendix A.

The production of crops depends on the employment of various resources, which are called inputs or factors of production (Rae 1977).

According to Buckett (1981), output is a general term used to express the value of production of an enterprise or of a whole farm. Based on this definition, output as dependent variable in this study is the aggregate value of production of the whole farm in Rupiah per year.

Furthermore, Rae (1977) argued that the general specification of the relationship between output and inputs may be written as follows:

$$Y = f(X1, X2, \ldots\ldots\ldots\ldots Xn)$$

where: Xi, i = 1, 2, ...n, refers to a specific factor of production, and
Y denotes output.

In the other words, crop yield Y is a function, or depends on the levels, of the various input factors Xi.

Soekartawi (1987) defined a production function as the technical (physical) relationship between resource inputs and the product output.

$$Y = f(X)$$

where: Y = production, as dependent variable,
X = a vector of factors of production, as independent variables.

A list of such factors in this study would involve farm size, cost of soil cultivation, cost of fertilizers, educational level of the farmers. and others.

Farm size, which is measured per hectare, consists of irrigated lowland and upland areas, which are managed by each farmer respondent.

Cost of soil cultivation is the cost of human labour and livestock used to cultivate soil, in Rupiah per year.

Fertilizers can be divided into inorganic fertilizers such as Urea, Triple Super Phosphate (TSP), Potassium Chloride (KCl), and organic fertilizers such as legumes and the waste of livestock.

The total cost of fertilizers is the aggregate amount spent on inorganic fertilizers, in Rupiah per year. Organic fertilizer is livestock waste or manure which is used as a fertilizer in farming, in kilograms per year. Organic fertilizer has a zero price in the study area.

Educational level refers to the number of years of education of each farmer respondent.

b. Technique of Analysis

Several techniques are used in the analysis. One of

the main techniques in attempting to determine the relationship between independent and dependent variables will be explained by using an analysis in three steps.
The first step is a 'correlation matrix' analysis which shows the extent of collinearity of each variable.
The second step is a 'simple regression' which shows the influence of each independent variable on a dependent variable. The last step is 'multiple regression' analysis which shows the influence of independent variables (explanatory variables) on the dependent variable.
Analysis of variance has also been used extensively in the thesis.

1.4. Outline of Thesis

In this thesis, based on the references and/or the empirical studies, the definition of integrated farm management and small holdings, and the relationship between one and the other will be explained in Chapter Two.

The hypotheses to explain factors (independent variables) influencing the small holding's output (dependent variable) will be discussed in Chapter Three. In Chapter Four the methodology consisting of the number of respondents, and sampling methods which are used in this study, will be explained. The result of the survey will be discussed in Chapter Five. Chapter Six will discuss the expected prices of secondary crops. Testing of hypotheses about factors influencing the small holdings' output will be discussed in Chapter Seven, and in Chapter Eight manuring will be discussed. In the last chapter (Chapter Nine) the implications and conclusion of this study will be outlined.

CHAPTER TWO

THEORETICAL AND EMPIRICAL STUDIES OF FARM MANAGEMENT FOR SMALL HOLDINGS

2.1 Definition of Integrated Farm Management

There are many definitions of farm management. Several common points run through all of them. One of the more concise definitions by Castle et al (1972) is that farm management is concerned with decision making which affects the profitability of the farm business. This definition contains some important points: it identifies that decision making is part of the management process, and that profitability is an objective of the business. Dillon et al (1980) explained farm management from the farmer's view: farm management consists essentially of choosing between alternative uses of his scarce resources of land, labour, capital, time and management to best achieve his goals. Hence, farm management is a process whereby limited factors or resources are manipulated by the farmer (the farm manager) to achieve his goals.

Upton (1979) explained that in this process of production, farmers need a supply of productive resources (factors of production) such as land, seeds, breeding stock, human skill and effort, tools and machines. Another definition (Kay, 1986) is that farm management is the decision making process whereby limited resources are allocated to a number of alternatives to organize and operate the business in such a way as to attain some objectives.

In the farm business each farmer has objectives, and management is concerned with ensuring that these objectives are attained. Therefore, every farmer has to consider the organization of his resources into a suitable plan.

Two major tasks facing today's farmer in pursuing his and his family's goals (Makeham et al, 1986) are:

1. How best to incorporate new technology into the farming enterprise.

2. How to be sufficiently flexible, mentally and financially, to adjust the management of his resources to meet changing costs, prices and varying climatic conditions.

A strong institutional back-up is required to introduce a new technology up to a stage where it can be picked up by farmers.

The technology to be introduced has to be economically viable, socially acceptable, properly field tested, and fit well in the existing production system of the farmers.

In integrated farming systems the process of management will become more complex because in this system the business consists of two or more enterprises, and every enterprise must be integrated with the other. The farmer has to consider not only food production but also the crop residue output and other forage crops for animal feeds (Carangal et al, 1986). In other words, the farmer has to find the most efficient way of manipulating limited resources for better integration between one enterprise and the other.

Ruthernberg (1980) explained that livestock activities are related to each other and to crop production. The relationship with crops may be competitive with regard to labour and capital, but complementary through the use of manure, the utilization of crop residues, the reduction in risk and others.

A poultry enterprise, on the other hand, relying on purchased feeds, hired labourers, and the sale of manure, is unlikely to be closely related to crop activities on the same farm.

Ranjhan et al (1987) argued that the integration of livestock raising with crop production is inevitably very efficient. In turn, the animal provides the farm power requirements in the production of the crops.

2.2 Definition of Small Holding

Basically, the definition of small holding or small farmer are similar in any developing country. However, several differences exist between the characteristics of the small farmer in every country such as farm holding area, income level, capital, and educational level of the farmer. These factors can influence the farm management processes.

According to the Indonesian Agricultural Department (1986) the average farm size of Indonesian small farmers is 0.3 hectare of irrigated lowland and 0.8 hectare of upland. In most countries, the small farmer is large and sometimes quite large, compared to the Indonesian small farmer. Small farmers in Pakistan and Thailand for example are on average approximately one and two hectares larger than in Indonesia. In (West) Pakistan (Duckham et al, 1970) farm size for small farms varies from 0.36 to 1.50 hectares. In Thailand the size of farms varies from 0.75 to 4.0 hectares (Andreae, 1981).

In contrast to this, in Rio Grande do Sul, Southern Brazil, the average farm size for the small farmer varies between 1 to 50 hectares, and a majority of these farms are 10 to 25 hectares in size (Norman,1977).

Ismail (1984) said that Indonesian small farmers had a low income which is below the poverty limit and is approximately equal to 320 kilograms of rice per capita per year. This means the small farmers' income is less than Rp.500.00 per capita per day.

Rogers (1969) concluded that the most significant characteristic of small farmers from an economic point of view is:

' In general, they have control ... over only a small area of land which is often naturally poor or depleted and often fragmented; they have an extremely low level of human capital in terms of education, knowledge and health with which to work; and they suffer chronic indebtedness and lack accessibility to institutional credit and inputs. Concomitantly, they face unstable markets and prices; they receive inadequate extension support; they have little share in the control and operation of rural institutions ...'

The effort and attention paid to increase small scale farmers' income has been carried out by researchers since the early twentieth century. In 1904, Levy wrote as follows: 'If small farms generally provide their occupiers with inadequate incomes, is this simply because they are small, or is it partly because they are not efficiently managed?'

This question relating to the problem of low income in the small farm has stimulated other researchers to pay attention to studying the relationship between farm size and efficiency in farming to increase the small farmers' income.

The reports on Scale of Enterprise in Farming (Zuckerman 1961) and by MAFF (Ministry of Agriculture, Fisheries and Food) in 1963 began to classify farm size by 'standard man days' as well as by acreage, to provide a basis for studying size and efficiency relationships; A.G.Ball et al (1972) concluded that large farms on average are currently more efficient than small farms. In a study of 133 farms in various parts of Britain by the Economic Development Committee for Agriculture in 1973 it was found that productivity increased with the size of farms.

Gee-Clough (1985) reported on how to improve the technology of the small farmer and carried out agricultural research to help the small-scale farmer in developing countries.

In 1973, The Economic Development Committee for Agriculture concluded that large size allows greater flexibility in the combination of resources and hence greater efficiency in their use. Britton et al (1975) explained that the potential significance of size and efficiency relationships and the likelihood that limitations of size are one of reasons for the small farmers' lower efficiency. In addition, the managerial ability of the present occupiers of small farms is significantly lower than that of the present occupiers of larger farms.

2.3 The Problems of Small Holding in Improving Output

Many problems are faced by the small farmer in improving output. These problems have a very close relation to characteristics such as small farm size, lack of capital, less managerial ability, and others.

Small farm size is associated with under utilization of food resources.

The products are inadequate to finance basic family living and this problem is generally related to inadequate capital supplied by the small farmer.

In aiming to achieve improved productivity either through crop production or mixed farming, small farmers are facing the problems of understanding and applying new technology and managerial skill besides factors such as production, marketing, and credit. Mosher (1966) argued that for agricultural development to proceed these factors must be constantly changing. This means the farmer's knowledge or education must be always improving not only in agricultural technology practice, but also in farm management and agricultural economics.

2.4 The Roles of Integrated Farm Management in Increasing the Small Holding's Output

Management describes the function of taking decisions about how land, labour and capital resources should be used and carrying out the decisions in the farm. All production implies the taking of some risk, since decisions are made and inputs committed on the basis of expected yields and prices (Upton 1979).

The success of management is very much determined by the quality of judgement in relation to the decisions that have to be taken. It is this factor which separates the good farmer from the bad if they are working under similar conditions (Buckett, 1981).

Small farmers are both workers and managers (Mosher 1966). They are faced with the problems of organizing the labour of themselves and their families in conjunction with other inputs.

The relationship between integrated farm management and small holdings might, through more efficient use of resources, benefit both the individual small farmer and the community as a whole (Britton et al, 1975). This could result from better management of existing farms or from the better allocation of resources between farms of different size-structure.

The meaning of efficient in integrated farm managements is the utilization of resources which are available, including integration of one enterprise into another to achieve high outputs, based on better decision making in planning. Next, the plan has to be put into operation.

Integrated farm management involves managing the integration not only between food crop and livestock, and/or fisheries, but also between the kind of crop and others such as mixed cropping, multiple cropping, and crop rotation.

The purpose of these systems is to maximize the utilization of natural resources such as land,water, waste of crops and /or livestock in an effort to improve the farmer's output, especially small farmers who have, as constraints, land and adequate capital for their farming. Straw of cereal crops can be used as feed for livestock, and also as soil-cover (mulch).

Crop rotation will be discussed in more detail in Chapter Three. Multiple cropping and mixed cropping systems will help farmers increase their income, and also in diversifying their produces, and reducing the risk of harvest failure.

The multiple cropping and mixed cropping systems usually use two or more food crops on one farm. Choosing the varieties used in these systems must be considered in relation to pests and diseases which are always likely to attack them.

CHAPTER THREE

HYPOTHESES TO EXPLAIN FACTORS INFLUENCING THE SMALL HOLDING'S OUTPUT

The relationship between some factors of production and the small-holder's output can be put in the form of hypotheses.

3.1 Cost of Soil Cultivation

The sequence of operations involved is familiar to every farmer, in that the soil is disturbed to produce a good growing medium, seeds or plants are set, and subsequently harvested. Haines (1985) argued that the cultivation of the soil is generally necessary to ensure that the seed or plant roots are in intimate contact with the soil in order to obtain moisture and nutrients.

Compared with human labour, using livestock in soil cultivation activities can be advantageous as livestock is stronger, faster and gives better cultivated soil results (Soewardi et al 1985; Simanjuntak 1986; Ditjennak 1986). The ability of one head of livestock in soil cultivation is approximately equivalent to the ability of four humans. Livestock (cattle) are able to cultivate land for five hours, whereas buffaloes can cultivate for four hours per day (Ditjen Peternakan 1985). Soil cultivation on upland takes longer than on irrigated lowland, as is shown in Table 3.1.

Table 3.1

The Ability of Livestock to Cultivate Land (Irrigated Lowland and Upland) in days, per Hectare

LIVESTOCK	DAYS TO COMPLETE CULTIVATION	
	IRRIGATED LOWLAND	UPLAND
CATTLE (pair)	4	6
BUFFALOES (pair)	6.5	10

Source : Ditjennak (1985).
Note : Pair = 2 heads.
One work-day = 5 hours (6.00 - 11.00).

Based on Table 3.1 above, it is clear that (1) cultivating upland takes longer than irrigated lowland, and (2) the cattle are stronger than buffalo, because cattle can cultivate faster than buffaloes.

According to these reports, using livestock will then reduce the cost of soil cultivation and thus reduce the total cost of inputs. Better cultivated soil will improve the condition of the soil and the productivity .

3.2 Fertilizer

The use of fertilizer in farming can increase productivity. Plants absorb nutrients both from inorganic and organic compounds which are available in the soil.

There are two kinds of fertilizer, namely:

(1) Inorganic fertilizers such as Urea, Triple Super Phosphate (TSP), Potassium Chloride (KCl), Ammonium Sulphate $(NH4)_2$ SO4, and

(2) Organic fertilizers such as legumes, humus, manure (waste of livestock).

The advantages of fertilizers are:

(1) Inorganic fertilizer

a. improves the plant nutrients in the soil.

b. rapidly becomes available for plant's growth.

c. the use of inorganic fertilizer per hectare, measured by weight, is less than that of organic fertilizer.

(2) Organic fertilizer

a. improves the plant nutrients in the soil.

b. improves soil structure

c. with the use organic fertilizer, microorganisms in the soil will become more active in the chemical process.

The choice of fertilizer to use depends on factors such as the variety of plants, soil condition, and knowledge level of the farmer. Farmers, especially small farmers, usually consider which fertilizer changes the plants faster (eg. the colour of leaves).

Most Indonesian small farmers use inorganic fertilizer, especially Urea, for their crops. The effect of Urea can be very rapidly seen by the changes of leaves' colour.

The amount of fertilizer which is used depends on the farmer's income. Most small farmers use less than the optimum fertilizer rate because they have inadequate working capital.

Generally, the dosage of each kind of fertilizer especially for food crops is recommended by government (Agricultural Department) as is shown in Table 3.2.

The dosages may be changed, depending on the result of experiments which are conducted in every region.

The annual production of waste (manure) is approximately 6,600 kilograms per head of cattle, and 7,300 kilograms per buffalo. Each tonne contains 6 kilograms of nitrogen, 11.5 kilograms of phosphorus, and 4.5 kilograms of potassium (Dinas Peternakan Propinsi NTB, 1989).

Table 3.2

Recommendation for Food-Crop Fertilizer
in West Nusa Tenggara

CROPS / VARIETY	THE AMOUNT OF FERTILIZER (Kilograms / Ha)		
	UREA	TSP	KCL
RICE	300	100	50
SOYBEAN (ORBA)	50	200	50
SOYBEAN (LOCAL VARIETY)	25	100	50
CORN	200	75	50
PEANUT	50	75	50
MUNGBEAN	100	100	0
TOMATO	200	150	100
CABBAGE	150	50	50
ONION	300	100	50
CHILLI	250	100	50

Source: Food Crop Agricultural Office,
West Nusa Tenggara (1983).

One of the ways to overcome small farmer problems is to use legume or manures as fertilizer. This practice of using organic fertilizer, besides some advantages which are mentioned above, will reduce the other inputs and thus increase the gross margin.

3.3 Level of the Farmer's Education

Rogers (1969) concluded that one of the characteristics of the small farmer is little technical knowledge. As explained by Upton (1979), this condition may cause small farmers to make their decisions as managers by following tradition, so that they are still growing the same crops in the same quantities and by the same methods. In other words, they have less managerial skill which is caused by their low level of education.

The improvement of small farmers' knowledge especially in managerial skill, will cause the farmers to consider not only what to produce, but also how much to produce, what production methods to use, how to find markets for the products, and how to identify the products whose prices are high.

3.4 Crop Rotation

Another way to improve farming systems is crop rotation. Crop rotation is the practice of growing two or three kinds of crops in rotation which, with good management, provides many benefits, all contributing to reduced costs, increased crop yield and higher net returns (Mills, 1990).

Crop rotation or the pattern of crops grown depends on whether land or labour is the constraining factor (Kulp,1975).

Where land is a constraint, some farmers will be virtually without land. With the little land they have, they will attempt to guarantee the basic calories their families need, relying on outside labour opportunities for cash and proteins. Farmers with larger than average holdings will use hired labour and maximize their cash earning by growing only enough cereal and legumes for their families.

The usual rotation entails at least two or three crop varieties in a year. In some regions, in which water is a constraint, the farmers used two kinds of varieties, then in the dry season maintained fallow.

There are some variations on this pattern. Sometimes farmers with very little land concentrate on crops which are highly labour-intensive.

The minor crops are generally grown on small plots which do not vary much in proportion to the total land or labour available.

Farmers with more land or labour will grow a greater variety of minor crops in small plots to diversify their risks. A further variation is cultivation of an inferior food, a root crop such as cassava or sweet potatoes, less desirable as a source of calories, but more land-intensive than cereal.

The advantages of crop rotation are:

(1) To diversify the produce.

(2) To reduce risk of harvest failure.

(3) To maximize the utilizing of limited natural resources (such as land and water).

(4) To break the life-cycles of pest and/or disease.

(5) To increase the harvest frequencies in a year.

Milne, et al (1988) and Mills (1990), concluded that in crop rotation systems,legumes are well suited as opportunity crops because of their ability to fix more nitrogen in low nitrogen situations, which, in turn, will benefit subsequent crops.

Generally, the alternative typical crop rotations which are practised by farmers on Lombok are shown on diagrams as follow:

Figure 3.1

Diagram of Crop Rotations

On Irrigated Lowland:

```
           RICE                RICE                SFC
/-----------------/------------------/------------------/
Oct             Feb/Mar            June              Sept

           RICE                SFC                 RICE
/-----------------/------------------/------------------/
Oct             Feb/Mar          May/June            Sept
```

```
            RICE               SFC               SFC
/-----------------/------------------/-----------------/
Oct             Feb/Mar           May/June          Aug/Sep
```

Note: SFC = Another Food Crops (such as Soybean, Corn, Peanut, Sweet Potatoes,etc.).

On Non-Irrigated Upland:

```
            RICE              LEGUME              FALLOW
/------------------/-----------------/------------------/
Dec             April               July               Nov
```

```
            RICE               FALLOW             FALLOW
/------------------/-----------------/------------------/
Dec             April                                  Nov
```

```
   LEGUME or SFC              FALLOW           FALLOW
/------------------/-----------------/------------------/
Dec              Mar                                   Nov
```

```
      ROOT CROP                     FALLOW
/---------------------------/---------------------------/
Dec                     May/June                       Nov
```

Basically, some factors must be considered by the farmers in choosing which kind of crop rotation will be practised. They are:

(1) Technical factors:

a. The availability of natural resources such as land, and water.

b. Suitability of the soil for the chosen crop rotation.

(2) Economic factors:

a. The variety of crops having a good market and price (Douglas, 1987).

b. Capital availability.

In these crop rotations, most farmers plant rice as long as possible. The main purpose is to supply food for consumption for Indonesian people.

3.5 Importance of Rice as a Staple Food Crop

According to the Directorate General of Food Crops and Livestock, and Fisheries, Agricultural Department (1985) , food consumption per capita of some selected commodities such as rice, corn, cassava, sweet potato, soybean, peanut, meat, eggs, milk and fish, is shown in Table 3.3 below.

Table 3.3
Consumption of Selected Food Commodities
1984 and 1986, and the projection 1988
(Kilograms/Capita/Year)

COMMODITIES	1984	1986	1988
RICE	128.57	131.62	134.68
CORN	20.46	19.18	17.87
CASSAVA	72.49	66.37	60.28
SWEET POTATO	9.67	8.94	8.24
PEANUT (GROUND NUT)	3.72	4.12	4.52
SOYBEAN	6.73	7.17	7.71
MEAT	4.80	5.32	5.90
EGG	1.76	1.95	2.15
MILK	5.40	5.90	6.46
FISH	13.71	14.67	15.70

Source: Ditjen Tanaman Pangan, Ditjen Peternakan, dan Ditjen Perikanan (1986).

The annual national food consumption of the selected commodities is as follows:

Table 3.4

The Total Food Consumption of Selected Commodities 1984 and 1986 and projection 1988 (in '000 tonnes)

COMMODITIES	1984	1986	1988
RICE	20,549	21,968	23,444
CORN	3,270	3,201	3,111
CASSAVA	11,586	11,078	10,493
SWEET POTATO	1,546	1,492	1,434
PEANUT (GROUND NUT)	595	688	787
SOYBEAN	1,076	1,197	1,342
MEAT	767	889	1,023
EGG	282	326	376
MILK	863	989	1,125
FISH	2,193	2,451	2,739

Source: Ditjen Tanaman Pangan, Ditjen Peternakan, dan Ditjen Perikanan (1986)

Tables 3.3 and 3.4 show that rice is by far the most important primary food crop in Indonesia. The consumption of rice is higher than other carbohydrate crops such as corn and cassava. In terms of tonnage, as much rice grown as the aggregate of all the other above-mentioned foods.

Indonesia by almost any measure can now be considered self sufficient in rice production. In that case, it is clear that policies to increase rice production must be linked to policies to decrease production of other carbohydrate crops. This in turn will free much of the upland (currently used for cassava and sweet potatoes) for the production of protein crops (soybean, peanuts). To some extent, market forces,through the price system, will ensure that this will happen, but it may take a couple of years of low rice and cassava prices, and therefore much hardship before the adjustment takes place this way. To the extent that this can be forecast, such hardship can be prevented by appropriate Government annauncement.

CHAPTER FOUR

METHODOLOGY

The method used in this study is a Sample Survey of farmers on Lombok island. This study has examined the relationships between some explanatory variables and farmers' output.

Furthermore, this study has formulated four hypotheses to explain factors influencing the output.

4.1 The Number of Respondents

There is no simple rule of thumb for determining the best or optimal sample size for any particular situation (Witte 1985). Faced with the possibility of erroneous generalizations, it might be preferred to bypass the uncertainties of inferential statistics by surveying an entire population. This is often done if the size of the population is fairly small. If the size of the population is large, however, complete surveys are expensive. Therefore a sample survey is used.

This study was conducted in three regions of Lombok. They are: (1) West Lombok, (2) Central Lombok, and (3) East Lombok. These regions involve one district for each region, and two villages for each district (Table 4.1).

Table 4.1

Districts and Villages Surveyed in each Region
(The Locations of Survey)

REGIONS	DISTRICTS	VILLAGES
WEST LOMBOK	Gunung Sari	1. Gunung Sari
		2. Penimbung
CENTRAL LOMBOK	Praya Barat	1. Darek
		2. Ranggagata
EAST LOMBOK	Aikmel	1. Karang Baru
		2. Mamben Lauq

The number of farmers including both owner-operators and tenants in the selected villages are as set out in the table below.

Table 4.2

The Number of Farmers and
Farm Areas in the Selected Villages

VILLAGES	NUMBER OF FARMERS *)	TOTAL AREAS IRR. LOW (Ha)	UPLAND (Ha)
WEST LOMBOK			
(1) Gunung Sari	214	92.150	125.000
(2) Penimbung	311	152.165	459.590
CENTRAL LOMBOK			
(3) Darek	1398	1007.000	35.000
(4) Ranggagata	507	455.000	66.000
EAST LOMBOK			
(5) Karang Baru	4443	797.000	555.000
(6) Mamben Lauq	871	482.600	56.385

*) Number of Farmer Families

Table 4.2 above shows that the number of farmer families in sampled villages in West Lombok was 525. Of these, 141 farmers or 26.86 percent have and manage both irrigated lowland (sawah) and upland (lahan kering), consisting of 73 farmers have livestock and 68 farmers who do not.

Over all six villages, there were 329 respondents, divided into two groups:

(1) The farmers who do not carry livestock, and

(2) The farmers who carry livestock.

The number of farmers who have and manage both irrigated and upland in the selected villages, are shown on Table 4.3.

Table 4.3

The Number of Farmers who have and manage both Irrigated lowland and Upland in the Selected Villages

REGIONS	DO NOT HAVE LIVESTOCK	HAVE LIVESTOCK	TOTAL
WEST LOMBOK	68	73	141
CENTRAL LOMBOK	25	64	89
EAST LOMBOK	68	89	157
TOTAL	161	226	387

For the sake of easier comparison, it was decided to sample only those farmers who farmed both irrigated lowland and non irrigated upland. Of the 387 such farmers in the population, 329 usable responses eventuated.

The comparison of average size between population and sampled farmers in each regency is shown on Table 4.4.

Table 4.4

Comparison of Average Size Between
Population and Sampled Farmers in Each Regency
(in Hectare)

REGENCIES	POPULATION AVERAGE			SAMPLE AVERAGE		
	Irr.Low	Upl.	Total	Irr.Low	Upl.	Total
WEST LOMBOK	0.46	1.11	1.57	0.43	0.60	1.03
CENTRAL LOMBOK	0.76	0.05	0.81	1.82	0.85	2.67
EAST LOMBOK	0.24	0.11	0.35	0.59	0.88	1.47

The data in Table 4.4 above shows that in West Lombok, sample average size of holding is similar to population average size, particularly for the more important variable, irrigated lowland. This means that use of the sample should not bias the results. However, in Central and East Lombok, where the sampled farmers had much more land than the average of the population, using these samples might bias the results. This was another reason why the West Lombok data are used in the analysis.

The number of respondents in each region and in total, are shown on Table 4.5.

Table 4.5

The Number of Respondents in each Region

REGIONS	DO NOT HAVE LIVESTOCK	HAVE LIVESTOCK	TOTAL
WEST LOMBOK	63	58	121
CENTRAL LOMBOK	25	64	89
EAST LOMBOK	61	58	119
TOTAL	149	180	329

4.2 Sampling Methods

Early in the planning of the field study, the sampling method was chosen to be employed in determining the locations and the farmer respondents.

In this study, multistage sampling was used to represent the various districts and villages of the regions. The samples were drawn of one district within each region, then of two villages in each sampled district. The determining of the district sampled was purposely based on the highest of the irrigated lowland areas. The sampled villages were purposively based on the upland areas, because not all villages have enough upland areas. Finally, the respondents were drawn of those 329 farmers who have and manage both irrigated lowland and upland in the sampled villages. This was done in order to eliminate the bias which is caused by farmer's abilities in managing irrigated lowland and uplands.

CHAPTER FIVE

THE RESULTS OF THE SURVEY

The results in this Chapter are based on primary data collected by using the questionnaire of Appendix 1, that is the results of the interview with each farmer respondent.

5.1 Sex and Age of Respondent

Most of the respondents were male. Only two out of 121 or 1.65 per cent of respondents were female (Table 5.1).

Table 5.1

The Number of Respondents by Age Group

AGE GROUP (YEARS)	FEMALE	MALE	TOTAL
20 - 25	0	1	1
>= 25 - 30	0	2	2
>= 30 - 35	0	11	11
>= 35 - 40	1	27	28
>= 40 - 45	1	18	19
>= 45 - 50	0	29	29
>= 50 - 55	0	13	13
>= 55 - 60	0	8	8
>= 60	0	10	10
TOTAL	2	119	121

Table 5.1 also shows that 103 farmers or 85.12 per cent of total respondents were 20 - 55 years old, whereas 18 farmers or 14.88 per cent were more than 55 years old.

5.2 Family Members

The average number of members in the family is approximately 5 persons (Table 5.2), which commonly consists of the farmer himself, his wife, some children, and / or their parents.

Table 5.2

The Farmer's Family
(excluding the farmer)

RELATIONSHIP OF MEMBERS	NUMBER OF MEMBERS	AVERAGE
Farmers	121	
No. of Wives	113	0.93
No. of Children	313	2.59
No. of Grand children	17	0.14
No. of Parents	4	0.03
No. of Brothers	7	0.06
No. of Son-in-law	3	0.02
TOTAL MEMBERS	457	3.78

Table 5.2 above shows that the average of family

members is 3.78 or the household size is 4.78.
The number of children is an average of 2.59, as shown in Table 5.3.

Table 5.3

The Number of Children

	THE NUMBERS	AVERAGE
BOYS	162	1.34
GIRLS	151	1.25
TOTAL	313	2.59

5.3 The Educational Level of Respondent

According to Table 5.4 and Figure 5.1, 44 farmers or 36.36 per cent do not have a formal education, and 59 farmers or 48.76 per cent attended some years of primary school or completed primary school. And only 18 farmers or 14.88 per cent continued to high school.
So, it is clear that most respondents have little education. Logically, this condition would influence the

farmers' managerial capabilities; in other words, they may be slow in understanding and accepting new technology for their farming.

Table 5.4

The Educational Level of Respondents

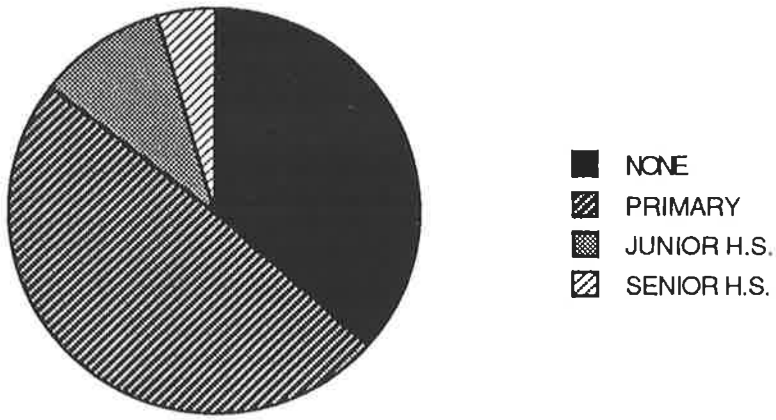
EDUCATIONAL LEVEL	THE NUMBER OF RESPONDENTS Respond.	Percents
NONE	44	36.36
PRIMARY	59	48.76
SECONDARY JUNIOR HIGH SCHOOL	12	9.92
SENIOR HIGH SCHOOL	6	4.96
TOTAL	121	100

5.4 The Activities of Respondents

The main activity of farmers is their own farming work, especially food crop production, and in some cases, livestock. Besides that, 111 farmers or 91.74 percent also

Figure 5.1

The Educational Level of Farmer's Respondents
(in %)



work in other activities depending on their capabilities, such as carpentry, merchanting, driving horsecarts, and as hired labour on other farms. Ten farmers or 8.26 percent do not have other jobs. This helps greatly to improve the income of the farmer's family. The income estimate from the other activities of a farmer (besides farming) is an average of Rp. 915,872 per year or approximately 29.26 per cent of the total income per year (Rp.3,130,262.10).

Table 5.5

Farm Incomes of Farmers of Various Sizes

INCOME CLASS (xRp1000)	NUMBER OF RESPONDENTS			
	Farm Income	%	Non Farm Income	%
< 1000	54	44.6	79	65.3
1000 - < 2000	51	42.1	24	19.8
2000 - < 3000	13	10.7	6	5.0
3000 - < 4000	3	2.6	2	1.6
TOTAL	121	100	111	91.7

If the farmer obtains more income from and also spends much more time on the other activities, it is possible that the farming will be shifted to a secondary business activity.

5.5 The Farm Holdings

Most farmers in these selected villages hold less than one hectare irrigated lowland (sawah). In Table 5.6 the farm holding size of irrigated lowland is shown.
This Table shows that 77 farmers or 63.64 per cent hold less than 0.5 hectare, while 111 farmers (91.74 per cent) hold less than one hectare irrigated lowland.

Table 5.6

The Farm Holding (Irrigated Lowland) of Respondents

FARM HOLDING/IRRIGATED LOWLAND (HA)	THE NUMBER OF RESPONDENTS		
< 0.250	33	77	111
>= 0.250 - < 0.500	44		
>= 0.500 - < 0.750	28		
>= 0.750 - < 1.000	6		
>= 1.000 - < 1.250	7		
>= 1.250 - < 1.500	2		
>= 1.500 - < 2.000	0		
>= 2.000	1		
TOTAL	121		

Table 5.7 shows that 61 farmers or 50.41 per cent hold less than 0.5 hectare, and 94 farmers (77.68 per cent) less than one hectare upland.

Table 5.7

The Farm Holding (Upland)
of Respondents

FARM HOLDING/UPLAND (HA)	THE NUMBER OF RESPONDENTS		
< 0.250	19	61	94
>= 0.250 - < 0.500	42		
>= 0.500 - < 0.750	25		
>= 0.750 - < 1.000	68		
>= 1.000 - < 1.500	18		
>= 1.500 - < 2.000	6		
>= 2.000 - < 4.000	2		
>= 4.000	1		
TOTAL	121		

Based on Tables 5.6 and 5.7 above, it is clear that more than half of all farmers hold less than half a hectare of irrigated lowland (sawah) and less than a hectare of upland (lahan kering).

The average of respondent's farm size or farm holdings is shown on Table 5.8 as follow:

Table 5.8

Average Farm Size
(Irrigated Lowland and Upland)

REGION	FARM SIZE (in Hectare)	
	IRR. LOWLAND	UPLAND
WEST LOMBOK	0.4343	0.6039
CENTRAL LOMBOK	1.8157	0.8483
EAST LOMBOK	0.5902	0.8765

5.6 Livestock Possession

Most farmers in Lombok possess livestock such as cattle and/or buffalo. The possession of livestock is determined mainly by the wealth of the farmer themselves.

The livestock population in three regencies is shown in Table 5.9 below.

Table 5.9

The Livestock Population in Lombok
(in 1988)

(HEADS)

REGENCIES	CATTLE	BUFFALOES
WEST LOMBOK	79,216	7,372
CENTRAL LOMBOK	82,699	27,937
EAST LOMBOK	88,297	11,767

The possession of cattle on average in the sampled areas is 2.12 head in West Lombok, 3.42 head in Central Lombok,and 2.64 head in East Lombok. The number of livestock possessed by respondents is shown on Table 5.10.

Table 5.10 below shows that of farmers who possess cattle, most possess 1 or 2 head of cattle: approximately 79 percent in West Lombok, 58 percent in Central Lombok, and 78 percent in East Lombok. Even though the number of respondents who possess 10 to 20 head of livestock is very small, it affects on the average calculation.

Table 5.10

The Number of Livestock Possessed

NUMBER OF LIVESTOCK (Head)	NUMBER OF RESPONDENTS		
	WEST LOMBOK	CENTRAL LOMBOK	EAST LOMBOK
1 - 2	46	37	45
3 - 4	7	14	8
5 - 6	1	9	3
7 - 8	-	1	-
9 - 10	-	2	1
11 - 15	1	-	-
16 - 20	-	1	1
TOTAL	58	64	58

The calculation without these farmers can change the average number of livestock which is possessed by respondent, to 1.82 head in West Lombok, 2.70 head in Central Lombok, and 2.19 head in East Lombok. So, overall, the average number of livestock (cattle), possessed by farmers who have cattle, and excluding the three largest holders, is two head.

The farmers manage their cattle in stables, and approximately half a day per week some farmers take out their cattle for feed on the field. In dry regions where water is very limited (South Lombok), farmers graze their livestock alongside the road or on the sports field.

Based on the results of the survey, the kinds of feed which are given by farmers (respondents) on average is approximately 5 kilograms of straw, 30 kilograms of grass and legumes 5 kilograms per head, per day. In the dry season when there is little grass, more straw will be used for cattle feed. Otherwise, if there is lot of grass the farmer will give the cattle more grass than straw.

5.7 The Farm Model

Brown (1979) explained that a farm model is a simplified representation of a farm. It is used to typify the different kinds of farming situations that may be found in a project and serves two important functions: to facilitate analysis of the project's effect, and to prepare for the aggregation of the total costs and benefits.

In this case, the farm model is based on the kinds of crop rotation which are used by the farmers in the villages sampled.

Seven farm models (that is, seven different rotation patterns) were used by the farmers in the sample.

(1) Model 1, used: rice - rice - corn (NOLS).

(2) Model 2, used: rice - rice - mixed crops* (LS).

(3) Model 3, used: rice - rice - mixed crops* (NOLS).

(4) Model 4, used: rice - rice - peanut (LS).

(5) Model 5, used: rice - rice - peanut (NOLS).

(6) Model 6, used: rice - rice - soybean (LS).

(7) Model 7, used: rice - rice - soybean (NOLS).

----

*) Mixed Crops: Soybean, Peanuts and/or Corn.
LS : Carry Livestock.
NOLS : Do not carry Livestock.

The choice of crop, particularly the secondary food crop after rice, usually depends on the demand for, and the prices of, the particular crop.

The number of farmers for each farm model is shown in Table 5.11.

We note, from Model 6 and 7 in Table 5.11 below, that more farmers (50 farmers or 41 per cent) used crop rotation 'rice - rice - soybean'. Those who used crop rotation 'rice - rice - peanut' numbered 39 farmers or 32 per cent.

Table 5.11

The Number of Farmer Respondents for each Farm Model

FARM MODEL	THE NUMBER OF RESPONDENTS
MODEL 1 [r-r-c(nols)]	4
MODEL 2 [r-r-mc(ls)]	17
MODEL 3 [r-r-mc(nols)]	11
MODEL 4 [r-r-p(ls)]	22
MODEL 5 [r-r-p(nols)]	17
MODEL 6 [r-r-sb(ls)]	19
MODEL 7 [r-r-sb(nols)]	31
TOTAL	121

' Rice - rice - mixed crops ' numbered 28 farmers or 23 per cent; additionally there were only 4 farmers or 3 per cent who grew ' rice - rice - corn '. This is because corn had a low price in 1988 and even more so in 1989, as set out in Figure 6.1, so it is likely that there was a shift away from corn in 1990.

It has been widely thought that soybeans are currently the most profitable second crop in West Lombok. Soybean-cake is widely eaten, and is high in proteins. The results of this thesis (see chapters six and seven in particular) cast considerable doubt on this belief.

In 1990, the area of soybean in West Nusa Tenggara is 106,080 hectare, higher than peanut (18,930 hectare) and corn (24,012 hectare) (see Appendix 41).

5.8 Inputs into Crop Production

Some activities and components that have a dominant effect on total inputs are soil cultivation, seeds, inorganic fertilizers, planting, weeding and harvesting.

Table 5.12

The Cost of Inputs in Rupiah and
% of Total Inputs

ACTIVITIES/COMPONENTS	TOTAL COST (xRp.1000)	% OF TOTAL INPUTS
TOTAL INPUTS	1197.32	100.00
(1) SOIL CULTIVATION	247.15	20.64
(2) SEEDS	125.94	10.52
(3) FERTILIZERS (INORG)	177.39	14.82
(4) PLANTING	89.38	7.46
(5) WEEDING	158.57	13.24
(6) HARVESTING	292.67	24.44
OTHER COMPONENTS	106.22	8.87

Table 5.12 shows that the largest component of total costs was for harvesting the food crop. It was responsible for 24 per cent of total inputs. Soil cultivation was next with 21 per cent , then fertilizers (15 per cent), weeding (13 per cent), and seeds (11 per cent).

5.8.1 Harvesting Costs

Traditionally in this region, payment of harvesting is based on the '**bawon**' system, where each unit of labour, in lieu of cash, is paid ten per cent of the total production. Therefore, the cost of harvesting was closely related to the production or yield.

Table 5.13

The Cost of Harvesting for Each Farm Model per Hectare (x Rp.1000)

FARM MODEL	COST OF HARVESTING RICE	ANOTHER CROP	TOTAL	RATIO OF TOTAL TO OUTPUTS
MODEL 1	203.05	19.60	237.42	0.08
MODEL 2	275.16	62.32	335.85	0.09
MODEL 3	225.56	34.29	270.61	0.09
MODEL 4	316.08	35.84	291.73	0.08
MODEL 5	236.54	35.82	275.64	0.08
MODEL 6	248.06	50.94	315.36	0.09
MODEL 7	226.32	46.52	280.05	0.09

5.8.2 Soil Cultivation

Soil cultivation refers to the preparation of the seed bed. The condition of the soil influences the quality of plant's growth and thus determines the yield or productivity. Therefore, to obtain a high level of productivity the farmer must consider soil cultivation in the light of capital constraints.

A farmer who is richer is likely to be able to afford to spend more on cultivation of the seed bed. As farmers become richer, they also own more livestock. Therefore it appears that the reason that farmers who have livestock spend more on average on cultivation is a consequence of the fact that they are on average, richer farmers. There does not appear to be a direct causative link between the ownership of livestock and the payment of more on cultivation.

Table 5.14

The Number of Work-Days and the Cost of Labour and Livestock Used in Soil Cultivation for Each Farm Model per Hectare

	LABOUR		LIVESTOCK	
FARM MODEL	THE NO.OF WORK-DAYS (days)	COSTS (x Rp.1000)	THE NO.OF WORK-DAYS (days)	COSTS (xRp1000)
MODEL 1	59.09	120.50	35.23	96.21
MODEL 2	88.48	179.86	41.28	114.36
MODEL 3	56.12	115.49	35.83	97.75
MODEL 4	92.85	166.08	36.12	104.36
MODEL 5	71.87	141.42	37.50	108.52
MODEL 6	79.62	163.60	35.93	103.13
MODEL 7	60.52	114.57	32.17	92.66
AVERAGE		144.86		102.29

Table 5.14 above shows, that, on average, farmers spend more on labour in soil cultivation than on livestock.

The total costs of soil cultivation for each farm model is shown as follow:

Table 5.15

The Total Costs of Soil Cultivation for Each Farm Model per Hectare

FARM MODEL	THE TOTAL COSTS (X Rp.1000)	
MODEL 1	216.71	
MODEL 2	294.22)	262.40
MODEL 3	213.24)	
MODEL 4	270.44)	261.50
MODEL 5	249.94)	
MODEL 6	266.73)	229.84
MODEL 7	207.23)	

Table 5.15 shows that the farm using the crop rotation 'rice - rice - mixed crop' had the highest cost for soil cultivation (Rp.262.40 thousand), then 'rice - rice - peanut' is Rp.261.50 thousand.

Crop rotation ' rice - rice - soybean' has the total cost Rp.229.84 thousand, and the rotation 'rice - rice - corn' has total costs Rp.216.71 thousand.

5.8.3 Inorganic Fertilizers

Both inorganic and organic fertilizers and the quality of seeds are important factors in the effort to increase the productivity.

Table 5.16

The Amount and Value of Fertilizer Used for Rice Crop, per Hectare, per Year

FARM MODEL	AMOUNT OF FERTILIZER Urea (Kg)	TSP (Kg)	KCl (Kg)	TOTAL VALUE (xRp.1000)
MODEL 1	558.42	207.95	108.02	169.66
MODEL 2	600.86	190.67	100.73	178.48
MODEL 3	612.73	205.00	100.70	186.92
MODEL 4	591.12	196.97	94.51	180.01
MODEL 5	569.76	198.87	105.93	173.15
MODEL 6	619.65	206.62	105.04	176.94
MODEL 7	597.35	200.24	95.87	175.13
AVERAGE	592.84	200.90	100.40	177.18

These amounts are almost exactly the recommended quantities of fertilizer. The reasons for this are firstly that the farmers are supplied with these fertilizers by the Government at subsidised prices (although the subsidies are not large). Secondly, groups of about 50 to 100 farmers which have been organised by extension workers have each in recent years decided (as a group) to follow the Government recommendations with respect to the fertilization of rice crops. The policing of this policy is also carried out by the extension workers, who are required to produce monthly reports on the extent to which farmers are using the fertilizer in the recommended quantities. (The survey on which these figures are based was carried out by extension workers, and it is possible that some farmers told the interviewers what they wanted to hear.)

Table 5.16 shows that while the farmers used very close to the recommended quantities of fertilizer for their rice-crops , they did not use enough fertilizer for the other crops. The amount and value of fertilizer used for the other crops is shown in Table 5.17.

Table 5.17

The Amount and Value of Fertilizer Used for Secondary Food Crops (Other Crops after Rice Crop), per Hectare

FARM MODEL	AMOUNT OF FERTILIZER Urea (Kg)	TSP (Kg)	KCl (Kg)	VALUE (xRp.1000)
MODEL 1	62.50	12.50	0	14.19
MODEL 2	0	37.03	0	7.78
MODEL 3	22.73	35.91	0	11.75
MODEL 4	0	25.88	0	5.43
MODEL 5	0	29.08	0	6.11
MODEL 6	0	8.77	0	1.94
MODEL 7	0	14.72	0	3.09
AVERAGE	12.18	23.41	0	7.18

According to Government recommendations, the amount and value of inorganic fertilizers to be applied per hectare are as follows:

Table 5.18

The Amount and Value of Fertilizer Used for Each Crop per Hectare (Recomendation)

KINDS OF CROP	AMOUNT OF FERTILIZER (Kg)	VALUE (xRp.1000)
(1) RICE (FIRST CROP)	UREA : 300	54.0
	TSP : 100	21.0
	KCL : 50	10.5
	TOTAL (1)	85.5
(2) RICE (SEC. CROP)	TOTAL (2)	85.5
(3) SECONDARY FOOD CROP (SOYBEAN)	UREA : 25	4.5
	TSP : 100	21.0
	KCL : 50	10.5
	TOTAL (3)	36.0
TOTAL (1) + (2) + (3)		207.0

Comparing the data in Table 5.17 and Table 5.18, it is clear that most farmers did not use enough fertilizer (or less than recommendation) for their secondary crops. The amount of Urea which was used (on average) by farmers for the secondary food crop was 12.18 kilograms or 49 per cent of recommendation. The amount of TSP used was 23.41 kilograms or 23 per cent, and no KCl was used. The value of these is approximately Rp.7180.00 (20 percent) of the recommended value of fertilizer for secondary food crops. Overall, however, the value of fertilizer applied was 89 per cent of the total value per hectare per year recommended. The main reason for this shortfall is that most farmers have inadequate funds for their farming.

5.8.4 Organic Fertilizer

Organic fertilizer especially manure was also used by some farmers for their secondary food crops even though this was less than what is recommended.

Table 5.19 shows that farmers who have livestock (Model 2, Model 4, and Model 6), used more manure than farmers do not have livestock.

The data in Table 5.19 shows that Model 2, 4 and 6 (with livestock) used more manure for fertilizer than Model 1, 3, 5 and 7 (without livestock).

The total livestock waste production for the sampled farmers was estimated to be 123 head x 6,600 kgs = 811,800 kgs/year, while the total waste used was only 14,550 kgs/year. This means the amount of manure which was used in farming per year, was 1.8 percent (see Appendix 2).

Table 5.19

The Amount of Manure Used for the Secondary Food Crops (in Kgs/Ha/Year)

FARM MODEL	THE AMOUNT OF MANURE
MODEL 1	0
MODEL 2	682.24
MODEL 3	106.95
MODEL 4	590.74
MODEL 5	0
MODEL 6	707.60
MODEL 7	46.08
AVERAGE	335.90

Models 2,4,6 are with livestock;
1,3,5,7 without.

5.8.5. Seed Variety

Seed variety is also an important factor which determines the productivity of plants. The choice of better seed variety depends on the availability or stock of seeds, and also the availability of capital. It has often happened that farmers must grow their seed both for consumption and for production. Hence, farmers would obtain lower productivity because of the degeneracy of the seed. Besides that, some farmers still choose a variety of rice which is much better in taste, but lower productivity. Another weakness of this variety is that it has a longer period of growth, and less resistance to pests and diseases.

The amount of seeds per hectare also influences the output of farming. Using more seed than the recommended will increase inputs (wasting), and also will decrease the productivity which is caused by competition between each plant for soil-nutrient and sunlight. On the other hand, using too few seeds will reduce the plant population or will reduce the output of farming.

In irrigated lowland, farmers grow rice-seed on the seed-bed. Then, after three weeks, they transplant the small plants to the field. In this region, planting (transplanting) is practised by hand, and uses the 'row system'. This method uses more labour than the 'direct seeding' system. Weeding or weed control also has high cost. It is approximately Rp.159 per hectare per year or 13 per cent of total inputs. According to the Agricultural Research and Development for Indonesia (1980), weeds may reduce rice yields significantly because they compete for nutrients, sunlight and space. And also some weeds act as a vector for several pests and diseases.

In this region, weeding or weed control is implemented by hand, and/or used a typical tool, called 'kis-kis' (a knife with double-edged blade). This method needs a long time (many work-days) to finish it.

5.9. Efficiency and Profitability

The total inputs, outputs and gross margin for each farm model are shown in Table 5.20.

According to this data, the farms where the farmers have livestock and used crop rotation Model 4 (rice-rice-peanut) have the highest total cost, while the farms where the farmers have livestock and used crop rotation Model 2 (rice-rice-mix crops) have the highest output, and also the highest gross margin. Farm Model 7 (rice-rice-soybean and no livestock) has the lowest output and gross margin.

Table 5.20

Mean Value of Total Inputs, Outputs and Gross Margin for Each Farm Model (in Mill. Rp./Ha)

FARM MODEL	OUTPUTS	INPUTS	GROSS MARGIN
MODEL 1	3.084	1.051	2.032
MODEL 2	3.600	1.278	2.322
MODEL 3	3.143	1.122	2.020
MODEL 4	3.690	1.327	2.363
MODEL 5	3.434	1.213	2.221
MODEL 6	3.209	1.221	1.987
MODEL 7	2.840	1.081	1.758

The output, inputs and gross margin of each kind of crop rotation, as is shown in Table 5.21.

Table 5.21 shows that the output and gross margin of using crop rotation 'rice - rice - soybean' is lower than for the other crop rotations. On the other hand, most farmers are still growing soybean as is discussed in Sub-Chapter 5.7. As a source of protein, more soybean is consumed than peanut. Note that the choice of supplementary crop is discussed in more detail in chapters 6 and 7, when past prices are introduced into the analysis.

Table 5.21

Mean Value of Output, Inputs and Gross Margin for Each Kind of Crop Rotation (in Mill. Rp.)

CROP ROTATION	OUTPUTS	INPUTS	GROSS MARGIN
(1) Rice-Rice-CORN	3.084	1.051	2.032
(2) Rice-Rice-MIXED CROPS	3.420	1.217	2.203
(3) Rice-Rice-PEANUT	3.579	1.277	2.301
(4) Rice-Rice-SOYBEAN	2.980	1.135	1.845

According to the Central Bureau of Statistics of Indonesia (1985 - 1989), soybean consumption in 1988 was 7.71 kilograms per capita per year, while that of peanut was 4.52 kilograms.

Britton et al (1975) suggested that many farmers may not be particularly interested in efficiency, but they want the greatest possible profit on each year farming. They also defined the efficiency as 'the ratio of the results achieved to the means used'.

In other words, the efficiency ratio is 'output / input'. A simple arithmetical example shows that efficiency and profitability are not identical, as follows:

> 'In terms of efficiency, it is better to achieve an output of 12,000 pounds from an input of 10,000 pounds than it is to achieve an output of 23,000 pounds from an input of 20,000 pounds, because the efficiency ratio (output per unit of input) is 1.2 in the first case and 1.15 in the second; but most farmers would certainly prefer the second situation, since it leaves them with a balance of 3,000 pounds which is a 50 per cent improvement onthe balance of 2,000 pounds which results from the first situation'.

Based on the efficiency ratio 'output/input', the efficiency of each farm model is shown in Table 5.22. Crop rotation 'rice - rice - corn'(Farm Model 1) has the highest efficiency ratio, even though the highest output is had by Farm Model 4, which used crop rotation 'rice-rice-peanut' (Figure 5.2).

The crop rotation Model 7 (rice-rice-soybean) has the lowest output and efficiency ratio.

Figure 5.2

Efficiency of Each Type of Crop Rotations

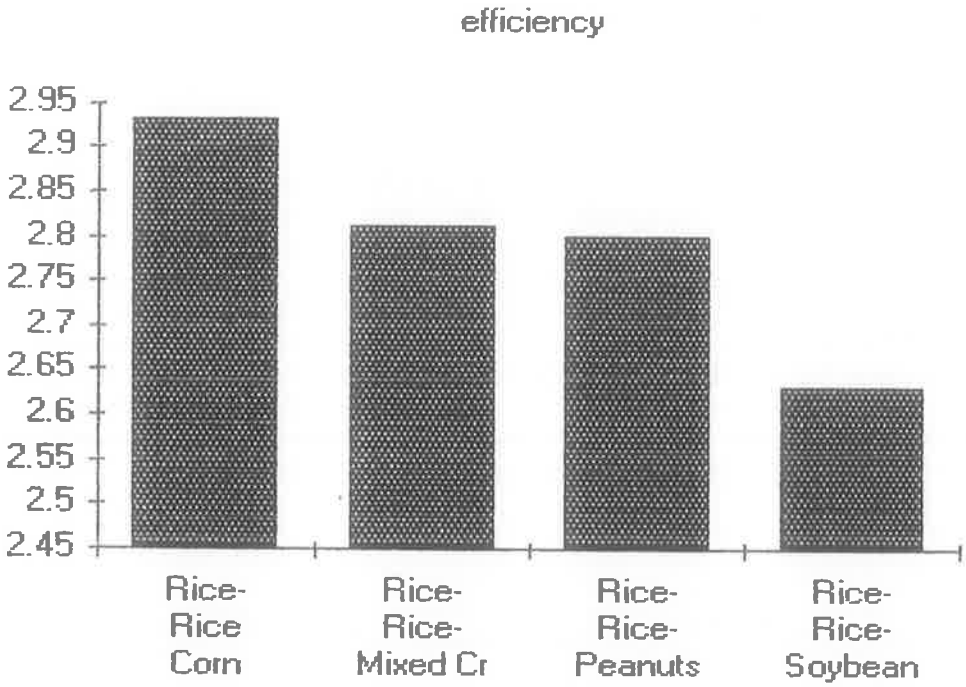


Table 5.22

The Efficiency of Each Farm Model
(Rice and Other Crops, per Ha, per Year)

FARM MODEL	OUTPUT	INPUT	GROSS MARGIN	EFFICIENCY
MODEL 1	3.084	1.051	2.032	2.93
MODEL 2	3.600	1.278	2.322	2.82
MODEL 3	3.143	1.122	2.020	2.80
MODEL 4	3.690	1.327	2.363	2.78
MODEL 5	3.434	1.213	2.221	2.83
MODEL 6	3.209	1.221	1.987	2.63
MODEL 7	2.840	1.081	1.758	2.63

The efficiency ratio of rice and other crops separately, is shown in Table 5.23 below.

Table 5.23

The Efficiency of Rice and Other Crops

(1) Rice Crop (2X)

FARM MODEL	EFFICIENCY
MODEL 1	2.71
MODEL 2	2.54
MODEL 3	2.85
MODEL 4	2.74
MODEL 5	2.87
MODEL 6	2.82
MODEL 7	2.77

(2) Other Crops (1X)

FARM MODEL	EFFICIENCY
MODEL 1	5.32
MODEL 2	5.08
MODEL 3	4.23
MODEL 4	3.37
MODEL 5	3.24
MODEL 6	3.41
MODEL 7	3.05

Table 5.23 - (1) shows that Model 5 which used crop rotation 'rice - rice - peanut' has the highest efficiency ratio, and Table 5.23 - (2) is also shows, the main reason that Farm Model 1 (rice - rice - corn) has the highest efficiency ratio. This is because corn cropping has the highest efficiency ratio (5.32).

Table 5.22 shows that there is a fairly high correlation between efficiency and gross margin. However, while corn has high efficiency, it is clearly outperformed in terms of gross margin as a secondary crop by peanuts.

CHAPTER SIX

TESTING HYPOTHESES ABOUT FACTORS INFLUENCING THE SMALL HOLDING'S OUTPUT

6.1 Introduction

We are undertaking a statistical analysis to try and find out what contributes most to farmers' gross margin, and also to the value of output.

Firstly, we shall use correlation analysis to get an idea of the main influences affecting gross margin and the value of output. (We then bypass the single regresssions, which contain essentially no more information than the corrrelation analysis). Secondly, we conduct some multiple regression analyses. Finally we undertake some analyses of variance.

We shall undertake the correlation analysis separately for those with and without livestock and also separately for irrigated and upland fields. In the first instance we shall do the analysis using the actual prices obtained by farmers for their crops in 1990. In Chapter Seven, we shall replace actual prices with expected prices, because at the time of making their decisions as to what to plant, the farmers do not know the harvest prices.

In the analysis, only the data from the two sampled villages in West Lombok regency have been used.

A correlation matrix shows the simple correlation between all pairs of variables under consideration. In this case, a different matrix was formed for farmers with livestock and for those without, and consisted of the outputs, total inputs, cost of labour and (separately) cost of cattle used in soil cultivation , the amount of inorganic fertilizer, the amount of waste or manure and educational level of farmers.

6.2. Farmers with livestoock

a. Irrigated lowland (sawah)

The correlation between each variable for farms on irrigated lowland (sawah) is shown on Table 6.1.

Table 6.1

Correlation Matrix Between Each Variable on Irrigated Lowland / Have Livestock

	output	input	labour	livestoc	fert	manure	educat
output	1.0000						
input	0.5379***	1.0000					
labour	0.0793	0.5835***	1.0000				
livestoc	0.0938	0.5641***	0.6061***	1.0000			
fert	0.2889*	0.3113*	0.0847	0.2520	1.0000		
manure	0.3212*	0.4966***	0.4390***	0.5040***	0.1449	1.0000	
educat	-0.0554	-0.0366	0.0947	0.0189	0.1578	-0.0676	1.0000

* significant at the 5% level
*** highly significant (i.e at the 0.1 % level)

The data above show that on irrigated lowland there were highly significant relationships between total inputs per hectare (input) and the output (output); that means higher input will be associated with higher output.

There were also highly significant relationships between total inputs and both total cost of labour and total cost of livestock (livestoc) used in soil cultivation . The higher costs will be associated with higher total inputs. Furthermore, there were highly significant relationships between the cost of livestock and the cost of labour used in soil cultivation.

There were also significant relationships between the amount of inorganic fertilizer (fert) and both total inputs and the output. This means higher fertilizer use will be associated with higher total inputs. Thus the use of the proper amount of fertilizer will improve the crops' productivity , and consequently the output.

As well as inorganic fertilizer, the amount of manure will also be associated with increased total inputs and output.

b. Upland (lahan kering)

On the upland, there was a highly significant correlation between both the total inputs (input) and costs of labour used in soil cultivation on the one hand and the output on the other, and also between costs of labour and the total inputs, as is shown on Table 6.2. Otherwise, there were no significant relationships between the outputs and other variables.

Table 6.2

Correlation Matrix Between Each Variable on the Uplands

	output	input	labour	livestoc	fert	manure	educat
output	1.0000						
input	*** 0.4885	1.0000					
labour	*** 0.5111	*** 0.7137	1.0000				
livestoc	0.0759	0.0195	0.2393	1.0000			
fert	-	-	-	-	-		
manure	-0.1368	-0.0474	0.1824	0.0342	-	1.0000	
educat	0.1398	0.0796	0.1106	0.1339	-	0.1789	1.0000

* significant at the 5 % level
*** highly significant (i.e at the 0.1 % level)

6.3. Farmers not having livestock

a. Irrigated lowland (sawah)

The relationships between variables of farms on the irrigated lowland (sawah), are shown below:

Table 6.3
Correlation Matrix Between Each Variable
on Irrigated Lowland

	output	input	labour	livestoc	fert	manure	educat
output	1.0000						
input	0.7577 ***	1.0000					
labour	0.5076 ***	0.5577 ***	1.0000				
livestoc	0.4073 ***	0.5546 ***	0.3552 *	1.0000			
fert	0.0395	0.1736	0.1432	0,1427	1.0000		
manure	0.2574	0.2336	01613	0.0761	0.1357	1.0000	
educat	0.1196	0.0656	0.2487	0.1526	0.0212	0.0332	1.0000

* significant at the 5 % level
*** highly significant (i.e at the 0.1 % level)

The data above shows that there were highly significant correlations between the output and total inputs (input), and between output and cost of soil cultivation, using both labour and livestock (livestoc) . There were also highly significant relationships between the total input (input) and cost of labour and cost of livestock in soil cultivation.

b. Upland (lahan kering)

On the upland there were significant relationships between the output and both cost of labour used in soil cultivation and the amount of manure ; and between total inputs (input) and the output, and between cost of labour and total inputs (input).

Table 6.4

Correlation Matrix Between Each Variable
(on Uplands /Without Livestock)

	output	input	labour	livestoc	fert	manure	educat
output	1.0000						
input	0.8208 ***	1.0000					
labour	0.2969 *	0.6007 ***	1.0000				
livestoc	0.0936	0.0323	0.2485	1.0000			
fert	-	-	-	-	-		
manure	0.3306 *	0.0202	0.1334	0.0566	-	1.0000	
educat	0.1349	0.0744	0.0845	0.2087	-	0.1791	1.0000

* significant at the 5% level
*** highly significant (i e at the 0.1% level)

6.4 Regression Analysis

First, we look at the simple linear regressions between output and the independent variables separately. From the correlation matrix for farmers with livestock (irrigated lowland) - see Table 6.1, we see that output is related to total inputs (in Rupiah), fertilizer used (in Rupiah) and to manure (in kilogram).

Next, we look at the influence of total inputs, manure and education on output simultaneously. It is not likely that education will be significant, since it is not significant in the single-variable regression.

The influence of variables simultaneously on the outputs is analysed by using Stepwise Regression analysis. The results of the analysis are found in Appendices 4 to 15. The reason that total inputs and the components of total inputs cannot be put into the same regression is because of multicollinearity, since total inputs equals the sum of all its components.

a. With Livestock

According to the results of Stepwise analysis (Appendix 5), the relationship between the output and inputs, manure and educational level of farmers (Irrigated Lowland/With Livestock) is as follows:

$$Y = \underset{(526)}{1431.88} + \underset{(0.424)}{1.617}\, I + \underset{(0.095)}{0.050}\, M - \underset{(31.6)}{8.920}\, E \quad ; \quad \bar{R}^2 = 0.29 \quad \ldots\ldots\ldots(1)$$

where: Y = Output (in Rupiah)

I = Total Inputs (in Rupiah)

M = Amount of Manure (in Kilogram)

E = Educational Level of Farmers.

Numbers in parentheses underneath the coefficients are standard errors of the coefficients.

Overall F (3,54) =7.51 (significant at 0.1 % level).

This regression analysis shows that there was a highly significant relationship between the output and inputs (F=14.53).

Otherwise, there were no significant relationships between output and either the amount of manure and educational level of farmers.

We have found that total inputs affect output, so we shall now look at which component of total input affects it most, by regressing the main components of total input, together with the level of manure and education, against total output. Multicollinearity is avoided by omitting the 'total input' variable.

The result of regression analysis (Appendix 6) between the output and cost of labour, cost of livestock, inorganic fertilizer, manure, and educational level (Irrigated Lowland /With Livestock), is as follows:

$$Y = \underset{(357)}{2928.27} - \underset{(1.35)}{0.07}\,Lb - \underset{(2.04)}{1.81}\,Ls + \underset{(0.33)}{0.69}\,F + \underset{(0.11)}{0.26}\,M + \underset{(35.60)}{4.18}\,E$$

$$\bar{R}^2 = 0.18 \qquad \qquad (2)$$

Where : Y = Output (in Rupiah)

Lb= Cost of labour in soil cultivation (in Rupiah)

Ls= Cost of Livestock (in Rupiah)

F = Inorganic Fertilizer (in Rupiah)

M = Amount of Manure (in Kilogram)

E = Educational Level of Farmers.

Numbers in parentheses underneath the coefficients are standard errors of the coefficients. Overall $F(5,52) = 2.30$ is not significant.

However, the equation with the nonsignificant variables Lb, Ls and E removed was significant at the 1 % level.

This analysis shows that there were significant relationships between the output and both inorganic fertilizer (F=4.42) and the amount of manure (F=6.00). There were no significant relationships between the output and cost of labour, cost of livestock, and educational level of farmers.

The results of this regression are somewhat in conflict with those in equation (1). In conjunction with total inputs (which are a significant explanator of output), manure is not significant, but in conjunction with the components of total input, manure is significant, along with fertilizer. Since fertilizer is used by all farmers on rice at the same recommended level, with a few minor variations only, it is likely that it is fertilizer use on the secondary crop which is significant. It is therefore an intriguing result that the two significant variables in equation (2) are organic and inorganic fertilizers, both acting on the secondary crop. Therefore, we shall look again later at the importance of manuring, in chapter eight.

To attempt to resolve the conflict between equation (1) and (2), we note that manure is highly correlated with the value of total inputs. (Manure is not included in the value of total inputs, as it does not have a price in Rupiah. Its units are kilograms).

When we look at how manure and total inputs affect output, it appears that total inputs affect it, but not manure. Because of multicollinearity, however, we suspend our judgement, because when total inputs is broken into expenditure on its components, it is now manure which appears to be the more important variable.

The result of the regression analysis (Appendix 8) between the output, inputs, the amount of manure, and educational level of farmers **(on Upland / With Livestock)** is:

$$Y = \underset{(56)}{691.66} + \underset{(0.17)}{0.673}\ I - \underset{(0.22)}{0.253}\ M + \underset{(8.08)}{8.614}\ E \ ; \ \bar{R}^2 = 0.27 \quad \ldots\ldots\ldots(3)$$

Where : Y = Output (in Rupiah)

I = Total Inputs (in Rupiah)

M = Amount of Manure (in Kilogram)

E = Educational Level of Farmers.

Numbers in parentheses underneath the coefficients are standard errors of the coefficients.

Overall $F(3,54) = 6.56$ is significant at the 1% level.

This analysis shows that there was a significant relationship between total inputs and output.

Once again, we look at the components of total inputs. The result of the regression analysis (Appendix 9) between the output and cost of labour, cost of livestock, the amount of manure and educational level **(Upland / With Livestock)** is as shown below:

$$Y = \underset{(71)}{639.38} + \underset{(0.96)}{4.26}\ Lb + \underset{(1.87)}{3.05}\ Ls - \underset{(0.22)}{0.08}\ M + \underset{(8.13)}{4.13}\ E$$

$\bar{R}^2 = 0.31$ ....(4)

Where: Y = Output (in Rupiah)

Lb= Cost of Labour in Soil Cultivation (in Rupiah)

Ls= Cost of Livestock (in Rupiah)

M = Amount of Manure (in Kilogram)

E = Educational Level of Farmers.

Numbers in parentheses underneath the coefficients are standard errors of the coefficients.

Overall $F(4,53) = 5.87$ is significant at the 1% level.

On the upland area, no farmers used inorganic fertilizer (Table 6.2), so the variable F does not appear in equation (4).

This analysis shows that there was a significant relationship between soil cultivation (particularly labour use) and the output.

b. Without Livestock

According to the results of Stepwise analysis (Appendix 11) the relationships between the output and total inputs, the amount of manure and educational level of farmers (Irrigated Lowland / Without Livestock) is shown as follows:

$$Y = -\ 1407.18 + 3.94\ I + 0.27\ M + 28.60\ E; \quad \bar{R}^2 = 0.59$$
$$\quad (516) \qquad (0.46) \qquad (0.28) \qquad (34.98) \ ....(5)$$

Where: Y = Output (in Rupiah)

I = Total Inputs (in rupiah)

M = Amount of Manure (in Kilogram)

E = educational Level of Farmers

Numbers in parentheses underneath the coefficients are standard errors of the coefficients.

Overall F (3,59) = 27.8 which is highly significant.

This regression analysis shows that there was a highly significant relationship between the output and inputs (F = 72.23). The effect of Manure (M) in equation (5) was not significant.

Breaking total input into its components (see Appendix 12), we examine the relationship between the output and cost of labour, cost of livestock, inorganic fertilizer, the amount of manure and educational level of farmers (Irrigated Lowland/Without Livestock).

$$Y = \underset{(548)}{2078.83} + \underset{(1.55)}{4.76}\ Lb + \underset{(2.81)}{6.67}\ Ls - \underset{(0.57)}{0.41}\ F + \underset{(0.35)}{0.60}\ M + \underset{(17.44)}{25.71}\ E$$

$\bar{R}^2$ = 0.36 ....(6)

Where : Y = Output (in Rupiah)

Lb= Cost of Labour in Soil Cultivation (in Rupiah)

Ls= Cost of Livestock (in Rupiah)

F = Inorganic Fertilizer (in Rupiah)

M = The Amount of Manure (in Kilogram)

E = Educational Level of Farmers.

Numbers in parentheses underneath the coefficients are standard errors of the coefficients.

Overall $F(5,57) = 6.30$, significant at the 1% level

This analysis shows that there were significant relationships between the output and expenditure on soil cultivation, both for labour and livestock. The amount of manure is significant only at the 10% level.

The relationships (see Appendix 14) between the output and inputs, the amount of manure and educational level of farmers (Upland / Without Livestock) is as follows:

$$Y = \underset{(55)}{329.12} + \underset{(0.13)}{1.75}\ I + \underset{(0.15)}{0.74}\ M + \underset{(10.47)}{3.09}\ E\ ;\ \bar{R}^2 = 0.77 \quad \text{..........(7)}$$

Where : Y = Output (in Rupiah)

I = Total Inputs (in Rupiah)

M = Amount of Manure (in Kilogram)

E = Educational Level of Farmers.

Numbers in parentheses underneath the coefficients are standard errors of the coefficients.

Overall F (3, 59) = 66.89, is highly significant.

This analysis shows that there were highly significant relationships between the output and both total inputs (F=170.75) and the amount of manure (F=24.29). The relationships (see Appendix 15) between the output and cost of labour, cost of livestock, the amount of manure and educational level of farmers **(Upland / Without Livestock)** is as follow:

$$\underset{}{Y} = \underset{(172)}{423.91} + \underset{(2.32)}{7.70}\,Lb + \underset{(4.08)}{5.33}\,Ls + \underset{(0.27)}{0.86}\,M + \underset{(19.42)}{11.71}\,E$$

$$\bar{R}^2 = 0.26 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Where : Y = Output (in Rupiah)

Lb= Cost of Labour in Soil Cultivation (in Rupiah)

Ls= Cost of Livestock (in Rupiah)

M = Amount of Manure (in Kilogram)

E = Educational Level of Farmers.

Numbers in parentheses underneath the coefficients are standard errors of the coefficients.

Overall F (4,58) = 5.08, is highly significant.

On the upland area, no farmer used inorganic fertilizer (Table 6.4).

This result shows that there were highly significant relationships between the output and both cost of labour (F=10.99) and the amount of manure (F=9.75).

Summary of regression analysis

The value of total output in all cases depended on the value of total inputs. When the components of total inputs were analysed, it was not clear that any one input dominated: cultivation costs were often an important determinant of output, and occasionally the use of inorganic fertilizer. Of the two non-monetised variables, the use of manure also featured prominently, despite the very small quantities of total manure production used. Education level, however, was never a significant variable.

6.5 Analysis of Variance

We have also undertaken a number of analyses of variance, to compare crop-models with each other and to compare farmers with and without livestock (called 'live-model'). This analysis shows which crop-model and which live-model gained the highest output and/or gross margin.

Before looking at these results,one thing must be stressed: the interaction between crop-model and live-model was insignificant in all analyses of variance. This simplifies the discussion, as we can look separately at crop models and live models in what follows.

The results of these analyses, between crop-model and live-model, are shown in Table 6.5. Let us look at some of these results in detail.

6.5.1. Input Differences for Live Models

The first line of Table 6.5 shows that the cost of labour in soil cultivation of the farmers who have livestock was significantly higher than that of the farmers who do not; and also, in line 7 the total inputs of farmers who have livestock was significantly higher than that of the farmers who do not. In other words, the farmers who have livestock spent more money for soil cultivation and spent more in total inputs. This implies that the farmers without livestock do not have enough capital, that is face a capital constraint.

The results of the analyses of Table 6.5 are presented in Appendix 16-30 in more detail.

Table 6.5

The Significance of Variables Between Crop-Model and Live-Model

VARIABLES	BETWEEN CROP-MODEL	BETWEEN LIVE-MODEL
1. COSCLBHA	NS	S***
2. COSCLSHA	NS	NS
3. FERTHA	NS	NS
4. WASTEHA	NS	S***
5. SEEDHA	S***	S***
6. PLANLBHA	S***	S***
7.IRRINPHA	S***	S***
8.IROUTHA	S***	S***
9.GROSSMHA	S***	S***

Note: See page xix for abbreviation names.
NS : Not Significant.
S : Significant:
* at the level 5 %
*** at the 0.1 % level

6.5.2. Soil Cultivation Costs

Based on the results of analysis in Appendix 17 and 19, it is clear that the farmers who have livestock have a higher total cost of soil cultivation per hectare (Rp.276,190) than the farmers who do not have livestock (Rp.220,450). The difference is approximately Rp.55,740 per hectare per year. There were no significant differences in the cost of cultivation for different crop patterns.

The higher expenditure of livestock owners on soil cultivation deserves some attention. The farmer with livestock paid Rp.276,000 for soil cultivation. If he had used his own cattle for cultivation rather than hiring cattle, he would have saved Rp.108,000 and have only paid Rp.168,000. Therefore he would have paid Rp.51,000 less than the farmer who had no livestock. If this had happened, it would have have confirmed Ranjhan's explanation (1978), that the integration of livestock raising with crop production is inevitably very efficient, and in turn, the animal provides the farm power requirements in the production of the crops. However, the actual situation was not like this, because it appears that farmers did not use their own livestock for cultivation.

The reasons for this difference between Ranjhan and the survey data seem to be because of cultural factor in this region, and also the purpose of the possession of cattle. That is, the farmers possess cattle as a method of saving or for social status in the society. Secondly, the farmers possess cattle for meat production. Usually, these cattle are not used for soil cultivation. The possession of cattle for soil cultivation is only a third and apparently minor reason for keeping them. Therefore, few farmers who have livestock will use them for soil cultivation.

6.5.3. Manure and Farming Models

With respect to the amount of manure used in farming, there was no significant difference between type of crop rotation, but a highly significant difference between the presence or absence of livestock, as is shown in Table 6.6.

Table 6.6
The Different Amount of Manure
Between Crop model and Live model

Analysis of Variance

Dependent Variable : The Amount of Manure

Source	DF	SS	MS	F Value	Pr>F
CROPMODEL	3	930926.5	310308.8	1.08	0.3614
LIVEMODEL	1	11402824.5	11402824.5	39.61	0.0001
CROPMDL*LIVEMDL	2	0.0	0.0	0.0	1.0000

Overall F (6,114) = 6.74 is highly significant (see Appendix 29).

Table 6.7 shows that there is a big difference in the amount of manure used between farmers who have livestock and those who do not. It appears that farmers who do not have livestock are unwilling to use the manure of other farmers' livestock on their crops, allowing instead for it to be wasted.

Table 6.7
Mean of Manure Used per Hectare, per Year

CROP MODEL	HAVE LIVESTOCK	DO NOT HAVE LIVESTOCK	MEAN
RICE-RICE-CORN	-	0	0
RICE-RICE-MIXED	682.24	106.95	456.23
RICE-RICE-PEANUT	590.74	0	333.23
RICE-RICE-SOYBEAN	707.60	46.08	297.46
MEAN	655.84	41.35	335.90

The analysis of variance of the relationship between the amount of manure used by the farmer for his crops and gross margin, is shown on Table 6.8 below.

Table 6.8

The Relationship Between Amount of Manure (per Ha) and Gross Margin (per Ha)

Analysis of Variance

Dependent Variable : Gross Margin

Source	DF	SS	MS	F Value	Prob>F
Model	1	2856157.74	2856157.23	9.322	0.003
Error	119	36460310.87	306389.17		
Total	120	39316468.61			

The regression equation of this relationship (see Appendix 41 for data) is :

$$Y = \underset{(57.53)}{1991.355} - \underset{(0.08)}{0.253}\,M \; ; \; \bar{R}^2 = 0.0729$$

Where: Y = Gross Margin (in Rupiah)

M = Amount of manure (in Kilogram)

Numbers in parentheses underneath the coefficients are standard errors of the coefficients.

Table 6.8 above shows that there was a highly significant relationship between the amount of manure used and gross margin (F Value = 9.322; Prob.>F = 0.003).

Table 6.9

Mean of Input's Components per Hectare of Each Crop Model

VARIABLES	CROP ROTATION				
	R-R-C	R-R-M	R-R-P	R-R-Sb	
LABOUR	68.00	77.30	82.60	67.30	NS
LABOUR COST	120.50	154.57	155.33	133.20	NS
LIVESTOCK	36.61	36.01	37.35	34.45	NS
STOCKCOST	96.21	107.83	106.17	96.64	*
SEED	62.93	112.16	191.70	191.71	***
PLANTCOST	89.44	85.56	94.39	87.62	NS
FERTILIZER	169.66	181.79	177.02	175.82	NS
WASTE	9.19	13.75	15.84	8.44	NS
WEEDLABOUR	88.86	80.42	94.99	87.03	NS
WEEDINGCOST	155.81	152.23	162.66	159.14	NS
HARVESTCOST	237.41	310.22	284.72	293.47	NS
INPUTS	1051.86	1217.27	1277.66	1135.09	***
OUTPUT	3084.09	3420.86	3579.13	2980.89	***
GROSSMARGIN	2032.22	2203.57	2301.46	1845.80	***
EFFICIENCY	2.93	2.81	2.80	2.63	

Note: R-R-C : Rice-Rice-Corn; R-R-P : Rice-Rice-Peanut
R-R-M : Rice-Rice-Mixed Crops; R-R-Sb : Rice-Rice-Soybean.

NS : Non Significant ;
* : Significant at the 5% level;

***: Highly Significant (i.e. at the 0.1% level).

6.5.4. Seeds and Crop Models

The difference of the value of seeds was significant between each type of crop rotation; this is probably because the cost of seed differs between different secondary crops, and is also related to the quantity of labour used for planting.

6.5.5. Summary of Results of Different Crop Models

We now look at mean of each input's components, total inputs, the output and gross margin per hectare of different crop model (crop rotation) separately (Table 6.9). The detail are given in Appendix 28 and 30. No further results of significance appear from this table.

6.5.6. Educational Level

We look once again at education level, which the regression analysis showed was not related to any of the other variables. As already noted in the correlation analysis, educational level did not significantly influence the gross margin. This is shown formally in Table 6.10, where the F-value = 0.60 and Pr > F = 0.6154 (see Appendix I).

Table 6.10

The Relation Between Educational Level and Gross Margin (ANOVA)

Dependent Variable : Gross Margin (GM)

Source	DF	SS	MS	F Value	Pr>F
EDC1	3	280076.85	93358.95	1.43	0.2383

Note: GM = Gross Margin
EDC1 = Farmer's Educational Level.

The mean of gross margin for each educational level is as follows:

Table 6.11

The Relation Between Level of Education and Gross Margin (xRp.ooo)

LEVEL OF EDUCATION	NO. OF FARMERS	GROSS MARGIN
1. Primary School	59	2020.62
2. Junior High School	12	2008.21
3. Senior High School	6	2295.75
4. None	44	2122.36

The education level of the farmer has for many years been regarded as a basic determinant for accelerating the success of agricultural development (Mosher, 1966). Rogers (1971) quotes a number of studies in which the education level of farmers is significant in improving their position.

One problem in this survey was the measurement of educational attainment. This referred to the education of the 'farmer' that is , the head of household. This person was often quite old, and in those cases usually had the 'help' of his sons and other younger members of the household, who were not called 'farmers' and who were usually much better educated. Notwithstanding this, what this study may also suggest, however, is that deficiencies in formal education can be remedied by a concerted effort in agricultural extension. Formal education alone may not assure a change in the behaviour of farmers, particularly in improving the farmer's skill. Therefore, informal education in the form of agricultural extension may be required as a complement to improve the ability of farmers in both farming techniques and managerial skills.

CHAPTER SEVEN

ANALYSIS OF EXPECTED PRICES AND EXPECTED GROSS MARGIN

How does a farmer know what secondary crop to plant? Clearly, at the time of planting, he does not know the selling price of the crop, although in the case of rice he knows the price will not be below the floor price. Somehow, he has to estimate the price which he will get for each possible crop, and to choose that crop which maximises his gross margin. How does the farmer estimate the price he will get? One presumes that it is by remembering the price over the last year or two, and recalling any unexpected variations in past prices. It is a difficult task to model this process, and one in which any a number of different assumption may be made.

Let us assume that farmers have the last five years' prices for the crops in question. In fact, they are unlikely to have this in accessible written form, but that means that their analysis is likely to be subject to greater error than the process we are to go through. This means in turn that if our analysis is unable to choose between two or three alternative secondary crops, then neither presumably will the farmer be able to do so.

The analysis ideally should be done in real terms, as a large increase in prices received might simply occur because the rate of inflation is high. To the extent that the rate of inflation is constant, and that the prices of all crops go up in the same ratio, the farmer's decision as to what to plant will not be affected by the rate of inflation. As it happened the rate of inflation was reasonably constant over the period 1985 to 1990. In both 1989 and 1990, it was 9 per cent, so no great loss in precision occurs if we try to predict 1990 prices of crops by extrapolating actual prices from 1985 to 1989 rather than real ones.

7.1 The Case of Corn

Farmgate and retail prices of corn in Lombok over the period 1985-1990 are shown in Table 7.1, and also Figure 7.1 shows a picture of farmgate, retail and real farmgate prices of corn.

Table 7.1

Farmgate and Retail Prices of Corn in Lombok, Period 1985-1990

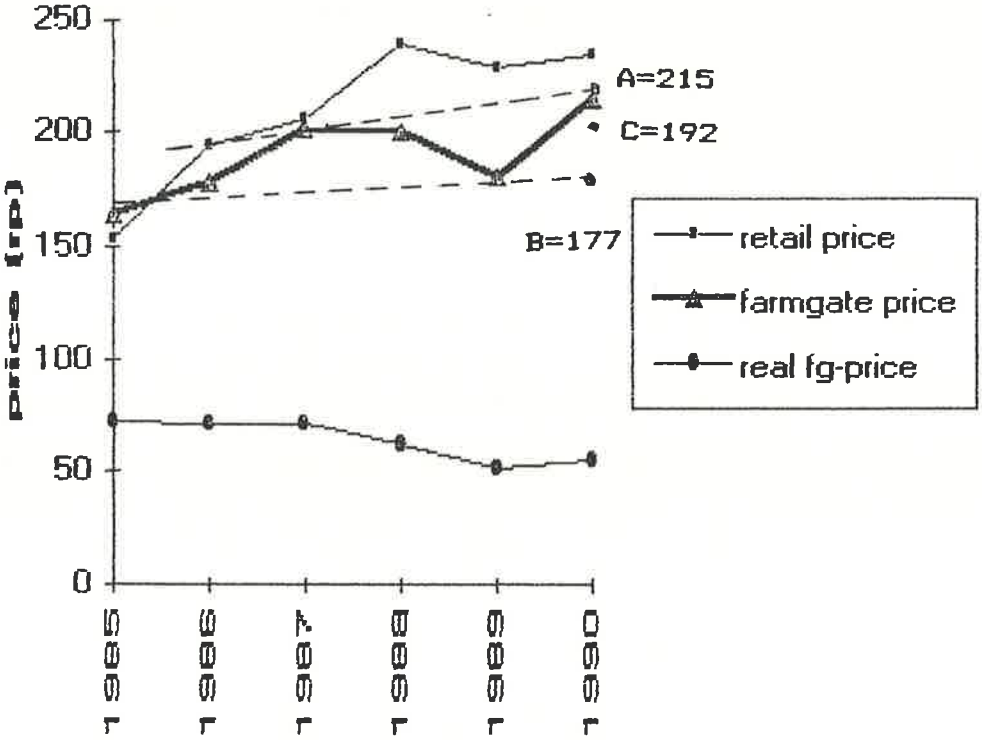
YEAR	FARMGATE PRICE (Rp./Kg)	RETAIL PRICE (Rp./Kg)
1985	164	153
1986	178	195
1987	202	206
1988	200	240
1989	180	229
1990	215	235

If we look at the graph of farmgate prices in Figure 7.1, we can draw in two lines, marked A and B, based on the prices of 1985 to 1989, to predict the 1990 price of corn. Line A is based on the two higher observations of 1987 and 1988, and line B on the three lower ones (1985, 1986 and 1989). The prediction of line A for 1990 is 215, and for line B is 177. On the basis that line B contains the weight of 3 observations and line A has 2, we suggest that the probability of the lower price is 3/5 and of the higher price 2/5, giving a weighted average predicted price of 192.

If we use the linear regression of corn prices against line, as shown in Figure 7.3, we find the estimated price of corn in 1990 is Rp.202.

Figure 7.1

Retail, Farmgate and Real Farmgate Prices of Corn in Lombok



Source: Central Bureau of Statistics of Indonesia (1985-1989) and Food Crop Agricultural Office ,West Nusa Tenggara Province (1991).

We now have two separate 1989 prediction of the price of corn in 1990: Rp.192, using the sort of 'chartist' method a farmer or local agent may make, and Rp.202 using a linear regression using the same data. We shall use both methods as a rough check of the sensitivity of the prediction.

7.2 The Case of Soybean

Farm-gate and retail prices of soybean over the past six years (Agricultural Department and Bulog, 1991), are as follows:

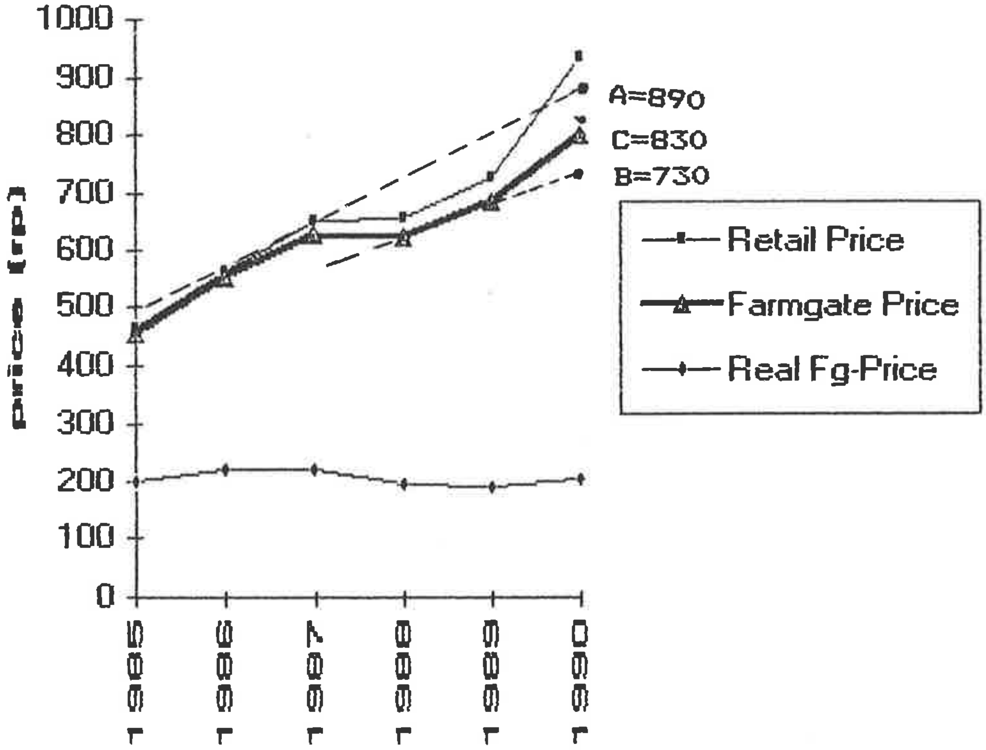
Table 7.2

Farm-gate and Retail Prices of Soybean in Lombok, Period 1985-1990

YEARS	FARM-GATE PRICE (Rp. / Kg)	RETAIL-PRICE (Rp. / Kg)
1985	454	464
1986	554	562
1987	630	650
1988	625	655
1989	682	728
1990	802	937

Figure 7.2

Retail, Farmgate and Real Farmgate Prices of Soybean, in Lombok



Source: Central Bureau of Statistics of Indonesia (1985-1989) and Food Crop Agricultural Office West Nusa Tenggara Province (1991).

Figure 7.3
Regression Estimate Price of Corn
In 1990

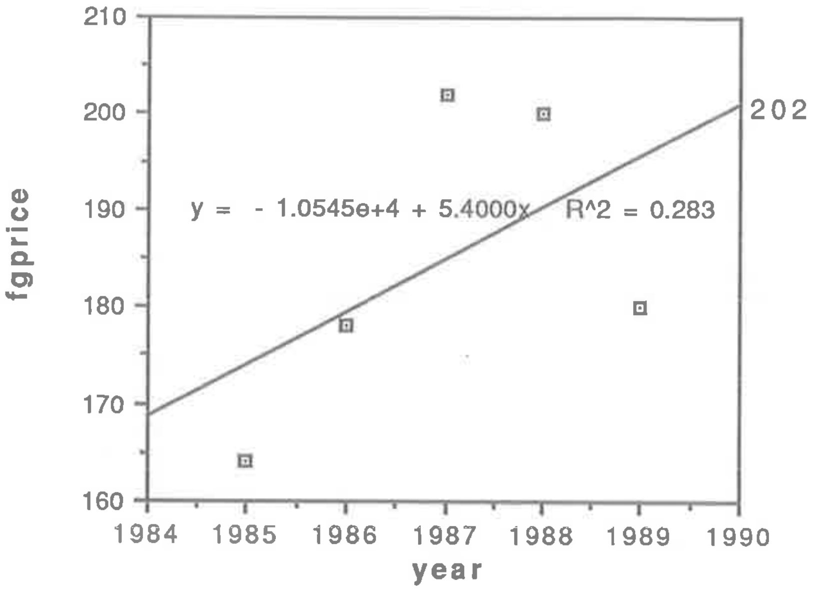


Figure 7.4
Regression Estimate Price of Soybean
In 1990

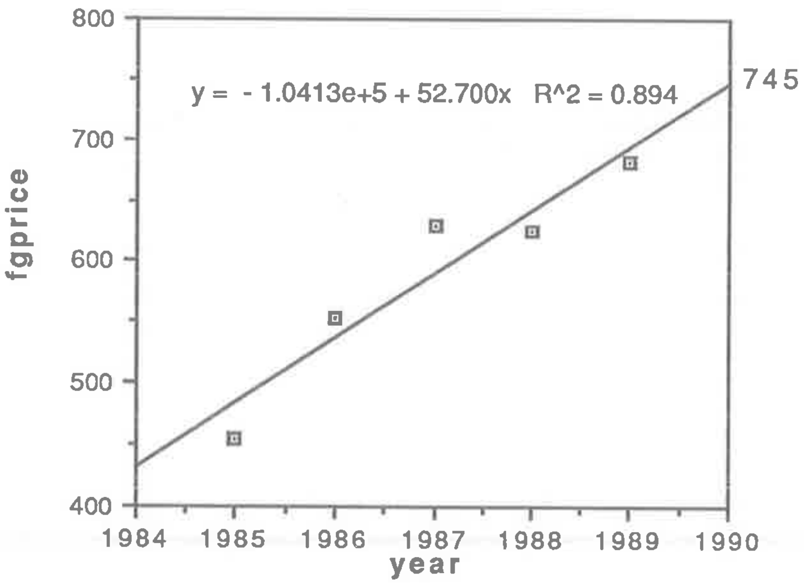


Figure 7.2 shows the picture of farmgate , retail and real farmgate prices of soybean. Knowing the 1985 to 1989 prices of soybeans, what would a farmer be likely to predict the 1990 price to be?

Using the same methodology as for corn, we suggest that a farmer draw line A to give an optimistic forecast for 1990 of 890; line B to give a pessimistic forecast of 730, and a weighted average predicted price of point C of 836.

In Figure 7.4, if we use linear regression we find the regression estimate price of soybean to be Rp. 745.

7.3. The Case of Peanuts

The farm-gate and retail price of peanuts over the past six years, are as follows:

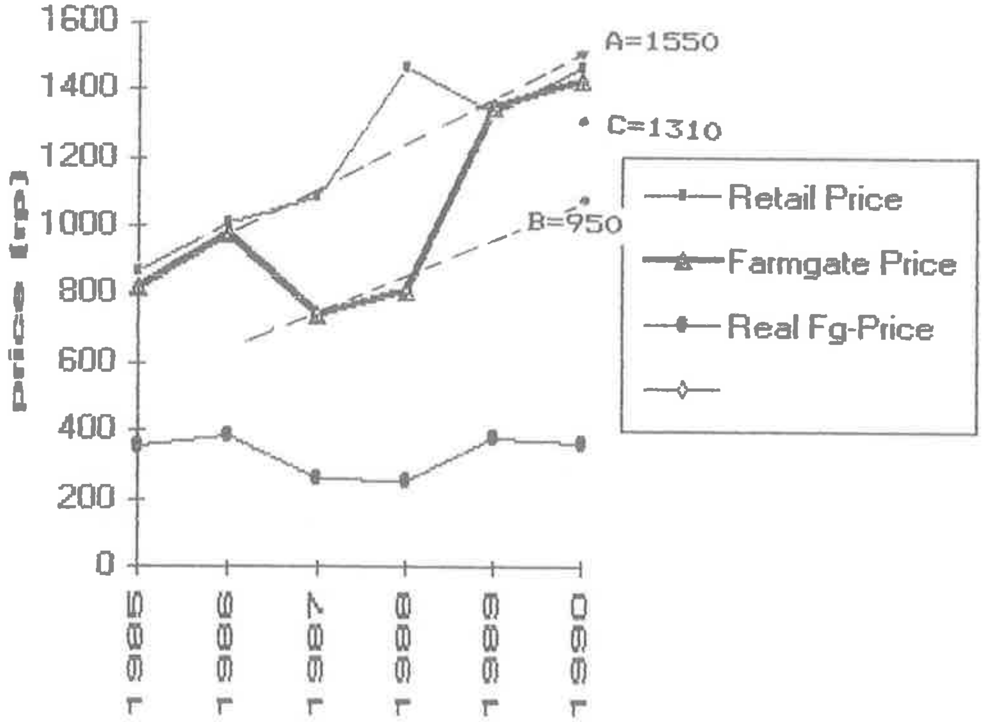
Table 7.3

Farm-gate and Retail Prices of Peanut in Lombok,Period 1985-1990

YEARS	FARM GATE PRICE (Rp. /Kg)	RETAIL PRICE (Rp. /Kg)
1985	817	866
1986	973	1011
1987	740	1086
1988	865	1461
1989	1344	1330
1990	1426	1466

Figure 7.5

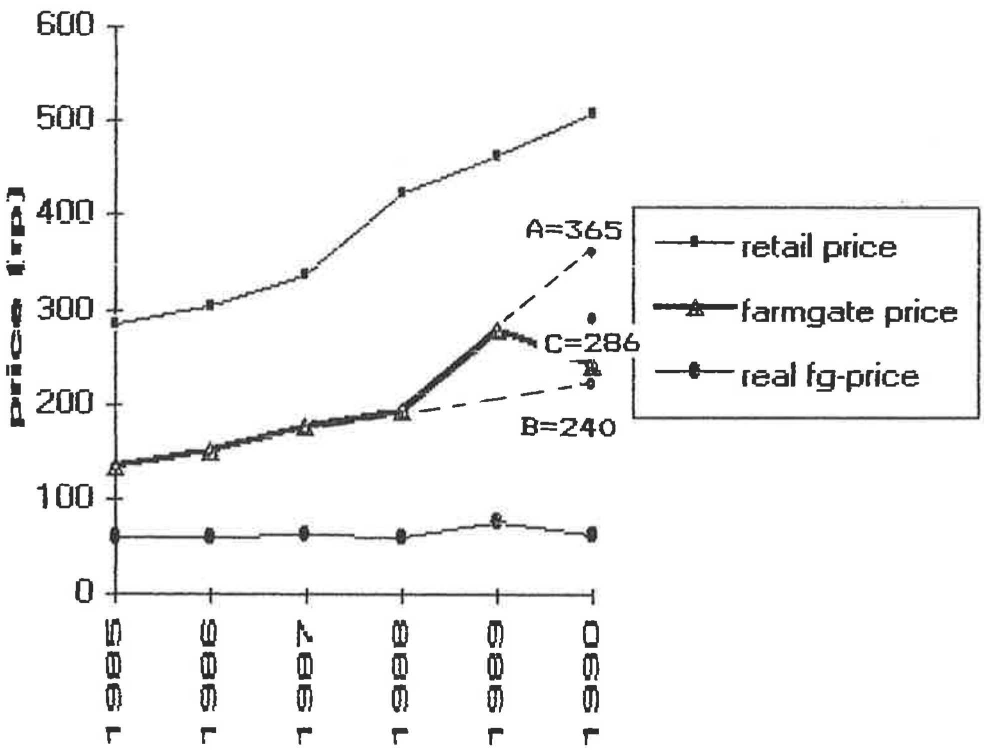
Retail, Farmgate and Real Farmgate Prices
of Peanut, in Lombok



Source: Central Bureau of Statistics of Indonesia (1985-1989) and Food Crop Agricultural Office, West Nusa Tenggara Province (1991).

Figure 7.6

Retail, Farmgate and Real Farmgate Prices
of Rice in Lombok



Source: Central Bureau of Statistics of Indonesia (1985-1989)
and Food Crop Agricultural Office West Nusa Tenggara
Province (1991)

Figure 7.7
Regression Estimate Price of Peanuts
in 1990

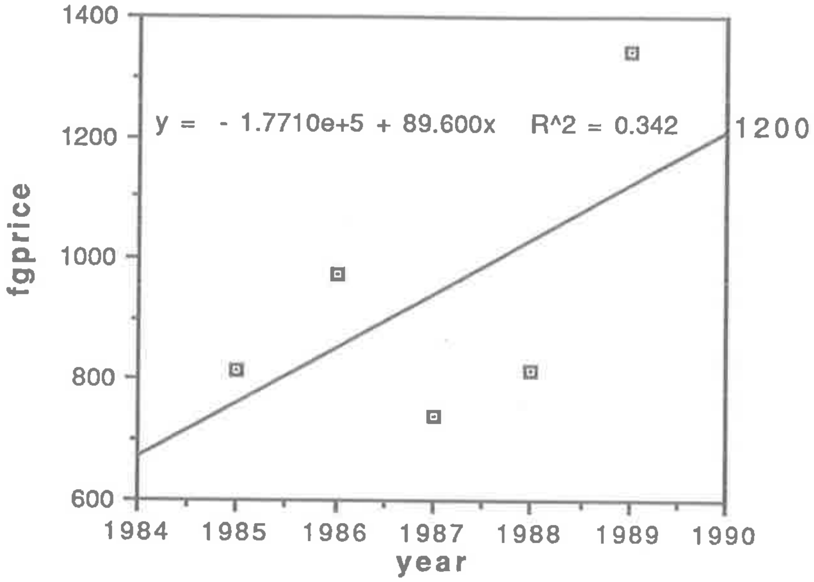
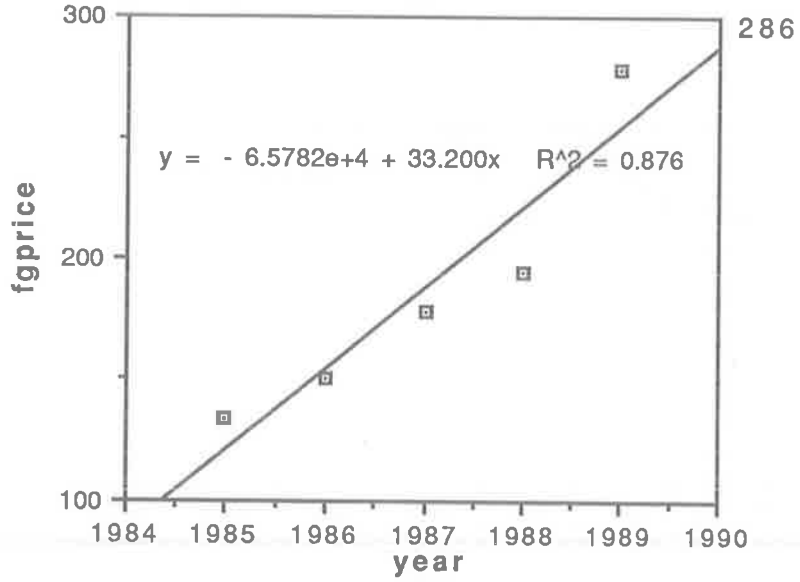


Figure 7.8
Regression Estimate Price of Rice
in 1990



Using the same methods as before, we suggest that a farmer might have an optimistic price forecast of 1550 (point A), a pessimistic one of 950 (point B) and a weighted average (point C) of 1310, which we regard the farmer's expected price (Figure 7.5).
Based on the farmer's best guess of price, the expected price (EPc) will be at C = Rp.1310.

In Figure 7.7, using the same methods as for the regression of corn and of soybean against time, we can find the regression estimate price of peanuts is Rp.1200 and Figure 7.8 shows that regression estimate price of rice is Rp.286.

A summary of Expected Prices, Actual Prices and Regression Estimate Prices is shown in Table 7.4 as follows:

Table 7.4

Expected Prices, Actual Prices
and Regression Estimate Prices of Corn,
Soybean, Peanut and Rice

CROPS		EPa	EPb	Observed Expected (Epc)	Regression Estimate	Actual Prices
1.	Corn	215	177	192	202	215
2.	Soybean	890	730	836	745	802
3.	Peanuts	1550	950	1310	1200	1426
4.	Rice	365	240	265	286	241

EPa=Expected Good Price

EPb=Expected Poor Price

EPc=Expected Price

7.4. Expected Gross Margins

The output (in value terms) calculated by using actual prices is referred to as 'actual output', and calculated by using observed ('chartist') expected prices is referred to as 'observed expected output; the output calculated by using regression estimate prices is referred to as 'regression estimate output'. The respective gross margin concepts are referred to as 'actual gross margin', 'observed expected gross margin' and 'regression estimate gross margin'.

According to the result of the analyses of variance (Appendix 31), the actual gross margin per hectare was highly significantly different between both crop model (F = 6.52 ; Pr > F = 0.0004) and live model (F = 8.66 ; Pr > F = 0.0039).

Table 7.5 shows the mean actual gross margin per hectare of each crop model and each live model.

Table 7.5

Mean of Actual Gross Margin per Hectare of Each Crop Model and Live Model

CROP MODEL	WITH LIVESTOCK	WITHOUT LIVESTOCK	MEAN
Rice-Rice-Corn	-	2099.91	2099.91
Rice-Rice MixedCrop	2328.70	1996.28	2198.11
Rice-Rice-Peanuts	2359.42	2221.26	2299.20
Rice-Rice-Soybean	1963.35	1727.57	1817.17
MEAN	2220.67	1931.35	

Table 7.5 above shows that the actual gross margin of crop model Rice-Rice Peanuts is higher than the others. Likewise, the farmer with livestock has actual gross margin higher than the farmer without livestock.

The observed expected gross margin per hectare was highly significantly different between both crop model (F = 4.00 ; Pr > F = 0.0095) and live model (F = 8.48 ; Pr > F = 0.0043).

The mean of the observed expected gross margin per hectare is shown in Table 7.6 below.

Table 7.6

Mean of Observed Expected Gross Margin per Hectare of Each Crop Model and Live Model

CROP MODEL	WITH LIVESTOCK	WITHOUT LIVESTOCK	MEAN
Rice-Rice-Corn		2314.24	2314.24
Rice-Rice-MixedCrop	2588.08	2209.78	2439.46
Rice-Rice-Peanuts	2519.87	2376.88	2457.54
Rice-Rice-Soybean	2246.81	1980.13	2081.47
MEAN	2450.42	2148.50	

Table 7.6 above shows that the observed expected gross margin of crop model Rice-Rice Peanuts is higher than the others. (As expected, farmers with livestock have observed expected gross margin significantly higher than farmers without livestock. This result is virtually the same as for actual gross margins, because there is no interaction between crop and live models).

Furthermore, the regression estimate gross margin was highly significantly different between both crop model (F = 3.56 ; Pr > F =0.0165) and live model (F = 7.99 ; Pr > F = 0.0055).

The mean of the regression estimate gross margin per hectare is shown in Table 7.7 below.

Table 7.7

Mean of Regression Estimate Gross Margin per Hectare of Each Crop Model and Live Model

CROP MODEL	WITH LIVESTOCK	WITHOUT LIVESTOCK	MEAN
Rice-Rice-Corn		2569.30	2569.30
Rice-Rice-MixedCrop	2747.37	2349.66	2591.13
Rice-Rice-Peanuts	2653.46	2506.91	2589.58
Rice-Rice-Soybean	2406.00	2129.46	2234.54
MEAN	2599.92	2297.68	

Table 7.7 above shows that the regression estimate gross margin of crop model Rice-Rice Peanuts is higher than the others. (As before farmers with livestock have regression estimate gross margin significantly higher than farmers without livestock). The use of expected prices rather than actual ones for 1990 has not substantially changed the significance of the results. Using actual prices, farmers who grew peanuts were clearly better-off than those who grew soybeans. Although the expected price of peanuts was lower than the actual price and that of soybeans higher, nevertheless on this analysis, farmers who chose to plant peanuts for 1990 would have had a significantly higher expected gross margin than for those who chose soybeans.

The difference between the gross margins based on the 'chartist' and the regression estimates of 1990 price was not great, showing that the results do not appear to be sensitive to the method used for predicting the 1990 prices.

The difference in gross margins (both actual and predicted) between farmers growing soybeans and those growing peanuts is quite marked. We shall for this analysis ignore the four farmers growing rice-rice-corn (too small a sample for comparative purposes) and the 28 growing rice-rice-mixed crops (because of the difficulty in interpreting the diverse nature of the mixed crops and their varying percentage). The average actual gross margin per hectare for the 39 farmers growing rice-rice-peanuts in thousand Rupiah was 2,299 per hectare and for the 50 growing rice-rice-soybeans was only 1,817 per hectare. The mean difference was 482 per hectare. The 95 % confidence limits for the difference are 260 to 710 per hectare. Those growing peanuts gained an average 26.6 % higher gross margin per hectare (20 % for those with livestock, 28 % for those without) than those growing soybeans. Considering that almost half of the gross margin comes from the two rice crops, this implies that the increase in gross margin for peanuts over soybeans was in 1990 close to 50 %.

Now part of that difference was due to the relatively high price of peanuts in 1990 (and to smaller differences from their expected prices of the other crops).

But even the expected gross margins between rice-rice-peanut and rice-rice soybean differed by Rp.376,000 per hectare (using the 'chartist' method) or by Rp.365,000 per hectare (using the regression method), with peanuts being 16 to 18 % higher. (The 95 % confodence limits for this difference are Rp.140,000 to Rp.600,000, so again, the difference by any standards is likely to be quite large).

Why are there such large differences between the returns to peanuts compared with soybean? Two explanations probably account for most of the difference.

The first is that the price of peanuts has been relatively volatile, so there is, comparatively, something of a risk involved in growing peanuts. This can be seen over the years 1985 -1989 from the regression equations of Figure 7.3 to 7.6. Over that time, the soybean and rice prices were close to linear, the regression R^2 being 0.89 and 0.88 respectively. However, for peanuts the R^2 was 0.34 (and for corn, even lower, at 0.28).

For all that, however, a rough calculation shows that the price of peanuts would have to fall dramatically, to Rp.800 per kilogram, or less, before the gross margin of growing it as the second crop fell to that of soybeans. From Table 7.4, the 'chartist' pessimistic forecast of peanut price was Rp.950 per kilogram, so it is reasonable to suppose that even under pessimistic assumptions, the gross margin of using peanuts as the second crop would be greater than using soybeans. So price instability and risk-aversion alone are not likely to account for the difference.

The other main explanation is that the Indonesian Government recommends the growing of soybeans as the second crop. This is likely to be powerful force, not easily quantified. It is likely that those two explanations (government advice plus risk-aversion) between them can account for farmers' behaviour.

This analysis suggests that government policy towards the recommendation of soybeans as a second crop may need modification. The problem is that the extent that government exhortation can affect the quantity grown is unknown, and too great a change in government policy could change the relative quantities of soybean and peanuts too much. This would result in the price of peanuts going too low, and that of soybeans too high, reversing the current position, and sending the peanut-growing farmers into great debts and subsequent hardship.

The policy implications for government are to decrease the emphasis on soybeans as the main second crop, but to do so gradually. Prices will have to be monitored carefully, particularly if peanut prices fall quickly relative to soybeans.

The other main implication is that farmers should be encouraged to grow a mixture of secondary crops.

Diversification of this kind will enable farmers to stabilise their incomes: if peanut prices are low, farmers could still make a profit out of soybeans, and vice versa. In fact, the policy of de-emphasising soybeans and the policy of diversifying risk could be combiined, because recommendations to diversify are likely automatically to de-emphasise soybeans to some degree. Such a policy change would also be less likely to lead to income instability than other changes, because the act of diversifying is likely to create more stable incomes.

One further caution is necessary. The study relates to Lombok, and for reasons of differences in soils, climate, cropping patterns etc. may not translate exactly to the whole of Indonesia.

CHAPTER EIGHT

MANURING

This chapter will discuss manuring in six sampled villages. We shall examine the amount of manure used as organic fertilizer by farmers, the problems in using manure, the benefits and value of manure.

Manure is the organic fertilizer which is the waste of livestock. Manure consists of two components, solid matter and liquid matter or slurry.

The amount of manure which was used annually by farmers in the two sampled villages in West Lombok for their crops is approximately 335.90 kilograms per hectare (Table 5.19). This is only 1.8 percent of manure production among sampled farmers. Only these two of the six sampled villages in Lombok used manure at all.
In Central and East Lombok, no respondents whatsoever used manure as fertilizer for their food crop (see Appendix B).

The reason why farmers used a very small amount of manure as organic fertilizer, is that manure has a very small amount of nutrient content per kilogram when compared with the inorganic fertilizer used. So farmers must use much more manure to get the same amount of nutrient content as inorganic fertilizer (the calculation is shown in chapter 8). Therefore, manure is bulky to transport from stable to the field.

In order to preserve manure in the stable, it is necessary for the floor to be covered with a bedding of soft resilient material such as rice straw, so that the cattle may stand or lie down comfortably. This kind of bedding will also help to absorb liquid matter (slurry). Thus the slurry consistency changes to a semi-solid until it becomes a stackable solid (Grundey, 1980).

According to Statistik Peternakan (1989), the annual production of waste or manure is approximately 6.6 tonnes per head of cattle and 7.3 tonnes per head of buffalo. Furthermore, Setyamidjaja (1986) added that the manure production per year of horse is 6.5 tonnes per head, 0.6 - 0.9 tonne per head of goat / sheep, and 1.4 tonnes per head of pig.

Leaver (1988) concluded that a cow typically defaecates 10 - 15 times during the day. If we used an average of 12 times per day, that means a cow will defaecate every two hours and produce approximately 1.5 kilograms per time. This means that weekly manure produced = 7 (days) x 12 (times) x 1.5 kilograms = 126 kilograms.

8.1 Passive and active manuring

There are two ways of transporting manure to the field. If manure is produced in a stable and then deliberately placed on the fields, we shall call this "**active manuring**".

Otherwise, when animals are grazing in the field and deposit their manure there, we shall call this process **"passive manuring"**. This cannot be done to any extent when farmers grow three crops in a year.

Passive manuring can only occur during fallow periods, but these are very limited in duration in this village situation. Given that cattle in the field have to be minded, we consider that eight hours per week is a reasonable estimate of the time they could be in the field. This is less than 5 per cent of the time (8 hours out of 168 hours in a week) and then only may occur during about 6 fallow weeks in a year. Thus passive manuring would put only about half a per cent of all manure produced on the fields. Therefore a deliberate policy of active manuring is necessary to manure the fields to any extent.

8.2. The Characteristics of Manure

According to Buckman, et al.(1982) characteristics of manure are:

(1) High moisture content

The moisture content of manure ranges between 50 and 80 percent, depending on whether it is old or new.

(2) Nutrients easily lost

The plant nutrients in the manure are very easily lost, whether as a gas or by leaching into the ground.

(3) Low in nutrient content compared with artificial fertilizer

Each ton of cattle manure contains 6 kilograms Nitrogen, 11.5 kilograms P_2O_5, and 4.5 kilograms K_2O. In comparison, the nutrient content of artificial fertilizer is, Urea, 46 percent Nitrogen; Triple Super Phosphate (TSP), 46 percent P_2O_5; and Potassium Chloride (KCl), 49 percent K_2O. It is clear that the nutrient content of manure is lower than artificial fertilizer.

(4) Unbalanced nutrient content

In the soil P_2O_5 (phosphate acid) is usually not available in sufficient quantity, and also the phosphorus which is in fertilizer will be absorbed by the soil. Therefore, compound inorganic fertilizer should contain more P_2O_5 than Nitrogen and K_2O. Usually, the composition of nutrients (N - P_2O_5 - K_2O) in the compound fertilizer is, 1 - 1 - 1, 1 - 2 - 1, and / or 1 - 3 - 1; while, according to Buckman et al (1982), the composition of nutrients in manure is 5 - 1 - 5.

8.3. The Content of Nutrients in Manure

The content of nutrients in manure depends on the kind of livestock, as is shown in Table 8.1.

The data in Table 8.1 below show that the content of Nitrogen and K2 O in slurry is higher than in solid manure; conversely the content of P2 O5 (except cattle) is lower. (It seems that Setyamidjaja might have included a typing error in P2 O5 content for slurry for cattle).

Table 8.1

The Nutrient Content of Manure

LIVESTOCK	THE CONTENT OF NUTRIENT AND WATER (%)			
	N	P2 O5	K2 O	WATER
1. HORSE				
- solid	0.55	0.30	0.40	75
- slurry	1.40	0.02	1.60	90
2. BUFFALO				
- solid	0.60	0.30	0.34	85
- slurry	1.00	0.15	1.50	92
3. CATTLE				
- solid	0.40	0.20	0.10	85
- slurry	1.00	0.50	1.50	92
4. GOAT				
- solid	0.60	0.30	0.17	60
- slurry	1.50	0.13	1.80	85
5. SHEEP				
- solid	0.75	0.50	0.45	60
- slurry	1.35	0.05	2.10	85
6. PIG				
- solid	0.95	0.35	0.40	80
- slurry	0.40	0.10	0.45	97
7. CHICKEN				
- solid+ slurry	1.00	0.80	0.40	55

Sources: Setyamidjaja (1986).

8.4 Benefits of Manuring

Sunarlim et al (1989) in their experiment concluded that applying 20 tonnes per hectare of manure on Soybean increased plant dry weight, total Nitrogen, nodule number, number of filled pods and grain yield (Table 8.2)

Table 8.2

The Influence of Manure on Soybean growth

Variables		The Amount of Manure (t/ha)	
		0	20
- plant dry weight			
(gr/plant)	(6 wap)*	2.23	3.17
	(8 wap)*	6.29	7.58
- total Nitrogen			
(gr/plant)		0.076	0.110
- nodule number/plant		28.00	36.40
- number of			
filled pod / plant		14.30	22.10
- grain yield (Kg/ha)		1563	1694

* wap : weeks after planting

Table 8.2 above shows that the use of 20 tonnes of manure as fertilizer on soybean increased yield 131 kilograms per hectare. If the soybean price was Rp.802 per kilogram (its price in 1990), that means the manure would have contributed an additional revenue of 131 x Rp.802 = Rp.105 062. This works out at Rp.5253 per tonne, or Rp.5.25 per kilogram of manure.

8.5. The Money Value of Manure

Based on the nutrient contents, the comparison of the value of manure (organic fertilizer) and inorganic fertilizers (Urea, T.S.P., and KCl), is as follows:

(1) The nutrient content of manure

Nitrogen (N) : 6.0 kilograms / Tonne;

P_2O_5 : 11.5 kilograms / Tonne;

K_2O : 4.5 kilograms / Tonne.

(2) The annual nutrient content of the manure from one head of cattle:

Nitrogen (N) : 6,6 x 6,0 kgs = 39.6 kgs / Year;

P_2O_5 : 6.6 x 11.5 kgs = 75.9 kgs / Year;

K_2O : 6.6 x 4.5 kgs = 29.7 kgs / Year.

Since Nitrogen gas loss is 10 percent, the annual content of Nitrogen in manure is 39.6 kgs - 3.96 kgs = 35.6 kgs /Year.

(3) The annual amount and value of inorganic fertilizers used for Rice-Rice-Soybean (Based on Recommendation)

Urea (46 % N) : 625 kgs = 287.50 kgs N = Rp.112500.

TSP (46%P2 O5) : 300 kgs = 138 kgs P2 O5= Rp. 63000.

KCl (49 %K2 O) : 150 kgs = 73.5 kgs K2 O= Rp. 31500.

TOTAL = Rp.207000.

(4) The annual value of the Manure from one head of cattle:

Nitrogen =(35.64/287.50) x Rp.112500 = Rp.13946.09

P2 O5 = (75.9/138) x Rp.63000 = Rp.34650.00

K2 O = (29.7 /73.50) x Rp.31500 = Rp.12728.57

(5) The value of cattle manure per Tonne

Nitrogen (N) = Rp. 2113.04 / Tonne;

P2 O5 = Rp. 5250.00 / Tonne;

K2 O = Rp. 1928.57 / Tonne.

TOTAL = Rp. 9291.61 / Tonne.

or the value of manure = Rp.9.29 / Kg.

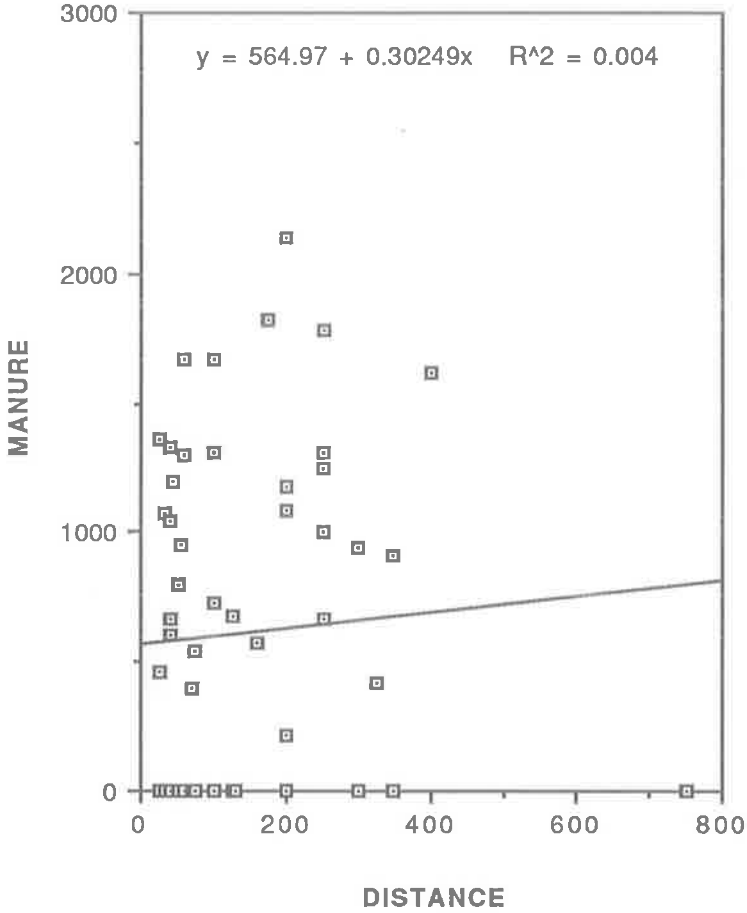
In other words, one Tonne of manure is mathematically equal / equivalent to : Urea 12.69 kgs; TSP 25.00 kgs; and KCL 9.18 kgs. Based on the prices of these chemicals, the implied value of manure is Rp.9.3 per kilogram. This corresponds closely with the price of manure in Java, of between 10 and 20 rupiah per kilogram. The implied value does not take into account any other ingredients or the contribution of manure to soil structure. According to Sunarlim's analysis in chapter 8.4 above, the manure would be valued at about Rp.5.25 per kilogram, somewhat lower than Rp.9.3 according to this section.

8.6 The Relationship between Distance of Stable from Field and Application of Manure

We need to consider whether the low volume of manure added to secondary crops was due to transportation costs to the field.

The amount of manure which is used by the farmer for his secondary crop showed no significant relationship to the distance of the store of manure to the nearest field of the farmer. To investigate the possibility that the manure was not used because of the implicit cost of transporting it to more distant fields we examine the villages surveyed. We have looked to see whether more manure was spread by farmers whose nearest field was closest to the cattle stables. The data on this distance was not collected directly in the survey, but the author knows the villages well, and has been able to estimate the relative distances

Figure 8.1
The Relationship Between Distance and Application of Manure



for all farmers with what is hoped is reasonable accuracy. The relationship between distance of nearest field and application of manure is shown in Appendix C. The scatterplot of the points, is given in Figure 8.1.

As can be seen in the figure, and is confirmed in regression equation $Y = 564.97 + 0.3025 X$ and $R^2 = 0.004$, there is no apparent relationship between these variables. Thus, even allowing for the subjective nature of the data, it seems that the quantity of manure spread on the field does not depend on the distance of transporting it.

The reasons for manure not being used to any extent appear therefore to be primarily social or informational ones, or related to the cost and inconvenience of storage and spreading.

8.7. Manure Storage

According to Buckman et al.(1982), the ways of the manure storage, are:

(1) Storage in a pile

The farmer often stores the manure in an open place. To protect the manure from leaching, a level concrete floor must be used.

(2) Store in a tank or box

Farmers in Europe usually store the manure in a concrete tank or box. But in Lombok, this is not common because the cattle stable is very close to the farmer's house; and also the farmer has a small sized yard.

(3) Covered Stable

The farmer stores manure in a covered stable. Buckman said that the nutrient losses can be minimized in this way.

Additionally, Setyamidjaja (1986) mentioned that there are two ways of manure storage. They are :

1). Mixed-storage, where the solid and slurry (liquid waste) are mixed in one place as a postal. This way causes gaseous loss either as NH3 or as N gas.

2). Separated-storage, where the solid and slurry are stored in different places.

2.a Solid manure storage

Solid manure is better stored in a place which has a concrete floor and walls, and is covered. The floor size is approximately 3 x 5 metres per head of cattle. The way of storage is, as follows:

- The manure is mixed to become homogeneous;

- It is spread on the floor, and stepped on to be compacted. This way will minimize N loss, and will keep the moisture in the manure;
- The surface of the manure must be covered by soil, to protect it from moisture and sunlight.

2.b. Slurry storage

The storage of slurry uses a concrete tank or box; it is approximately 2 x 3 metres per head of cattle. The tank or box must be covered closely to prevent losses of NH_3.

Grundey (1980) said that there are three principal routes by which plant nutrients are lost from farmyard manure, namely by leaching, loss of gases and seepage of liquid.

(1) Leaching

If enough rain falls onto the manure the nutrients will be lost into the ground. The amount of such loss varies with rainfall, exposure to wind, the storage arrangements and length of time in the store.

(2) Gaseous loss

In this way about 10 percent of Nitrogen is lost either as NH_3 produced by partial decomposition or as N gas, while manure in a compacted heap loses little gas.

(3) Seepage is the loss of liquids from within the heap or the gravy, into the ground.

Grundey (1980) also noted that Dutch investigations into this admittedly difficult problem put Nitrogen losses at about 20 percent, phosphate at 5 percent or just over, and potash at 35 percent over the winter storage period. On the other hand, other researchers have tried to investigate the amounts of Nitrogen loss in practically sized stores with very varying results. Reports are available showing losses from as little as 5 percent to over 6.5 percent.

Furthermore, Nitrogen is lost as a gas; the amount depending on:

- the length of storage period;
- the type of material put in the store, in turn affected by the livestock concerned and their plane of feeding;
- the weather; mainly a temperature effect, less loss in cold weather;
- the exposure of the store, which is linked to the weather effect.

This problem faces the practising farmer who wants to determine the fertilizer value of his store before calculating how much to spread per hectare. By this means, the thinking farmer will reduce his artificial Nitrogen to save money and also avoid using excessive Nitrogen on the crop.

8.8 Storage and Spreading Costs

The storage of manure is still a problem to the farmer, particularly for small farmers who do not have enough room. The storage of manure near the farmer's place will pollute the environment.

Let us estimate roughly the cost of storage of manure. We shall ignore labour costs entirely to begin with. A covered shed of dimension 4 metres x 2 metres, and 2.5 metres high, could store approximately 20 tonnes of manure. The shed would require a concrete floor (lasting 20 years), at an estimated cost of Rp.50,000. The construction of brick walls and a waterproof roof is estimated to cost a further Rp.150,000, but would need to be replaced every five years. The approximate annual cost of storage would be of the order of Rp.40,000 (1/5 of Rp.150,000 + 1/20 of Rp.50,000 + interest on initial loan).

At Rp.5,250 per tonne (i.e. the lower figure of Rp.5.25 per kilogram), the amount stored would have a value of Rp.105,000. At Rp.9.3 per kilogram the value stored would be Rp.180,000. (Currently, when manure is little used, a farmer intent on manuring a secondary crop could probably obtain enough fresh manure from droppings in the vicinity of the village, and so not have to store it. However, if manure were to be widely used, this would not be possible, and storage costs would need to be calculated).

Thus,ignoring the labour costs of putting the manure into storage, taking it out, transporting it to the field and spreading it, the cost of storage would be a relatively small amount compared with of the value of the manure to the farmer. On top of this, however, a farmer not only has to transport manure to the fields but also spread it. To remove, transport and spread 20 tonnes on one hectare as part of cultivation is estimated to take 10 person days. At a labour cost of Rp.2,000 per day, it would cost Rp.20,000 to do this. Added to the cost of storage, the total cost of utilizing the manure is estimated to be Rp.60,000 per 20 tonnes. The cost of putting manure in storage is estimated to be zero, as it would simply be an extra daily chore. However, if the cost of putting the manure into store is included at ordinary wage rates, a cost of Rp.10,000 per year is estimated, over and above the cost of sweeping it away. In total, the full cost of manure, in terms of both material costs and imputed labour costs, is thus Rp.70,000 per year.

The above analysis assumes that the storage of manure consists of putting it in the shed till the shed is full to the roof, leaving it till it is needed, then emptying the shed once per year. If secondary crops are used at different times of the year (eg.some fields use rice-soybean-rice, and others, rice-rice-soybean) then it would be possible to fill and empty a store twice annually. This would effectively halve the storage cost (though not the labour cost of storage), so the total cost would be Rp.50,000 per 20 tonnes.

8.8.1 Summary

	(1) Filled once per year Rp.	(2) Filled twice per year Rp.
Annual cost of storage of 20 tonnes manure	40,000	20,000
Labour cost of storing of 20 tonnes (putting it in and removing it)....	10,000	10,000
Labour cost of removing, transportation and spreading 20 tonnes	20,000	20,000
	--------	-------
	70,000	50,000
Benefit at implied value of Rp.5.25/kg	105,000	
Benefit at implied value of Rp.9.3/kg	186,000	

From the cost-benefit analysis of manure use, it is concluded that the value of 20 tonnes of manure net of the costs of storing, transporting and spreading it on one hectare, is between Rp 35,000 and Rp.135,000, on average say Rp.85,000. For a farmer owning 0.40 hectare, the benefit would be on average Rp.34,000 per year (between Rp.14,000 and Rp.54,000), compared with an income of

Rp.2,000,000 per year. That is, the farmer's income would increase by about 1.7 percent per year (between 0.7 and 2.7 percent) as a result of utilizing manure more fully.

The policy implication is that Government authorities should look more closely at the potential for using natural manures more fully. The costing for storage and spreading should be done more rigorously, and if the sums still remain significantly positive, greater emphasis on extension work, for applications for credit, etc. should be placed on the encouragement of natural manuring by farmers.

8.9. Timing Problem of Manuring

The other problem is one of timing. The variety of rice which is grown by farmers is a High Yield Variety (HYV), which has a short growth period. This variety needs a large burst of N at a particular time. N is slow-release in manure. Thus rice will need inorganic fertilizer. Manure is therefore only useful for secondary crops.

8.10 Soil structure improvement

One of benefits of using manure as fertilizer is to improve soil structure. It is not useful to do this for rice because it needs a lot of water, so soil is still flooding during rice growing. However, manure is very useful for the secondary crop after rice. On soil which has a good structure, manure can be spread on the field at the time of soil cultivation of the secondary crop directly . But on heavy soil such as fertisol, the farmer may perhaps put manure into the rice cycle because it is more easily incorporated into the soil then. There is a trade-off between ease of application and the loss of nutrients due to its early application.

8.11. The Application of Manure

According to Buson (1981) animal manures are considered as a source of pollution to be purified. The most effective and the most economic way of dealing with this problem is its recycling in agriculture through spreading on soil.

Buckman et al (1982) advised that manure should be utilized as soon as possible. This way minimizes the time and labour of fertilizing, and also minimizes leaching of plant nutrients.

For annual crops such as rice, corn, soybean, peanut, the manure is usually spread on the soil approximately 1 to 2 weeks before planting or at the time of soil cultivation (Setyamidjaja, 1986).

8.12. Extra Benefits

Beside the economical benefits as mentioned above, utilizing the waste of livestock as fertilizer means purifying the pollution, in other words, creating an environmental conservation, and also it can be used to build up the soil.

8.13 Overview

Manure may be of moderate or occasionally significant benefit to the farmer. Its value per kilogram is low. An estimate of its value implied by its nutrients is Rp.9 per kilogram, while from the study of its effect on soybean production is only Rp.5.3 per kilogram. In the presence of widespread use of inorganic fertilizer, it is of no use for rice production, and its benefits must be weighed against its bulkiness and storage costs. It is estimated that the application of stored manure to secondary crops would increase farmers' income by between 0.7 and 2.7 percent per year.

CHAPTER NINE

IMPLICATIONS AND CONCLUSION

9.1 Introduction

This study has looked at a number of aspects of the economics of two villages in West Lombok (Gunung Sari and Penimbung). The sampled villages are typical of villages in that part of Indonesia. The income of villages is derived mostly from farming. About 90 percent of the households are primarily farmers, 8 percent are merchants, 1.5 percent shopkeepers and 0.5 percent others. The main farming activity consists of the growing of crops. On irrigated lowland, three crops are grown per year, typically two of rice and one of a secondary crop (corn, soybean and peanuts). There are 92.150 hectare in Gunung Sari and 152.165 hectare in Penimbung of this sort of land. On unirrigated upland, one crop is grown per year, usually cassava. There are 125.000 hectare in Gunung Sari and 459.590 hectare in Penimbung of this sort of land. The average size of holding is 0.406 hectare in Gunung Sari and 0.472 hectare in Penimbung.

The richer farmers also own cattle, which are used to cultivate the fields, for meat on rare (and usually ceremonial) occasions, and importantly, as a store of value. Prior to independence in 1945 there were no banks serving the village, and the primary store of value was in the form of livestock. The tradition is still largely maintained.

The aim of this study has been to see how improvements can be made to the welfare of the people of these villages. In particular, it has been hoped to see whether gains can be made in the greater integration of crop farming with livestock farming. But it has also been the aim to look at the whole farming enterprise, to see where improvements can be made.

9.2 Findings

The following main findings have been made.

(1) Farmers with livestock have significantly higher gross margins than those without.

At first glance, this would appear to suggest that there are gains through integration of livestock farming with cropping. However, farmers with livestock pay as much or more for soil cultivation as those without livestock, so there is no saving by individual farmers through the integration of livestock and cropping. Furthermore, very little manure is used (less than 2 percent of that available per annum) on crops, although most of the manure used is by farmers with livestock. What is apparent is that the total inputs of farmers with livestock are significantly higher than those without (14 percent higher). It is therefore inferred that the reason for the difference in gross margin of 14.5 percent between those with and those without livestock is due mainly to a lack of capital.

(2) The gross margin of farmers growing peanuts in 1990 was over 25 percent higher than that of farmers growing soybeans as the secondary crop. Given that of the total receipts from cropping, some 40 percent or more is due to the two rice crops and nearly 60 percent due to the secondary crop, it is clear that for the secondary crop alone, the gross margin of peanuts was almost 50 percent higher than that of soybeans.

One innovative aspect of this thesis has been to examine whether this was due to the high peanut prices of 1990. By examining the prices from 1985 to 1989, a price for all major crops was predicted for 1990. Since farmers make their planting decisions on the basis of predicted prices rather than actual ones, it was felt to be important to examine whether the expected gross margins based on the predicted prices still showed a difference between the peanut growers and the soybean growers. Although the difference was no longer so great (down from 26% , to between 16% and 18%), peanut growing was still significantly more profitable (on an expected basis) than soybean farming. The reasons for this discrepancy are apparently a combination of risk aversion (peanut prices are much more variable than those of soybeans) and government encouragement of soybean planting.

(3) A case has been made for encouraging the use of natural manures. The benefits of supplementing inorganic fertilizers with organic ones have been examined carefully. Two ways of putting an implicit value on manure have been used, giving values of Rp.5.25 and Rp.9.3 per kilogram, compared with a selling price on Java of Rp.10 to Rp.20 per kilogram. Against this are placed considerable costs of storing , transporting and spreading the manure, as well as the disadvantage of manure not being able to be used on rice, which needs quick- release nitrogen. Nevertheless, the research done points to the possibility of some modest gains (of about 0.7 t0 2.7 percent of income) to be made by increasing efforts to store and use more manure than is currently the case.

(4) No relationship was found to exist between the level of formal education and the farmer's level of economic performance. This could have been for several reasons.
The first is due to the way information was recorded about farming households. The 'farmer' was invariably the oldest working-age male in the household, except for two households headed by women. Such older men are likely to have low formal education. Their sons who remained in the

village were not treated as farmers, but as helpers, and it is not clear whether decisions affecting the profitability of the enterprise would be made in conjunction with these better- educated younger men. That is, decisions made on farms headed by uneducated farmers might have been made or influenced by their better educated sons.

The other explanation for the lack of a relationship between education and gross margin per hectare is that the informal educational system, particularly the agricultural extension system, fill the gaps left by the formal system.

(5) A case has been made for increasing the quantities of protein crops by decreasing the secondary starch crops such as cassava and sweet potato, and replacing those crops by higher outputs of rice.

9.3 Policy Implications

(1) As a lack of capital amongst poorer farmers appears to be a major cause of low productivity, further extension of rural credit schemes specially aimed at farmers with the smallest amounts of land, or who are landless, should be investigated and piloted. This could give rise to a dramatic improvement in productivity.

(2) Government encouragement of soybeans as a secondary crop should be reviewed carefully. Consideration should be given to schemes of encouraging diversity of secondary cropping. This would have two effects: it would help to stabilise incomes, but it would also allow a gradual transition to higher value crops, notably peanuts. This policy would need careful annual monitoring, as the increased incomes from a greater reliance on peanuts depend crucially on relative prices.

(3) Schemes to encourage the greater use of animal manures should be considered. This thesis has provided a framework for conducting a cost-benefit study of the greater use of animal manures, but further work needs to be done to improve some of the cost estimates.

(4) A study of the effectiveness of the agricultural extension system is required, to determine the extent to which it can overcome the lack of formal education.

Of those implications, probably the most important, in order , are (2), (1), (3), and (4). Of course, they are all important, but in terms of the ease and speed of implementation, it would appear that the second implication could be undertaken quickly and at little cost, for some potentially large rewards. The first implication could have even more dramatic rewards, but would be harder to implement. The third is more modest in its potential benefits, but may not be hard to implement, while the fourth is a much longer-term project.

For the whole country, there is reason to believe that the second implication may not be as beneficial as it would be to an individual farmer who switches from soybean to peanuts. A single farmer who does so, could expect to increase his gross margin by about 17 percent, or so. However, if the switch to peanuts occurs more widely, the gain to those switching to peanuts will be largely offset by the loss to those already growing peanuts, as their returns will fall when the price of peanuts falls. There will be a net positive gain in this process, but it may be of the order of only one or two percent, on average, per farmer as parity in gross margins is reached.

9.4 Research Implications

Integrated Farm Management involves science disciplines such as food crop production, livestock production, management, economics (including agricultural economics), marketing, and others.

To support the results of this survey, it would be beneficial to carry out further studies on the integration of food crop production and livestock production, whether concerning crop production itself or other subjects. One important study would be further applied science research on how to collect and store waste from livestock before it is used as fertilizer to minimize the loss of nutrients.

9.5 Conclusions

This thesis has shown how a systematic study of the economic conditions of poor farmers (small farmers) can point to a number of potential improvements in their conditions, in the areas of:

(1) improving the access to capital of the poorest farmers.
(2) increasing the gross margins by better crop selection.
(3) helping to stabilise incomes by greater crop diversity.
(4) increasing the protein crops by further phasing down the secondary starch crops.
(5) encouraging the use of animal manures on crops.
(6) better utilization of agricultural extension services
.

Further research into many of these issues is justified. In some cases, such as the evaluation of costs and benefits of animal manure, many of the estimated figures are not firmly based. This thesis has provided a framework into which firmer estimates can be placed.

Finally, it should be noted that in many respects this thesis has merely scratched the surface of the research that could be done in this area. No follow up on the costs and benefits of better seeds or of the benefits of additional expenditure on weeding, for example, have been attempted. Almost no work has been done on the sampled villages of Central and East Lombok. Nothing has been done on the contribution of livestock to meat production, or on the role of non farming employment, and almost none on any social or sociological variables, including the role played by women in the productive process. These items await further reasearch efforts.

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APPENDIX 1

FARM MANAGEMENT SURVEY

QUESTIONNAIRE

District :
Sub District :
Village :

No. Respondent: | |

Date interview: | |

I. IDENTITY

1. Full Name:

....

2. Sex:

.... Male
.... Female

3. Place of birth:

....

4. Date of birth:

......|......|......

5. Status respondent:

.... Married
.... Single
.... No longer married

6. If married, the number of children :
- Male ....
- Female ....
Total ....

7. The family's members:

No.	Relationships	Sex		Age
1.	....	M	F	.....
2.	....	M	F	.....
3.	....	M	F	.....
4.	....	M	F	.....
5.	....	M	F	.....
6.	....	M	F	.....
7.	....	M	F	.....
8.	....	M	F	.....
9.	....	M	F	.....
10.	....	M	F	.....

8. The number of fami - ly's members:

Age	Numbers'	
	M	F
< 10	.....	.....
10-14	.....	.....
15-39	.....	.....
40-50	.....	.....
> 50	.....	.....
Total	.....	.....

9. Education

Name	Relationship	Education
1.	....	....
2.	....	....
3.	....	....
4.	....	....
5.	....	....
6.	....	....
7.	....	....
8.	....	....
9.	....	....
10.	....	....

10. Occupation:

... farmer
... official
... merchant
... others

11. Incomes (per-year)

Sources	Rp.	A$.
a. As a farmer	....	....
b. Besides as a farmer	....	....
Total Income	....	....

II. ENTERPRISES

12. Farm size:

Status	Size(Ha)
Own	....
Tenant	....
Total	....

13. Based on condition:

Conditions	Size (Ha)
a.Irrigated lowlands	....
b.Rainfed lowlands	....
c.Uplands	....
Total	....

14. Crops grown in 1989/1990 (Rainy and Dry seasons)

(1).Irrigated lowlands

..... rice ... peanut
..... corn ... other foodcrops
..... soybean

(2).Rainfed lowlands

....rice .... peanut
....corn .... other foodcrops
....soybean

(3). Uplands

..... rice ..... soybean .... other foodcrops
..... corn ..... peanut

15. Crops rotation (per-year)

a.Irriagated lowlands

..................¦.................¦.............

b.Rainfed lowlands

..................¦.................¦.............

c.Uplands

..................¦.................¦.............

16. Livestock

	Number's
a. Cattle	....
b. Buffallo	....
Total	....

17. The benefits

- organic fertilizer ...
- power of cultiva tion .
- others ...

18. How did you manage your livestock ?

..... in the stable

..... free on the field

19. What kind of feed are you given ?

.... straw
.... grass
.... legumes
.... others

20. How many kilograms of feed do you give your livestock ?

Livestock	Feed	Per-day (kg)	Per-year (kg)
a. Cattle	-straw	....	....
	-grass	....	....
	-legumes	....	....
	-others	....	....
b. Buffalo	-straw	....	....
	-grass	....	....
	-legumes	....	....
	-others	....	....

III. INTEGRATED FARMING SYSTEMS

21. Condition of lands:

-irrigated lowlands ¦ rainfed lowlands ¦ uplands

22. In one year:

First crop :	- Rice	Corn	Soybean	Peanut	Others
Second crop:	- Rice	Corn	Soybean	Peanut	Others
Third Crop :	- Rice	Corn	Soybean	Peanut	Others

23. How much labour did you use in Soil cultivation activities ?

.... persons, including family members ... persons

.... livestock (... cattle ; ... buffalo)

24. What kind of fertilizers did you use?

... UREA
... TSP
... KCl
... ZK
... ZA
... Waste of livestock
... legumes

25. How many kilograms of fertilizers did you use ?

Fertilizers	kg/size holding	kg/ha
UREA	....	....
TSP	....	....
KCl	....	....
ZK	....	....
ZA	....	....
Waste o.ls.	....	....
Legumes	....	....

26. If the farmer / respondent did not use waste o. ls. and/or legumes fertilizers, give some reasons !

27. What system did you use in your farming?

-Intercropping ....

-Mixed cropping ....

-Mixed farming ....

28. What crops :

...............¦..................¦................

IV. ANALYSIS OF FARMING (PER-YEAR)

29. Crops: ... Rice (irrigated ¦ rainfed ¦ uplands)
... Corns ... Peanuts
... Soybeans ... Others

30. Analysis

A. INPUTS	Volume	Rp./ea.	Total	
			Rp.	A $.
1. Soil Cultivation				
- Labour	....	....	....	....
- Livestock	....	....	....	....
2. Seeds..........	....	....	....	....
3. Planting	....	....	....	....
4. Fertilizers				
UREA	....	....	....	....
TSP	....	....	....	....
KCl	....	....	....	....
ZK	....	....	....	....
ZA	....	....	....	....
Waste o.ls.	....	....	....	....
Legumes	....	....	....	....
5. Fertilizing	....	....	....	....
6. Weeds control	....	....	....	....
7. Pesticides	....	....	....	....
8. Spraying	....	....	....	....
9. Other maintenance	....	....	....	....
10.Harvesting	....	....	....	....
11.Post harvest	....	....	....	....
TOTAL INPUTS			....	....
B. Production / OUTPUTS	....	....	....	....
GROSS-MARGIN (B-A)			....	....

FARM INCOME ANALYSIS (PER YEAR)

Name of Respondent :.........................

District :.........................

Farm size :.............hectare.

ENTERPRISES	hectare	% area	Yields (qt/ha)	Total Gross Margin (Rp.)
1. Rice	....	....	....	....
2. Soybean	....	....	....	....
3. Corn	....	....	....	....
4. Peanut	....	....	....	....
5. others	....	....	....	....

TOTAL FARM GROSS MARGIN...............................

Fixed Costs :

1.	....	....	....
2.	....	....	....
3.	....	....	....
4.	....	....	....
5.	....	....	....

TOTAL FIXED COSTS ....

PROFIT / FARM INCOME ....

Interviewer:............................
Occupation :............................
Signiture :

FARM SIZE DISTRIBUTION

FARM SIZE (in hectare)		DISTRIBUTION	% AREA
< .1		....	....
.1 -	< .2	....	....
.2 -	< .3	....	....
.3 -	< .4	....	....
.4 -	< .5	....	....
.5 -	< .75	....	....
.75 -	< 1.00	....	....
1.00 -	< 1.50	....	....
1.50 -	< 2.00	....	....
2.00 -	>	....	....

AVERAGE REAL YIELD OF EACH DISTRICT in 1989

District	Average Real Yield (qt/ha)
1. West Lombok	....
2. Central Lombok	....
3. East Lombok	....
4. Sumbawa	....
5. Dompu	....
6. Bima	....
AVERAGE REAL YIELD OF PROVINCE	....

APPENDIX 2

The Amount of Manure Used

HAVE LIVESTOCK			DO NOT HAVE LIVESTOCK		
No.	Area Ha.	Manure kgs	No.	Area Ha.	Manure kgs
A.West Lombok					
1.	1.075	0	1.	0.400	0
2.	2.500	2000	2.	0.470	0
3.	0.250	300	3.	0.170	200
4.	1.400	300	4.	0.400	0
5.	0.185	300	5.	0.400	0
6.	0.220	300	6.	0.390	0
7.	0.590	400	7.	0.500	0
8.	0.480	500	8.	0.930	0
9.	0.280	300	9.	1.250	0
10.	0.300	0	10.	1.000	0
11.	0.280	300	11.	0.140	0
12.	1.050	600	12.	0.075	0
13.	0.170	200	13.	0.110	0
14.	0.415	300	14.	0.500	0
15.	0.920	500	15.	0.530	0
16.	0.500	300	16.	0.650	0
17.	0.685	0	17.	0.250	0
18.	0.220	200	18.	0.110	0
19.	0.110	200	19.	0.080	0
20.	0.380	500	20.	0.070	100
21.	0.300	500	21.	0.300	0
22.	0.120	400	22.	0.100	0
23.	0.140	300	23.	0.350	0
24.	0.460	500	24.	0.150	0
25.	0.450	300	25.	0.400	0
26.	0.380	500	26.	0.100	0
27.	0.650	300	27.	0.250	0
28.	0.210	200	28.	0.300	0
29.	0.230	300	29.	0.300	0
30.	1.075	0	30.	0.300	0
31.	0.750	500	31.	0.300	0
32.	0.300	400	32.	0.300	0
33.	0.450	0	33.	0.450	0
34.	0.050	0	34.	0.550	0
35.	0.170	0	35.	0.250	0
36.	0.400	500	36.	0.200	0
37.	0.200	0	37.	0.170	0
38.	0.250	0	38.	0.500	0
39.	0.200	0	39.	0.170	0
40.	0.100	100	40.	0.600	0
41.	0.150	0	41.	0.100	0
42.	0.500	0	42.	0.500	0
43.	0.250	0	43.	0.500	0
44.	1.000	0	44.	0.500	0
45.	0.500	0	45.	0.500	0
46.	0.500	200	46.	0.150	0

47.	1.000	0	47.	1.000	0
48.	0.250	0	48.	0.400	0
49.	0.250	0	49.	0.500	0
50.	0.850	0	50.	0.350	0
51.	0.870	0	51.	0.400	0
52.	0.500	0	52.	0.500	0
53.	0.850	800	53.	0.170	0
54.	0.300	500	54.	0.600	0
55.	0.400	0	55.	0.350	0
56.	0.200	0	56.	0.250	0
57.	0.600	250	57.	0.400	0
58.	0.500	0	58.	0.500	0
			59.	0.200	0
			60.	0.500	0
			61.	0.500	0
			62.	0.500	0
			63.	0.500	0
Total:	28.365	14,250	Total:	33.970	300

The total of livestock which are possessed by respondents is 123 heads.
The production of waste or manure annually 6,600 kgs per head. This is equal to 123 x 6,600 kgs = 811,800 kgs= 811.8 tons.
The amount of manure which are used for farming= 14,550 kgs or 1.79 percent of manure production.

HAVE LIVESTOCK			DO NOT HAVE LIVESTOCK		
No.	Area Ha.	Manure kgs	No.	Area Ha.	Manure kgs
B. Central Lombok					
1.	2.000	0	1.	7.500	0
2.	0.750	0	2.	0.500	0
3.	1.000	0	3.	1.000	0
4.	1.000	0	4.	1.000	0
5.	3.000	0	5.	0.500	0
6.	2.000	0	6.	1.000	0
7.	0.500	0	7.	0.500	0
8.	2.000	0	8.	1.000	0
9.	0.600	0	9.	0.800	0
10.	0.500	0	10.	0.250	0
11.	5.000	0	11.	1.000	0
12.	1.000	0	12.	1.000	0
13.	0.500	0	13.	0.250	0
14.	0.500	0	14.	0.500	0
15.	1.000	0	15.	0.500	0
16.	0.500	0	16.	0.500	0
17.	1.000	0	17.	0.750	0
18.	0.500	0	18.	1.750	0
19.	0.500	0	19.	1.000	0
20.	1.000	0	20.	2.000	0
21.	1.000	0	21.	2.000	0
22.	0.500	0	22.	4.000	0
23.	0.500	0	23.	4.000	0
24.	1.000	0	24.	8.000	0
25.	0.500	0	25.	6.500	0
26.	1.500	0			
27.	0.500	0			
28.	15.000	0			
29.	15.000	0			
30.	8.000	0			
31.	1.000	0			
32.	0.750	0			
33.	0.200	0			
34.	3.000	0			
35.	4.000	0			
36.	0.750	0			
37.	4.000	0			
38.	2.000	0			
39.	0.700	0			
40.	0.500	0			
41.	1.200	0			
42.	1.000	0			
43.	2.500	0			
44.	1.300	0			
45.	0.500	0			
46.	2.000	0			
47.	3.000	0			

48.	1.000	0
49.	0.500	0
50.	0.250	0
51.	1.500	0
52.	1.500	0
53.	2.000	0
54.	2.000	0
55.	0.500	0
56.	0.500	0
57.	0.500	0
58.	0.500	0
59.	0.500	0
60.	1.000	0
61.	0.500	0
62.	1.000	0
63.	1.000	0
64.	0.800	0

Total: 113.800	0	Total:	47.800	0

The total of livestock which are possessed by respondents is 219 heads.

The production of waste or manure annually = 219 x 6,600 kgs = 1,445,400 kgs.

The amount of manure which are used for farming = 0 kg. or 0 percent of manure production.

HAVE LIVESTOCK No.	Area Ha.	Manure kgs	DO NOT HAVE LIVESTOCK No.	Area Ha.	Manure kgs
C. East Lombok					
1.	0.400	0	1.	0.500	0
2.	0.250	0	2.	0.600	0
3.	0.400	0	3.	0.400	0
4.	0.400	0	4.	0.900	0
5.	0.500	0	5.	1.000	0
6.	0.500	0	6.	0.300	0
7.	0.600	0	7.	0.400	0
8.	0.250	0	8.	0.600	0
9.	0.250	0	9.	0.800	0
10.	0.500	0	10.	0.300	0
11.	0.350	0	11.	0.900	0
12.	0.250	0	12.	0.500	0
13.	0.500	0	13.	0.300	0
14.	0.250	0	14.	0.300	0
15.	0.750	0	15.	0.250	0
16.	0.200	0	16.	0.700	0
17.	0.200	0	17.	1.250	0
18.	0.350	0	18.	0.150	0
19.	0.300	0	19.	0.500	0
20.	0.450	0	20.	0.600	0
21.	0.250	0	21.	0.800	0
22.	0.250	0	22.	0.500	0
23.	1.000	0	23.	0.600	0
24.	0.450	0	24.	0.300	0
25.	0.250	0	25.	0.700	0
26.	0.500	0	26.	0.500	0
27.	0.250	0	27.	1.000	0
28.	4.000	0	28.	0.500	0
29.	0.250	0	29.	0.100	0
30.	0.120	0	30.	0.500	0
31.	0.520	0	31.	0.300	0
32.	3.500	0	32.	0.200	0
33.	5.000	0	33.	0.150	0
34.	1.000	0	34.	0.400	0
35.	0.150	0	35.	0.300	0
36.	0.300	0	36.	0.100	0
37.	0.750	0	37.	0.630	0
38.	0.300	0	38.	0.250	0
39.	0.300	0	39.	0.600	0
40.	0.400	0	40.	0.750	0
41.	0.300	0	41.	0.150	0
42.	0.500	0	42.	0.250	0
43.	0.500	0	43.	4.000	0
44.	0.800	0	44.	0.650	0
45.	0.150	0	45.	1.000	0
46.	0.250	0	46.	0.200	0
47.	0.350	0	47.	0.250	0

48.	0.600	0	48.	1.000	0
49.	0.900	0	49.	0.250	0
50.	0.200	0	50.	0.250	0
51.	0.800	0	51.	0.400	0
52.	0.300	0	52.	0.650	0
53.	0.900	0	53.	1.000	0
54.	0.150	0	54.	0.300	0
55.	0.200	0	55.	0.500	0
56.	1.000	0	56.	0.210	0
57.	0.300	0	57.	0.300	0
58.	0.300	0	58.	0.200	0
			59.	0.200	0
			60.	0.400	0
			61.	0.050	0
Total:	37.590	0	Total:	32.640	0

The total of livestock which are possessed by respondents is 153 heads.

The production of waste or manure annually =153 x 6,600 kgs = 1,009,800 kgs.

The amount of manure which are used for farming = o kg. or 0 percent of manure production.

APPENDIX 3

Farmgate, Retail and Real Farmgate Prices
of Rice, Corn, Peanut and Soybean
in Lombok, West Nusa Tenggara, Indonesia

RICE	1985	1986	1987	1988	1989	1990
Retail Price	286	306	339	424	463	510
Farmgate Price	134	150	178	194	278	241
Real Fg-Price	58.88	60.15	62.76	59.99	78.3	61.71

CORN	1985	1986	1987	1988	1989	1990
Retail Price	153	195	206	240	229	235
Farmgate Price	164	178	202	200	180	215
Real Fg-Price	72.07	71.38	71.22	61.84	50.7	55.05

PEANUT	1985	1986	1987	1988	1989	1990
Retail Price	866	1011	1086	1461	1330	1466
Farmgate Price	817	973	740	815	1344	1426
Real Fg-Price	359.03	390.2	260.89	252.01	378.56	365.14

SOYBEAN	1985	1986	1987	1988	1989	1990
Retail Price	464	562	650	655	728	937
Farmgate Price	454	554	630	625	682	802
Real Fg-Price	199.51	222.17	222.11	193.26	192.09	205.36

	1985	1986	1987	1988	1989	1990
RICE	58.88	60.15	62.76	59.99	78.3	61.71
CORN	72.07	71.38	71.22	61.84	50.7	55.05
PEANUT	3598.03	390.2	260.89	252.01	378.58	365.14
SOYBEAN	199.51	222.17	222.11	193.26	192.09	205.36

Source: Central Bureau of Statistics on Indonesia (1985-1989) and Food Crop Agricultural Office West Nusa Tenggara Province (1991).

APPENDIX 4

The Relationships Between Output and Inputs, Manure, and Educational Level of Farmers (Irrigated Lowland/With Livestock)

Dependent Variable: IROUT_HA

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	4484694.5168	4484694.5168	22.802	0.0001
Error	56	11014209.346	196682.30974		
C Total	57	15498903.862			

Root MSE	443.48879	R-square	0.2894
Dep Mean	3506.73832	Adj R-sq	0.2767
C.V.	12.64676		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	1292.136271	467.42150386	2.764	0.0077
IRINP_HA	1	1.732170	0.36274940	4.775	0.0001

Dependent Variable: IROUT_HA

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	1599406.3937	1599406.3937	6.444	0.0139
Error	56	13899497.469	248205.31194		
C Total	57	15498903.862			

Root MSE	498.20208	R-square	0.1032
Dep Mean	3506.73832	Adj R-sq	0.0872
C.V.	14.20699		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	3354.652811	88.70655022	37.817	0.0001
IWAST_HA	1	0.231894	0.09135163	2.538	0.0139

Dependent Variable: IROUT_HA

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	47675.56394	47675.56394	0.173	0.6792
Error	56	15451228.299	275914.79105		
C Total	57	15498903.862			

Root MSE	525.27592	R-square	0.0031
Dep Mean	3506.73832	Adj R-sq	-0.0147
C.V.	14.97905		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > ¦T¦
INTERCEP	1	3550.270591	125.39737983	28.312	0.0001
EDC1	1	-15.302252	36.81246733	-0.416	0.6792

APPENDIX 5

The Relationships Between Output and Inputs, Manure and Educational Level (Irrigated Lowland/With Livestock)

Step 1 Variable IRINP_HA Entered R-square = 0.28935559 C(p) = 0.37683403

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	1	4484694.5168103	4484694.5168103	22.80	0.0001
Error	56	11014209.345671	196682.30974413		
Total	57	15498903.862482			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	1292.13627079	467.42150386	1503019.3024669	7.64	0.0077
IRINP_HA	1.73216990	0.36274940	4484694.5168103	22.80	0.0001

Bounds on condition number 1 1

The above model is the best 1-variable model found.

Step 2 Variable IWAST_HA Entered R-square = 0.29323986 C(p) = 2.07961903

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	2	4544896.4078254	2272448.2039127	11.41	0.0001
Error	55	10954007.454656	199163.77190284		
Total	57	15498903.862482			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	1404.95403722	513.17293471	1492818.7787403	7.50	0.0083
IRINP_HA	1.61733924	0.42055957	2945490.0141302	14.79	0.0003
IWAST_HA	0.05183393	0.09427884	60201.89101505	0.30	0.5847

Bounds on condition number: 1.327384, 5.309536

The above model is the best 2-variable model found.

Step 3 Variable EDC1 Entered R-square = 0.29428039 C(p) = 4.00000000

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	3	4561023.5080848	1520341.1693616	7.51	0.0003
Error	54	10937880.354397	202553.33989624		
Total	57	15498903.862482			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	1431.87690530	526.24349704	1499606.4273865	7.40	0.0087
IRINP_HA	1.61691633	0.42412587	2943913.0664966	14.53	0.0004
IWAST_HA	0.05030136	0.09523274	56510.13124889	0.28	0.5995
EDC1	-8.92041987	31.61381139	16127.10025941	0.08	0.7789

Bounds on condition number: 1.331716, 10.99119

The above model is the best 3-variable model found.

No further improvement in R-square is possible.

APPENDIX 6

The Relationships Between Outputs and Soil Cultivation, Inorganic Fertilizer, Manure, and Educational Level of Farmer (Irrigated Lowland/With Livestock)

Step 1 Variable IWAST_HA Entered R-square = 0.10319481 C(p) = 2.95395986

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	1	1599406.3936952	1599406.3936952	6.44	0.0139
Error	56	13899497.468786	248205.31194262		
Total	57	15498903.862482			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	3354.65281126	88.70655022	354972616.02098	1430.16	0.0001
IWAST_HA	0.23189437	0.09135163	1599406.3936952	6.44	0.0139

Bounds on condition number: 1, 1

The above model is the best 1-variable model found.

Step 2 Variable IFERT_HA Entered R-square = 0.16320812 C(p) = 1.14265712

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	2	2529547.0362874	1264773.5181437	5.36	0.0074
Error	55	12969356.826194	235806.48774899		
Total	57	15498903.862482			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	2837.58817620	274.32649948	25230099.185527	106.99	0.0001
IFERT_HA	0.61321849	0.30875842	930140.64259218	3.94	0.0520
IWAST_HA	0.20598144	0.08999156	1235402.1833965	5.24	0.0259

Bounds on condition number: 1.021472, 4.085886

Step 3 Variable ICLS_HA Entered R-square = 0.18090390 C(p) = 2.01884091

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	3	2803812.0840109	934604.02800362	3.98	0.0124
Error	54	12695091.778471	235094.29219390		
Total	57	15498903.862482			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	2937.24371103	289.03387164	24278651.968907	103.27	0.0001
ICLS_HA	-1.84668840	1.70973748	274265.04772350	1.17	0.2849
IFERT_HA	0.68455462	0.31528699	1108271.5982824	4.71	0.0343
IWAST_HA	0.26027462	0.10296005	1502340.1655373	6.39	0.0144

Bounds on condition number: 1.402045, 11.43461

The above model is the best 3-variable model found.

Step 4 Variable EDC1 Entered R-square = 0.18115434 C(p) = 4.00293584

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	4	2807693.6860835	701923.42152087	2.93	0.0291
Error	53	12691210.176398	239456.79578110		
Total	57	15498903.862482			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	2920.13283176	321.17375701	19794852.829124	82.67	0.0001
ICLS_HA	-1.86790663	1.73355706	278010.50697335	1.16	0.2861
IFERT_HA	0.69140918	0.32272126	1099112.8651076	4.59	0.0368
IWAST_HA	0.26143090	0.10430706	1504227.8470441	6.28	0.0153
EDC1	4.44695455	34.92776279	3881.60207259	0.02	0.8992

Bounds on condition number: 1.415124, 19.61093

The above model is the best 4-variable model found.

Step 5 Variable ICLAB_HA Entered R-square = 0.18120057 C(p) = 6.00000000

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	5	2808410.1706474	561682.03412949	2.30	0.0579
Error	52	12690493.691834	244047.95561220		
Total	57	15498903.862482			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	2928.27509528	357.36837392	16385763.774636	67.14	0.0001
ICLAB_HA	-0.07291795	1.34576317	716.48456397	0.00	0.9570
ICLS_HA	-1.81130316	2.03817700	192740.80715854	0.79	0.3783
IFERT_HA	0.68933490	0.32804185	1077648.6402193	4.42	0.0405
IWAST_HA	0.26251622	0.10719043	1463778.8730762	6.00	0.0177
EDC1	4.18248150	35.59724529	3369.07321603	0.01	0.9069

Bounds on condition number: 1.919349, 35.90155

The above model is the best 5-variable model found.

No further improvement in R-square is possible.

UPLAND / WITH LIVESTOCK
Correlation Analysis

4 'VAR' Variables: UPOUT_HA UPINP_HA UWAST_HA EDC1

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
UPOUT_HA	58	915.8	128.4	53114.8	373.3	1200.0
UPINP_HA	58	301.8	89.9552	17505.7	173.5	415.0
UWAST_HA	58	14.6901	69.6355	852.0	0	428.6
EDC1	58	2.8448	1.8900	165.0	1.0000	5.0000

Pearson Correlation Coefficients / Prob > ¦R¦ under Ho: Rho=0 / N = 58

	UPOUT_HA	UPINP_HA	UWAST_HA	EDC1
UPOUT_HA	1.00000	0.48853	-0.13681	0.13986
	0.0	0.0001	0.3058	0.2951
UPINP_HA	0.48853	1.00000	-0.04745	0.07969
	0.0001	0.0	0.7236	0.5521
UWAST_HA	-0.13681	-0.04745	1.00000	0.17895
	0.3058	0.7236	0.0	0.1789
EDC1	0.13986	0.07969	0.17895	1.00000
	0.2951	0.5521	0.1789	0.0 1

APPENDIX 7

The Relationships Between Output and Inputs, Manure, and Educational Level (Upland / With Livestock)

Dependent Variable: UPOUT_HA

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	224292.53923	224292.53923	17.555	0.0001
Error	56	715485.60327	12776.52863		
C Total	57	939778.14249			

Root MSE	113.03331	R-square	0.2387
Dep Mean	915.77178	Adj R-sq	0.2251
C.V.	12.34296		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	705.299357	52.38032700	13.465	0.0001
UPINP_HA	1	0.697339	0.16643432	4.190	0.0001

Dependent Variable: UPOUT_HA

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	17591.04023	17591.04023	1.068	0.3058
Error	56	922187.10226	16467.62683		
C Total	57	939778.14249			

Root MSE	128.32625	R-square	0.0187
Dep Mean	915.77178	Adj R-sq	0.0012
C.V.	14.01291		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	919.477768	17.22735676	53.373	0.0001
UWAST_HA	1	-0.252277	0.24408864	-1.034	0.3058

Dependent Variable: UPOUT_HA

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	18382.42091	18382.42091	1.117	0.2951
Error	56	921395.72158	16453.49503		
C Total	57	939778.14249			

Root MSE	128.27118	R-square	0.0196
Dep Mean	915.77178	Adj R-sq	0.0021
C.V.	14.00689		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > ¦T¦
INTERCEP	1	888.740619	30.62175327	29.023	0.0001
EDC1	1	9.501864	8.98952030	1.057	0.2951

APPENDIX 8

The Relationship Between Output and Inputs, Manure and Educational Level (on Upland/With Livestock)

Step 1   Variable UPINP_HA Entered   R-square = 0.23866541   C(p) = 2.09068846

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	1	224292.53922649	224292.53922649	17.56	0.0001
Error	56	715485.60326608	12776.52862975		
Total	57	939778.14249257			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	705.29935740	52.38032700	2316452.7079833	181.31	0.0001
UPINP_HA	0.69733886	0.16643432	224292.53922649	17.56	0.0001

Bounds on condition number: 1, 1

The above model is the best 1-variable model found.

Step 2   Variable UWAST_HA Entered   R-square = 0.25160748   C(p) = 3.13719290

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	2	236455.20589603	118227.60294801	9.25	0.0003
Error	55	703322.93659654	12787.68975630		
Total	57	939778.14249257			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	710.71252609	52.69633442	2326050.9205932	181.90	0.0001
UPINP_HA	0.68962531	0.16669474	218864.16566194	17.12	0.0001
UWAST_HA	-0.21000801	0.21533643	12162.66666954	0.95	0.3337

Bounds on condition number: 1.002256, 4.009025

The above model is the best 2-variable model found

Step 3 Variable EDC1 Entered R-square = 0.26704291 C(p) = 4.00000000

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	3	250961.09218994	83653.69739665	6.56	0.0007
Error	54	688817.05030263	12755.87130190		
Total	57	939778.14249257			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	691.66372276	55.57945098	1975475.3717445	154.87	0.0001
UPINP_HA	0.67363111	0.16716145	207148.66767050	16.24	0.0002
UWAST_HA	-0.25282544	0.21878427	17034.11161169	1.34	0.2529
EDC1	8.61395046	8.07765499	14505.88629391	1.14	0.2910

Bounds on condition number: 1.041467, 9.26714

The above model is the best 3-variable model found.

No further improvement in R-square is possible.

APPENDIX 9

The Relationships Between Outputs and Soil Cultivation, Inorganic Fertilizer, Manure, and Educational Level (Upland/With Livestock)

Maximum R-square Improvement for Dependent Variable UPOUT_HA

Step 1 Variable UCLAB_HA Entered R-square = 0.26131383 C(p) = 2.50948297

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	1	245577.02713447	245577.02713447	19.81	0.0001
Error	56	694201.11535810	12396.44848854		
Total	57	939778.14249257			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	734.63325964	43.24352038	3577637.7922269	288.60	0.0001
UCLAB_HA	4.00089583	0.89890131	245577.02713447	19.81	0.0001

Bounds on condition number: 1, 1

The above model is the best 1-variable model found.

Step 2 Variable UCLS_HA Entered R-square = 0.30304066 C(p) = 1.31738143

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	2	284790.98442046	142395.49221023	11.96	0.0001
Error	55	654987.15807211	11908.85741949		
Total	57	939778.14249257			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	638.63437450	67.78778787	1056992.1297112	88.76	0.0001
UCLAB_HA	4.39506758	0.90742829	279367.95272309	23.46	0.0001
UCLS_HA	3.26418067	1.79882494	39213.95728599	3.29	0.0750

Bounds on condition number: 1.060786, 4.243144

The above model is the best 2-variable model found.

Step 3 Variable EDC1 Entered R-square = 0.30559999 C(p) = 3.12159216

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	3	287196.19358870	95732.06452957	7.92	0.0002
Error	54	652581.94890387	12084.85090563		
Total	57	939778.14249257			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	634.68759888	68.85753077	1026735.1555177	84.96	0.0001
UCLAB_HA	4.33393099	0.92432396	265678.77358994	21.98	0.0001
UCLS_HA	3.12793081	1.83762471	35014.01618147	2.90	0.0945
EDC1	3.50702412	7.86109376	2405.20916823	0.20	0.6573

Bounds on condition number: 1.090919, 9.650062

The above model is the best 3-variable model found.

Step 4 Variable UWAST_HA Entered R-square = 0.30718943 C(p) = 5.00000000

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	4	288689.91483712	72172.47870928	5.87	0.0005
Error	53	651088.22765545	12284.68354067		
Total	57	939778.14249257			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	639.38399915	70.71885472	1004192.7076900	81.74	0.0001
UCLAB_HA	4.25696386	0.95771724	242710.90701801	19.76	0.0001
UCLS_HA	3.05004770	1.86616987	32815.18746835	2.67	0.1081
UWAST_HA	-0.07692415	0.22060224	1493.72124842	0.12	0.7287
EDC1	4.13377495	8.12706971	3178.26175147	0.26	0.6131

Bounds on condition number: 1.14547, 17.76749

The above model is the best 4-variable model found.

No further improvement in R-square is possible.

APPENDIX 10

The Relation Between Output and Inputs, Manure, and Educational Level (Irrigated Lowland/Without Livestock)

Dependent Variable: IROUT_HA

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	20085697.537	20085697.537	82.265	0.0001
Error	61	14893641.17	244158.05196		
C Total	62	34979338.707			

Root MSE	494.12352	R-square	0.5742
Dep Mean	3035.99436	Adj R-sq	0.5672
C.V.	16.27551		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-1468.136248	500.48267974	-2.933	0.0047
IRINP_HA	1	4.065813	0.44826976	9.070	0.0001

Dependent Variable: IROUT_HA

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	2317466.2281	2317466.2281	4.328	0.0417
Error	61	32661872.479	535440.53243		
C Total	62	34979338.707			

Root MSE	731.73802	R-square	0.0663
Dep Mean	3035.99436	Adj R-sq	0.0509
C.V.	24.10209		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	3001.432565	93.67520593	32.041	0.0001
IWAST_HA	1	0.835838	0.40176400	2.080	0.0417

Dependent Variable: IROUT_HA

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	500497.93314	500497.93314	0.885	0.3504
Error	61	34478840.773	565226.89793		
C Total	62	34979338.707			

Root MSE	751.81573	R-square	0.0143
Dep Mean	3035.99436	Adj R-sq	-0.0019
C.V.	24.76341		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > ¦T¦
INTERCEP	1	2912.650690	161.71915758	18.011	0.0001
EDC1	1	49.811867	52.93502007	0.941	0.3504

APPENDIX 11

The Relation Between Output and Inputs, Manure, and Educational Level (Irrigated Lowland/Without Livestock)

Step 1 Variable IRINP_HA Entered R-square = 0.57421605 C(p) = 1.64152957

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	1	20085697.537043	20085697.537043	82.27	0.0001
Error	61	14893641.169562	244158.05196004		
Total	62	34979338.706605			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	-1468.13624751	500.48267974	2100998.1453441	8.61	0.0047
IRINP_HA	4.06581275	0.44826976	20085697.537043	82.27	0.0001

Bounds on condition number: 1, 1

The above model is the best 1-variable model found.

Step 2 Variable IWAST_HA Entered R-square = 0.58104684 C(p) = 2.66880840

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	2	20324599.162813	10162299.581406	41.61	0.0001
Error	60	14654739.543792	244245.65906321		
Total	62	34979338.706605			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	-1361.51698919	512.04954924	1726827.7029188	7.07	0.0100
IRINP_HA	3.95926705	0.46111148	18007132.934712	73.73	0.0001
IWAST_HA	0.27600284	0.27907274	238901.62577001	0.98	0.3266

Bounds on condition number: 1.057736, 4.230943

The above model is the best 2-variable model found.

Step 3 Variable EDC1 Entered R-square = 0.58574176 C(p) = 4.00000000

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	3	20488859.405340	6829619.8017800	27.81	0.0001
Error	59	14490479.301265	245601.34408924		
Total	62	34979338.706605			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	-1407.18563464	516.49634245	1823051.8647617	7.42	0.0085
IRINP_HA	3.93671567	0.46321094	17739494.117009	72.23	0.0001
IWAST_HA	0.27177314	0.27989396	231556.38247357	0.94	0.3355
EDC1	28.60284085	34.97504721	164260.24252719	0.67	0.4168

Bounds on condition number: 1.061498, 9.372788

The above model is the best 3-variable model found.

No further improvement in R-square is possible.

APPENDIX 12

The Relationships Between Output and Soil Cultivation, Inorganic Fertilizer, Manure and Educational Level (Irrigated Lowland/Without Livestock)

Maximum R-square Improvement for Dependent Variable IROUT_HA

Step 1 Variable ICLAB_HA Entered R-square = 0.25767983 C(p) = 6.70072037

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	1	9013469.8870225	9013469.8870225	21.17	0.0001
Error	61	25965868.819583	425669.98064890		
Total	62	34979338.706605			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	2252.50621552	189.06747418	60418699.794106	141.94	0.0001
ICLAB_HA	6.45961798	1.40377447	9013469.8870225	21.17	0.0001

Bounds on condition number: 1, 1

The above model is the best 1-variable model found.

Step 2 Variable ICLS_HA Entered R-square = 0.31665589 C(p) = 3.48091043

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	2	11076413.783926	5538206.8919629	13.90	0.0001
Error	60	23902924.922679	398382.08204466		
Total	62	34979338.706605			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	1796.56222511	271.29377784	17470472.794089	43.85	0.0001
ICLAB_HA	5.28501697	1.45282249	5271903.6040269	13.23	0.0006
ICLS_HA	6.16362043	2.70858255	2062943.8969032	5.18	0.0265

Bounds on condition number: 1.144468, 4.577872

The above model is the best 2-variable model found.

Step 3 Variable IWAST_HA Entered R-square = 0.34655931 C(p) = 2.83424166

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	3	12122415.313212	4040805.1044041	10.43	0.0001
Error	59	22856923.393393	387405.48124395		
Total	62	34979338.706605			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	1823.28447943	268.02402920	17927806.991029	46.28	0.0001
ICLAB_HA	4.94233250	1.44776748	4514732.7452504	11.65	0.0012
ICLS_HA	6.07410698	2.67156267	2002626.2447217	5.17	0.0266
IWAST_HA	0.56911071	0.34634863	1046001.5292867	2.70	0.1057

Bounds on condition number: 1.168719, 10.02242

The above model is the best 3-variable model found.

Step 4 Variable IFERT_HA Entered R-square = 0.35266519 C(p) = 4.29382637

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	4	12335995.201082	3083998.8002705	7.90	0.0001
Error	58	22643343.505523	390402.47423316		
Total	62	34979338.706605			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	2157.12216371	525.45939522	6579361.0628117	16.85	0.0001
ICLAB_HA	5.03221838	1.45842866	4647946.7233220	11.91	0.0011
ICLS_HA	6.26870159	2.69475016	2112665.5056501	5.41	0.0235
IFERT_HA	-0.41760718	0.56460414	213579.88786946	0.55	0.4625
IWAST_HA	0.59858144	0.34996135	1142138.8076408	2.93	0.0925

Bounds on condition number: 1.176891, 17.6726

The above model is the best 4-variable model found.

Step 5 Variable EDC1 Entered R-square = 0.35598499 C(p) = 6.00000000

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	5	12452119.606707	2490423.9213414	6.30	0.0001
Error	57	22527219.099898	395214.37017365		
Total	62	34979338.706605			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	2078.83537920	548.05965008	5686136.3279285	14.39	0.0004
ICLAB_HA	4.75726276	1.55258734	3710521.2909313	9.39	0.0033
ICLS_HA	6.66784218	2.80951667	2226076.6996073	5.63	0.0210
IFERT_HA	-0.40704631	0.56840699	202675.63430300	0.51	0.4768
IWAST_HA	0.59818119	0.35211224	1140606.8866732	2.89	0.0948
EDC1	25.71465774	47.43898189	116124.40562519	0.29	0.5899

Bounds on condition number: 1.317521, 28.96945

The above model is the best 5-variable model found.

No further improvement in R-square is possible.

The Relationships Between Output and Inputs, Manure, and Educational Level (Upland /Without Livestock)

Correlation Analysis

4 'VAR' Variables: UPOUT_HA UPINP_HA UWAST_HA EDC1

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
UPOUT_HA	63	958.4	298.7	60382.3	267.9	2720.0
UPINP_HA	63	348.6	138.8	21959.2	114.3	1134.7
UWAST_HA	63	15.8730	126.0	1000.0	0	1000.0
EDC1	63	2.4762	1.8037	156.0	1.0000	5.0000

Pearson Correlation Coefficients / Prob > ¦R¦ under Ho: Rho=0 / N = 63

	UPOUT_HA	UPINP_HA	UWAST_HA	EDC1
UPOUT_HA	1.00000 0.0	0.82085 0.0001	0.33067 0.0081	0.13492 0.2918
UPINP_HA	0.82085 0.0001	1.00000 0.0	0.02024 0.8749	0.07447 0.5619
UWAST_HA	0.33067 0.0081	0.02024 0.8749	1.00000 0.0	0.17913 0.1601
EDC1	0.13492 0.2918	0.07447 0.5619	0.17913 0.1601	1.00000 0.0

APPENDIX 13

The Relationships Between Output and Inputs, Manure, and Educational Level (Upland / Without Livestock)

Dependent Variable: UPOUT_HA

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	3727542.2453	3727542.2453	125.998	0.0001
Error	61	1804636.4672	29584.20438		
C Total	62	5532178.7124			

Root MSE	172.00059	R-square	0.6738
Dep Mean	958.44946	Adj R-sq	0.6684
C.V.	17.94571		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	342.715990	58.97961548	5.811	0.0001
UPINP_HA	1	1.766516	0.15737518	11.225	0.0001

Dependent Variable: UPOUT_HA

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	604891.69833	604891.69833	7.489	0.0081
Error	61	4927287.0141	80775.196952		
C Total	62	5532178.7124			

Root MSE	284.20978	R-square	0.1093
Dep Mean	958.44946	Adj R-sq	0.0947
C.V.	29.65308		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	946.005092	36.09467769	26.209	0.0001
UWAST_HA	1	0.783995	0.28649262	2.737	0.0081

Dependent Variable: UPOUT_HA

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	100705.11459	100705.11459	1.131	0.2918
Error	61	5431473.5978	89040.550784		
C Total	62	5532178.7124			

Root MSE	298.39663	R-square	0.0182
Dep Mean	958.44946	Adj R-sq	0.0021
C.V.	31.13327		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	903.121900	64.18654197	14.070	0.0001
EDC1	1	22.343821	21.00997766	1.063	0.2918

APPENDIX 14

The Relationships Between Output and Inputs, Manure, and Educational Level (Upland / Without Livestock)

Maximum R-square Improvement for Dependent Variable UPOUT_HA

Step 1 Variable UPINP_HA Entered R-square = 0.67379281 C(p) = 25.71042111

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	1	3727542.2452636	3727542.2452636	126.00	0.0001
Error	61	1804636.4671551	29584.20437959		
Total	62	5532178.7124187			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	342.71599002	58.97961548	998906.30839606	33.76	0.0001
UPINP_HA	1.76651601	0.15737518	3727542.2452636	126.00	0.0001

Bounds on condition number: 1, 1

The above model is the best 1-variable model found.

Step 2 Variable UWAST_HA Entered R-square = 0.77246379 C(p) = 2.08725805

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	2	4273407.7227791	2136703.8613895	101.85	0.0001
Error	60	1258770.9896396	20979.51649399		
Total	62	5532178.7124187			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	335.66140514	49.68645741	957463.49621016	45.64	0.0001
UPINP_HA	1.75283264	0.13255404	3668516.0244480	174.86	0.0001
UWAST_HA	0.74491410	0.14603640	545865.47751550	26.02	0.0001

Bounds on condition number: 1.00041, 4.001639

The above model is the best 2-variable model found.

Step 3 Variable EDC1 Entered R-square = 0.77279981 C(p) = 4.00000000

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	3	4275266.6328696	1425088.8776232	66.89	0.0001
Error	59	1256912.0795491	21303.59456863		
Total	62	5532178.7124187			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	329.11896348	54.74869302	769858.99705942	36.14	0.0001
UPINP_HA	1.74998343	0.13392172	3637631.5727331	170.75	0.0001
UWAST_HA	0.73704390	0.14955240	517431.45608953	24.29	0.0001
EDC1	3.09365571	10.47295486	1858.91009048	0.09	0.7687

Bounds on condition number: 1.038538, 9.232096

The above model is the best 3-variable model found.

No further improvement in R-square is possible.

APPENDIX 15

The Relationships Between Output and Soil Cultivation, Inorganic Fertilizer, Manue, and Educational Level. (Upland / Without Livestock)

Maximum R-square Improvement for Dependent Variable UPOUT_HA

Step 1 Variable UWAST_HA Entered R-square = 0.10934059 C(p) = 10.74720649

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	1	604891.69833111	604891.69833111	7.49	0.0081
Error	61	4927287.0140876	80775.19695226		
Total	62	5532178.7124187			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	946.00509182	36.09467769	55485389.292913	686.91	0.0001
UWAST_HA	0.78399491	0.28649262	604891.69833111	7.49	0.0081

Bounds on condition number: 1, 1

The above model is the best 1-variable model found.

Step 2 Variable UCLAB_HA Entered R-square = 0.22780900 C(p) = 3.46998981

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	2	1260280.0865916	630140.04329581	8.85	0.0004
Error	60	4271898.6258271	71198.31043045		
Total	62	5532178.7124187			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	630.33807531	109.42301413	2362650.1777950	33.18	0.0001
UCLAB_HA	6.85809314	2.26041849	655388.38826050	9.21	0.0036
UWAST_HA	0.89391913	0.27140256	772392.92509191	10.85	0.0017

Bounds on condition number: 1.018144, 4.072577

The above model is the best 2-variable model found.

Step 3 Variable UCLS_HA Entered R-square = 0.25471151 C(p) = 3.36326403

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	3	1409109.5968250	469703.19894168	6.72	0.0006
Error	59	4123069.1155937	69882.52738294		
Total	62	5532178.7124187			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	440.89349635	169.12666508	474910.55043591	6.80	0.0116
UCLAB_HA	7.67886882	2.30897964	772899.26621726	11.06	0.0015
UCLS_HA	5.80546876	3.97811256	148829.51023343	2.13	0.1498
UWAST_HA	0.88457638	0.26895923	755903.52058367	10.82	0.0017

Bounds on condition number: 1.082363, 9.502517

The above model is the best 3-variable model found.

Step 4 Variable EDC1 Entered R-square = 0.25935033 C(p) = 5.00000000

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	4	1434772.3614583	358693.09036456	5.08	0.0014
Error	58	4097406.3509605	70644.93708553		
Total	62	5532178.7124187			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	423.91295170	172.36483910	427304.09755349	6.05	0.0169
UCLAB_HA	7.69791874	2.32175596	776594.92856187	10.99	0.0016
UCLS_HA	5.33040816	4.07667704	120778.42425787	1.71	0.1962
UWAST_HA	0.85669758	0.27434986	688853.15441401	9.75	0.0028
EDC1	11.70793174	19.42535582	25662.76463321	0.36	0.5490

Bounds on condition number: 1.107834, 17.26546

The above model is the best 4-variable model found.

No further improvement in R-square is possible.

APPENDIX 16

Analysis of Labour Used for Soil Cultivation Between Crop Model and Live Model

Analysis of Variance Procedure

Dependent Variable: SCLABHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	22494.9349	3749.1558	3.21	0.0060
Error	114	133142.2891	1167.9148		
Corrected Total	120	155637.2240			

R-Square	C.V.	Root MSE	SCLABHA Mean
0.144534	45.81028	34.1748	74.6007

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	5551.6054	1850.5351	1.58	0.1970
LIVEMDL	1	19186.7978	19186.7978	16.43	0.0001
CROPMDL*LIVEMDL	2	0.0000	0.0000	0.00	1.0000

Analysis of Variance Procedure

Dependent Variable: COSCLBHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	77897.0690	12982.8448	3.48	0.0034
Error	114	425139.8391	3729.2968		
Corrected Total	120	503036.9081			

R-Square	C.V.	Root MSE	COSCLBHA Mean
0.154854	42.15628	61.0680	144.861

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	16085.5649	5361.8550	1.44	0.2355
LIVEMDL	1	66566.3249	66566.3249	17.85	0.0001
CROPMDL*LIVEMDL	2	0.0000	0.0000	0.00	1.0000

APPENDIX 17

Analysis of Livestock Used for Soil Cultivation Between Crop Model and Live Model

Analysis of Variance Procedure

Dependent Variable: SCLSHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	432.402459	72.067077	0.27	0.9477
Error	114	29890.091556	262.193786		
Corrected Total	120	30322.494015			

R-Square	C.V.	Root MSE	SCLSHA Mean
0.014260	45.20584	16.1924	35.8193

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	188.683511	62.894504	0.24	0.8684
LIVEMDL	1	30.678961	30.678961	0.12	0.7329
CROPMDL*LIVEMDL	2	213.039987	106.519993	0.41	0.6671

Analysis of Variance Procedure

Dependent Variable: COSCLSHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	6492.29944	1082.04991	0.74	0.6195
Error	114	166989.25358	1464.81801		
Corrected Total	120	173481.55302			

R-Square	C.V.	Root MSE	COSCLSHA Mean
0.037424	37.41656	38.2729	102.289

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	3190.99595	1063.66532	0.73	0.5384
LIVEMDL	1	2357.37425	2357.37425	1.61	0.2072
CROPMDL*LIVEMDL	2	943.92924	471.96462	0.32	0.7252

APPENDIX 18

Analysis of Seed's Value per Hectare Between Crop Model and Live Model

Analysis of Variance Procedure

Dependent Variable: SEEDHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	268128.589	44688.098	48.31	0.0001
Error	114	105446.973	924.973		
Corrected Total	120	373575.562			

R-Square	C.V.	Root MSE	SEEDHA Mean
0.717736	24.14963	30.4134	125.937

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	264169.078	88056.359	95.20	0.0001
LIVEMDL	1	20584.237	20584.237	22.25	0.0001
CROPMDL*LIVEMDL	2	0.000	0.000	0.00	1.0000

APPENDIX 19

**Analysis of Planting per Hectare
Between Crop Model and Live Model**

Analysis of Variance Procedure

Dependent Variable: PLANLBHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	9890.96443	1648.49407	4.23	0.0007
Error	114	44410.85509	389.56890		
Corrected Total	120	54301.81952			

R-Square	C.V.	Root MSE	PLANLBHA Mean
0.182148	31.74351	19.7375	62.1781

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	5713.35090	1904.45030	4.89	0.0031
LIVEMDL	1	4416.15474	4416.15474	11.34	0.0010
CROPMDL*LIVEMDL	2	0.00000	0.00000	0.00	1.0000

Analysis of Variance Procedure

Dependent Variable: COPLANHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	1897.97359	316.32893	1.17	0.3297
Error	114	30938.91656	271.39400		
Corrected Total	120	32836.89015			

R-Square	C.V.	Root MSE	COPLANHA Mean
0.057800	18.43042	16.4740	89.3851

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	1541.73020	513.91007	1.89	0.1346
LIVEMDL	1	199.11898	199.11898	0.73	0.3935
CROPMDL*LIVEMDL	2	157.12441	78.56220	0.29	0.7492

APPENDIX 20

Analysis of Fertilizing per Hectare
Between Crop Model and Live Model

Analysis of Variance Procedure

Dependent Variable: FERTHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	1877.00044	312.83341	0.76	0.6060
Error	114	47174.55003	413.81184		
Corrected Total	120	49051.55047			

R-Square	C.V.	Root MSE	FERTHA Mean
0.038266	11.46778	20.3424	177.387

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	910.763729	303.587910	0.73	0.5340
LIVEMDL	1	152.327134	152.327134	0.37	0.5452
CROPMDL*LIVEMDL	2	813.909578	406.954789	0.98	0.3772

Analysis of Variance Procedure

Dependent Variable: FERTLBHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	536.402610	89.400435	0.57	0.7558
Error	114	17973.466529	157.661987		
Corrected Total	120	18509.869139			

R-Square	C.V.	Root MSE	FERTLBHA Mean
0.028979	61.33468	12.5564	20.4719

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	414.798639	138.266213	0.88	0.4553
LIVEMDL	1	30.024931	30.024931	0.19	0.6634
CROPMDL*LIVEMDL	2	91.579040	45.789520	0.29	0.7485

Analysis of Variance Procedure

Dependent Variable: COFERTHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	1337.63907	222.93984	2.04	0.0656
Error	114	12442.48911	109.14464		
Corrected Total	120	13780.12818			

R-Square	C.V.	Root MSE	COFERTHA Mean
0.097070	66.29250	10.4472	15.7593

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	169.12537	56.37512	0.52	0.6717
LIVEMDL	1	1097.62249	1097.62249	10.06	0.0020
CROPMDL*LIVEMDL	2	70.89121	35.44561	0.32	0.7234

APPENDIX 21

Analysis of Weeding per Hectare Between Crop Model and Live Model

Analysis of Variance Procedure

Dependent Variable: WEEDLBHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	3679.46136	613.24356	0.79	0.5794
Error	114	88471.39280	776.06485		
Corrected Total	120	92150.85417			

R-Square	C.V.	Root MSE	WEEDLBHA Mean
0.039929	31.61068	27.8579	88.1282

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	3566.30520	1188.76840	1.53	0.2101
LIVEMDL	1	46.55746	46.55746	0.06	0.8069
CROPMDL*LIVEMDL	2	66.59871	33.29935	0.04	0.9580

Analysis of Variance Procedure

Dependent Variable: COWEEDHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	2672.01934	445.33656	0.20	0.9769
Error	114	257036.17391	2254.70328		
Corrected Total	120	259708.19325			

R-Square	C.V.	Root MSE	COWEEDHA Mean
0.010289	29.94571	47.4837	158.566

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	1824.15266	608.05089	0.27	0.8471
LIVEMDL	1	514.75363	514.75363	0.23	0.6337
CROPMDL*LIVEMDL	2	333.11304	166.55652	0.07	0.9288

APPENDIX 22

Analysis of Pesticide per Hectare Between Crop Model and Live Model

Analysis of Variance Procedure

Dependent Variable: PESTICHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	2057.82753	342.97126	3.62	0.0025
Error	114	10812.83826	94.84946		
Corrected Total	120	12870.66579			

R-Square	C.V.	Root MSE	PESTICHA Mean
0.159885	133.1980	9.73907	7.31172

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	1902.55976	634.18659	6.69	0.0003
LIVEMDL	1	2.88367	2.88367	0.03	0.8619
CROPMDL*LIVEMDL	2	152.38410	76.19205	0.80	0.4504

APPENDIX 23

Analysis of Spraying per Hectare
Between Crop Model and Live Model

Analysis of Variance Procedure

Dependent Variable: SPRALBHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	156.984128	26.164021	3.80	0.0017
Error	114	785.511399	6.890451		
Corrected Total	120	942.495527			

R-Square	C.V.	Root MSE	SPRALBHA Mean
0.166562	116.4577	2.62497	2.25401

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	125.131855	41.710618	6.05	0.0007
LIVEMDL	1	27.644450	27.644450	4.01	0.0476
CROPMDL*LIVEMDL	2	4.207824	2.103912	0.31	0.7375

Analysis of Variance Procedure

Dependent Variable: COSPRAHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	247.938013	41.323002	3.33	0.0047
Error	114	1414.899058	12.411395		
Corrected Total	120	1662.837071			

R-Square	C.V.	Root MSE	COSPRAHA Mean
0.149105	123.6992	3.52298	2.84802

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	227.809029	75.936343	6.12	0.0007
LIVEMDL	1	5.017598	5.017598	0.40	0.5262
CROPMDL*LIVEMDL	2	15.111385	7.555693	0.61	0.5458

APPENDIX 24

Analysis of Harvesting per Hectare
Between Crop Model and Live Model

Analysis of Variance Procedure

Dependent Variable: COHARVHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	68927.0654	11487.8442	3.14	0.0069
Error	114	416677.3945	3655.0649		
Corrected Total	120	485604.4600			

R-Square	C.V.	Root MSE	COHARVHA Mean
0.141941	20.65697	60.4571	292.672

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	23332.6537	7777.5512	2.13	0.1006
LIVEMDL	1	43372.1240	43372.1240	11.87	0.0008
CROPMDL*LIVEMDL	2	2222.2876	1111.1438	0.30	0.7385

APPENDIX 25

Analysis of Inputs per Hectare
Between Crop Model and Live Model

Analysis of Variance Procedure

Dependent Variable: IRRINPHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	1058985.87	176497.64	9.68	0.0001
Error	114	2079198.57	18238.58		
Corrected Total	120	3138184.44			

R-Square	C.V.	Root MSE	IRRINPHA Mean
0.337452	11.27943	135.050	1197.32

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	541145.332	180381.777	9.89	0.0001
LIVEMDL	1	734453.962	734453.962	40.27	0.0001
CROPMDL*LIVEMDL	2	0.000	0.000	0.00	1.0000

APPENDIX 26

Analysis of Output per Hectare Between Crop Model and Live Model

Analysis of Variance Procedure

Dependent Variable: IROUTHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	12301783.0	2050297.2	5.84	0.0001
Error	114	40038625.8	351216.0		
Corrected Total	120	52340408.8			

R-Square	C.V.	Root MSE	IROUTHA Mean
0.235034	18.07400	592.635	3278.94

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	8671747.57	2890582.52	8.23	0.0001
LIVEMDL	1	5780855.89	5780855.89	16.46	0.0001
CROPMDL*LIVEMDL	2	0.00	0.00	0.00	1.0000

APPENDIX 27

Analysis of Gross Margin per Hectare Between Crop Model and Live Model

Analysis of Variance Procedure

Dependent Variable: GROSSMHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	6510418.18	1085069.70	3.84	0.0016
Error	114	32221540.60	282645.09		
Corrected Total	120	38731958.79			

R-Square	C.V.	Root MSE	GROSSMHA Mean
0.168089	25.53990	531.644	2081.62

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	5091623.48	1697207.83	6.00	0.0008
LIVEMDL	1	2394255.37	2394255.37	8.47	0.0043
CROPMDL*LIVEMDL	2	0.00	0.00	0.00	1.0000

Analysis of Variance Procedure

Dependent Variable: EFFICNCY

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	1.25239780	0.20873297	1.19	0.3176
Error	114	20.02582919	0.17566517		
Corrected Total	120	21.27822699			

	R-Square	C.V.	Root MSE	EFFICNCY Mean
	0.058858	15.31687	0.41912	2.73636

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	1.20059330	0.40019777	2.28	0.0833
LIVEMDL	1	0.04647514	0.04647514	0.26	0.6080
CROPMDL*LIVEMDL	2	0.00532937	0.00266468	0.02	0.9849

APPENDIX 28

Mean of Variables Each Crop Model and Live Model

Analysis of Variance Procedure

Level of CROPMDL	N	SCLABHA Mean	SCLABHA SD	COSCLBHA Mean	COSCLBHA SD
1	4	68.0080214	28.5962161	120.504679	32.5764301
2	28	77.3482111	26.9950192	154.571772	54.1858173
3	39	82.6353676	43.0485817	155.333017	69.0405227
4	50	67.3223685	34.2666002	133.203036	67.5160348

Level of CROPMDL	N	SCLSHA Mean	SCLSHA SD	COSCLSHA Mean	COSCLSHA SD
1	4	36.6143048	13.0266297	96.206551	17.7458155
2	28	36.0080644	10.6025490	107.833717	31.9151845
3	39	37.3537338	15.1929537	106.171065	41.7761311
4	50	34.4530446	19.0692455	96.641991	39.2596972

Level of CROPMDL	N	SEEDHA Mean	SEEDHA SD	PLANLBHA Mean	PLANLBHA SD
1	4	62.930816	2.8654438	60.2673797	16.1300656
2	28	112.156342	36.5860050	49.8584879	15.5389875
3	39	191.706344	39.4197992	65.2719820	19.3732562
4	50	87.395096	17.0188398	66.8166252	23.4852241

Level of CROPMDL	N	COPLANHA Mean	COPLANHA SD	FERTHA Mean	FERTHA SD
1	4	89.4385027	17.4235016	169.663102	9.6755471
2	28	85.5609656	12.8667138	181.795710	19.7625533
3	39	94.3886430	13.1125386	177.022842	18.4513456
4	50	87.6195155	19.8878706	175.820290	22.3047887

Level of CROPMDL	N	FERTLBHA Mean	FERTLBHA SD
1	4	26.1731283	18.9538449
2	28	18.3449508	11.2014573
3	39	22.3197208	13.0415728
4	50	19.7655030	12.0935341

Level of CROPMDL	N	COFERTHA Mean	COFERTHA SD	WEEDLBHA Mean	WEEDLBHA SD
1	4	13.0865642	9.4769224	88.8569519	23.3027015
2	28	17.7964823	9.6533630	80.4212027	25.5290631
3	39	15.1836216	10.2676088	94.9978246	30.5354008
4	50	15.2813176	11.7970961	87.0276150	26.3133015

Level of CROPMDL	N	COWEEDHA Mean	COWEEDHA SD	PESTICHA Mean	PESTICHA SD
1	4	155.815508	43.6011002	8.3088235	5.7453406
2	28	152.228960	44.1255861	12.9920203	14.5140076
3	39	162.657201	43.8214517	2.3123862	4.7271629
4	50	159.143694	50.8374578	7.9504686	9.4027844

Analysis of Variance Procedure

Level of CROPMDL	N	SPRALBHA Mean	SPRALBHA SD	COSPRAHA Mean	COSPRAHA SD
1	4	3.97058824	2.67953929	3.97058824	2.67953929
2	28	3.03314737	2.44968088	4.43951472	4.10580787
3	39	0.81158440	1.72968282	0.95599938	2.00604756
4	50	2.80545679	3.25798891	3.34276233	4.05425163

Level of CROPMDL	N	COHARVHA Mean	COHARVHA SD	IRRINPHA Mean	IRRINPHA SD
1	4	237.415775	56.8165641	1051.86581	27.603521
2	28	310.218403	62.6231807	1217.28795	140.168325
3	39	284.718189	61.0137471	1277.66391	113.354083
4	50	293.470195	64.7193008	1135.09413	179.341898

Level of CROPMDL	N	IROUTHA Mean	IROUTHA SD	GROSSMHA Mean	GROSSMHA SD
1	4	3084.08757	1307.87883	2032.22176	1302.85211
2	28	3420.85567	509.56906	2203.56772	422.97377
3	39	3579.12969	545.06534	2301.46579	528.89007
4	50	2980.89585	642.64325	1845.80172	516.81998

Level of CROPMDL	N	COSCLTOT Mean	COSCLTOT SD	EFFICNCY Mean	EFFICNCY SD
1	4	216.711230	37.4468399	2.92854336	1.23199219
2	28	262.405489	75.0686041	2.81162819	0.30545006
3	39	261.504082	95.8453326	2.81147435	0.42962236
4	50	229.845027	93.2977183	2.62024087	0.34967221

Level of LIVEMDL	N	SCLABHA Mean	SCLABHA SD	COSCLBHA Mean	COSCLBHA SD
1	58	87.7246175	37.6203614	169.305938	63.1972880
2	63	62.5182848	29.9943020	122.355927	58.0348119

Level of LIVEMDL	N	SCLSHA Mean	SCLSHA SD	COSCLSHA Mean	COSCLSHA SD
1	58	36.3440514	15.1918481	106.888984	44.4769712
2	63	35.3361252	16.6252125	98.053656	30.6822224

Level of LIVEMDL	N	SEEDHA Mean	SEEDHA SD	PLANLBHA Mean	PLANLBHA SD
1	58	139.530706	54.8818834	55.8817593	16.3487252
2	63	113.422574	54.0767258	67.9746619	23.6406765

Level of LIVEMDL	N	COPLANHA Mean	COPLANHA SD	FERTHA Mean	FERTHA SD
1	58	90.7220382	16.5749504	178.556458	25.6344984
2	63	88.1542172	16.5481795	176.310524	13.5854259

Analysis of Variance Procedure

Level of LIVEMDL	N	FERTLBHA Mean	FERTLBHA SD
1	58	20.9910268	12.0524021
2	63	19.9939022	12.8263851

Level of LIVEMDL	N	COFERTHA Mean	COFERTHA SD	WEEDLBHA Mean	WEEDLBHA SD
1	58	18.8982877	11.9698760	88.7747276	29.1563931
2	63	12.8694317	8.5342419	87.5330666	26.5332618

Level of LIVEMDL	N	COWEEDHA Mean	COWEEDHA SD	PESTICHA Mean	PESTICHA SD
1	58	160.715649	47.7474530	7.47261462	12.7270886
2	63	156.586998	45.6571623	7.16359851	7.6569507

Level of LIVEMDL	N	SPRALBHA Mean	SPRALBHA SD	COSPRAHA Mean	COSPRAHA SD
1	58	1.75585065	2.58287613	2.63579128	4.22004382
2	63	2.71263131	2.93639531	3.04341211	3.21969641

Level of LIVEMDL	N	COHARVHA Mean	COHARVHA SD	IRRINPHA Mean	IRRINPHA SD
1	58	312.403782	58.3455067	1278.51318	161.934177
2	63	274.506003	63.2701633	1122.56127	121.086336

Level of LIVEMDL	N	IROUTHA Mean	IROUTHA SD	GROSSMHA Mean	GROSSMHA SD
1	58	3506.73832	521.450471	2228.22514	455.290024
2	63	3069.21170	707.798142	1946.65043	628.903681

Level of LIVEMDL	N	COSCLTOT Mean	COSCLTOT SD	EFFICNCY Mean	EFFICNCY SD
1	58	276.194922	96.8478233	2.75678346	0.35225578
2	63	220.409582	73.6799103	2.71755342	0.47788101

Level of CROPMDL	Level of LIVEMDL	N	SCLABHA Mean	SCLABHA SD
1	2	4	68.0080214	28.5962161
2	1	17	89.9434911	22.0636979
2	2	11	57.8827784	22.4098154
3	1	22	91.0365475	47.9208729
3	2	17	71.7632523	34.1266376
4	1	19	81.9044431	36.2778429
4	2	31	58.3849679	30.1827922

Analysis of Variance Procedure

Level of CROPMDL	Level of LIVEMDL	N	COSCLBHA Mean	COSCLBHA SD
1	2	4	120.504679	32.5764301
2	1	17	179.858147	44.2855740
2	2	11	115.492830	44.9741796
3	1	22	166.081231	68.5220032
3	2	17	141.423564	69.2366552
4	1	19	163.598360	72.6221289
4	2	31	114.573644	57.7692212

Level of CROPMDL	Level of LIVEMDL	N	SCLSHA Mean	SCLSHA SD
1	2	4	36.6143048	13.0266297
2	1	17	38.1856456	12.8558890
2	2	11	32.6427117	4.3081773
3	1	22	36.4824441	17.4048069
3	2	17	38.4812851	12.1747540
4	1	19	34.5360651	14.9612815
4	2	31	34.4021611	21.4389364

Level of CROPMDL	Level of LIVEMDL	N	COSCLSHA Mean	COSCLSHA SD
1	2	4	96.206551	17.7458155
2	1	17	114.360858	38.6816139
2	2	11	97.746317	13.1064266
3	1	22	104.357762	49.2890169
3	2	17	108.517693	30.7569232
4	1	19	103.134511	44.9949105
4	2	31	92.662704	35.4924085

Level of CROPMDL	Level of LIVEMDL	N	SEEDHA Mean	SEEDHA SD
1	2	4	62.930816	2.8654438
2	1	17	119.649041	38.1404243
2	2	11	100.576718	32.3048608
3	1	22	195.238477	36.1728860
3	2	17	187.135349	43.9753349
4	1	19	92.815829	15.7677424
4	2	31	84.072711	17.1432453

Level of CROPMDL	Level of LIVEMDL	N	PLANLBHA Mean	PLANLBHA SD
1	2	4	60.2673797	16.1300656
2	1	17	45.7392099	12.2036753
2	2	11	56.2246449	18.4452631
3	1	22	63.1112720	14.4796677
3	2	17	68.0681950	24.5252032
4	1	19	56.5856572	17.5454650
4	2	31	73.0872185	24.6828819

Level of CROPMDL	Level of LIVEMDL	N	COPLANHA Mean	COPLANHA SD
1	2	4	89.4385027	17.4235016
2	1	17	84.6332264	11.6705535
2	2	11	86.9947444	15.0114584
3	1	22	95.8023445	11.1731962
3	2	17	92.5591469	15.4336377
4	1	19	90.2874625	23.1625021
4	2	31	85.9843221	17.8004541

Level of CROPMDL	Level of LIVEMDL	N	FERTHA Mean	FERTHA SD
1	2	4	169.663102	9.6755471
2	1	17	178.477119	22.7741922
2	2	11	186.924443	13.3037355
3	1	22	180.012672	20.2817505
3	2	17	173.153649	15.5074244
4	1	19	176.941304	33.6839759
4	2	31	175.133216	11.4253830

Level of CROPMDL	Level of LIVEMDL	N	FERTLBHA Mean	FERTLBHA SD
1	2	4	26.1731283	18.9538449
2	1	17	19.9359110	13.5887532
2	2	11	15.8861940	5.6900269
3	1	22	22.3226649	9.7023476
3	2	17	22.3159108	16.7449482
4	1	19	20.3931811	13.5067892
4	2	31	19.3807971	11.3586249

Level of CROPMDL	Level of LIVEMDL	N	COFERTHA Mean	COFERTHA SD
1	2	4	13.0865642	9.4769224
2	1	17	21.5306424	9.7801516
2	2	11	12.0255074	6.1826010
3	1	22	16.6594515	11.4970448
3	2	17	13.2737242	8.3679169
4	1	19	19.1353596	14.2037927
4	2	31	12.9191628	9.5441974

Level of CROPMDL	Level of LIVEMDL	N	WEEDLBHA Mean	WEEDLBHA SD
1	2	4	88.8569519	23.3027015
2	1	17	80.0992151	20.9805113
2	2	11	80.9188201	32.4798347
3	1	22	96.3463923	31.6437058
3	2	17	93.2526193	29.9082061
4	1	19	87.7698375	31.4684747
4	2	31	86.5727044	23.1555980

Level of CROPMDL	Level of LIVEMDL	N	COWEEDHA Mean	COWEEDHA SD
1	2	4	155.815508	43.6011002
2	1	17	155.423344	40.3662151
2	2	11	147.292186	51.0473885
3	1	22	163.048043	39.8294174
3	2	17	162.151406	49.7810229
4	1	19	162.750201	62.3120688
4	2	31	156.933255	43.3393661

Level of CROPMDL	Level of LIVEMDL	N	PESTICHA Mean	PESTICHA SD
1	2	4	8.3088235	5.7453406
2	1	17	14.4646558	18.2115636
2	2	11	10.7161290	5.3600635
3	1	22	2.7696847	5.3468318
3	2	17	1.7205882	3.8587182
4	1	19	6.6620756	10.5295289
4	2	31	8.7401288	8.7286083

Level of CROPMDL	Level of LIVEMDL	N	SPRALBHA Mean	SPRALBHA SD
1	2	4	3.97058824	2.67953929
2	1	17	2.87711306	3.01885242
2	2	11	3.27429130	1.23110583
3	1	22	0.84780872	1.78036179
3	2	17	0.76470588	1.71498585
4	1	19	1.80403285	2.67005345
4	2	31	3.41923276	3.46916061

Level of CROPMDL	Level of LIVEMDL	N	COSPRAHA Mean	COSPRAHA SD
1	2	4	3.97058824	2.67953929
2	1	17	4.65913747	5.15323662
2	2	11	4.10009775	1.67857042
3	1	22	1.10381708	2.23350046
3	2	17	0.76470588	1.71498585
4	1	19	2.59929378	4.49810087
4	2	31	3.79843660	3.76067138

Level of CROPMDL	Level of LIVEMDL	N	COHARVHA Mean	COHARVHA SD
1	2	4	237.415775	56.8165641
2	1	17	335.847798	53.8660186
2	2	11	270.609338	55.7097381
3	1	22	291.733503	58.6855257
3	2	17	275.639546	64.5436080
4	1	19	315.361564	55.9668533
4	2	31	280.052905	66.8763708

Level of CROPMDL	Level of LIVEMDL	N	------------IRRINPHA---------- Mean	SD
1	2	4	1051.86581	27.603521
2	1	17	1278.36186	124.218142
2	2	11	1122.90100	110.536290
3	1	22	1327.48340	108.920435
3	2	17	1213.19161	84.359214
4	1	19	1221.94622	221.750432
4	2	31	1081.86221	123.791297

Level of CROPMDL	Level of LIVEMDL	N	------------IROUTHA----------- Mean	SD
1	2	4	3084.08757	1307.87883
2	1	17	3600.55726	232.19893
2	2	11	3143.13504	689.25930
3	1	22	3690.93047	515.70620
3	2	17	3434.44633	563.12704
4	1	19	3209.51994	599.85057
4	2	31	2840.77141	636.60461

Level of CROPMDL	Level of LIVEMDL	N	------------GROSSMHA---------- Mean	SD
1	2	4	2032.22176	1302.85211
2	1	17	2322.19540	214.05608
2	2	11	2020.23404	590.62739
3	1	22	2363.44707	525.28488
3	2	17	2221.25472	538.58837
4	1	19	1987.57372	449.39525
4	2	31	1758.90920	542.73645

Level of CROPMDL	Level of LIVEMDL	N	------------COSCLTOT---------- Mean	SD
1	2	4	216.711230	37.446840
2	1	17	294.219005	74.742113
2	2	11	213.239147	43.559752
3	1	22	270.438993	106.443397
3	2	17	249.941257	81.821882
4	1	19	266.732871	105.241147
4	2	31	207.236348	78.625037

Analysis of Variance Procedure

Level of CROPMDL	Level of LIVEMDL	N	------------EFFICNCY---------- Mean	SD
1	2	4	2.92854336	1.23199219
2	1	17	2.83558225	0.26981569
2	2	11	2.77460828	0.36461693
3	1	22	2.79540049	0.42868447
3	2	17	2.83227583	0.44311725
4	1	19	2.64156483	0.30351763
4	2	31	2.60717134	0.37943442

APPENDIX 29

Analysis of Amount of Manure per Hectare Between Crop Model and Live Model

Analysis of Variance Procedure

Dependent Variable: NOWASTHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	11642766.6	1940461.1	6.74	0.0001
Error	114	32819805.1	287893.0		
Corrected Total	120	44462571.7			

R-Square	C.V.	Root MSE	NOWASTHA Mean
0.261855	159.7376	536.557	335.899

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	930926.5	310308.8	1.08	0.3614
LIVEMDL	1	11402824.5	11402824.5	39.61	0.0001
CROPMDL*LIVEMDL	2	0.0	0.0	0.00	1.0000

APPENDIX 30

Mean of Amount of Manure Each Crop Model and Live Model

Analysis of Variance Procedure

Level of CROPMDL	N	NOWASTHA Mean	NOWASTHA SD
1	4	0.000000	0.000000
2	28	456.234583	605.021839
3	39	333.235563	526.698858
4	50	297.459682	686.704829

Level of LIVEMDL	N	NOWASTHA Mean	NOWASTHA SD
1	58	655.839610	722.356839
2	63	41.349873	231.306988

Level of CROPMDL	Level of LIVEMDL	N	NOWASTHA Mean	NOWASTHA SD
1	2	4	0.000000	0.000000
2	1	17	682.241044	633.186731
2	2	11	106.951872	354.719229
3	1	22	590.735771	585.341709
3	2	17	0.000000	0.000000
4	1	19	707.600666	942.120363
4	2	31	46.082949	256.579003

APPENDIX 31

Analysis of Actual Gross Margin per Hectare Between Crop Model and Live Model

Dependent Variable: ACTGMHA (Actual Gross Margin per Ha)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	7283986.43	1213997.74	4.16	0.0008
Error	114	33283149.30	291957.45		
Corrected Total	120	40567135.73			

R-Square	C.V.	Root MSE	ACTGMHA Mean
0.179554	26.10255	540.331	2070.03

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	5708063.19	1902687.73	6.52	0.0004
LIVEMDL	1	2527838.66	2527838.66	8.66	0.0039
CROPMDL*LIVEMDL	2	0.00	0.00	0.00	1.0000

APPENDIX 32

Analysis of Observed Expected Gross Margin per Hectare Between Crop Model and Live Model

Analysis of Variance Procedure

Dependent Variable: EXPGMHA **(Observed Expected Gross Margin per Ha)**

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	5885349.28	980891.55	3.02	0.0089
Error	114	36999974.30	324561.18		
Corrected Total	120	42885323.58			

R-Square	C.V.	Root MSE	EXPGMHA Mean
0.137235	24.84292	569.703	2293.22

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	3895629.24	1298543.08	4.00	0.0095
LIVEMDL	1	2752693.68	2752693.68	8.48	0.0043
CROPMDL*LIVEMDL	2	0.00	0.00	0.00	1.0000

APPENDIX 33

Analysis of Regression Estimate Gross Margin per Hectare Between Crop Model and Live Model

Analysis of Variance Procedure

Dependent Variable: REGGMHA (**Regression Estimate Gross Margin per Hectare)**

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	5851968.19	975328.03	2.83	0.0133
Error	114	39346946.46	345148.65		
Corrected Total	120	45198914.64			

R-Square	C.V.	Root MSE	REGGMHA Mean
0.129471	24.05239	587.494	2442.56

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	3688761.02	1229587.01	3.56	0.0165
LIVEMDL	1	2758508.17	2758508.17	7.99	0.0055
CROPMDL*LIVEMDL	2	0.00	0.00	0.00	1.0000

APPENDIX 34

Mean of Actual, Observed Expected and Regression Estimate Gross Margin per Hectare Each Crop Model and Live Model

Analysis of Variance Procedure

Level of CROPMDL	N	ACTGMHA Mean	ACTGMHA SD	EXPGMHA Mean	EXPGMHA SD
1	4	2099.91483	1437.33518	2314.24511	1598.07439
2	28	2198.10770	419.53521	2439.46364	440.07724
3	39	2299.19737	526.39472	2457.54255	509.55754
4	50	1817.16672	522.54357	2081.46801	575.56496

Level of CROPMDL	N	REGGMHA Mean	REGGMHA SD
1	4	2569.30468	1727.08383
2	28	2591.12868	444.41297
3	39	2589.57625	503.28534
4	50	2234.54401	599.38517

Level of LIVEMDL	N	ACTGMHA Mean	ACTGMHA SD	EXPGMHA Mean	EXPGMHA SD
1	58	2220.66994	440.351243	2450.41557	438.904874
2	63	1931.34685	659.746673	2148.49872	685.710052

Level of LIVEMDL	N	REGGMHA Mean	REGGMHA SD
1	58	2599.92013	448.285519
2	63	2297.68458	706.943578

Level of CROPMDL	Level of LIVEMDL	N	ACTGMHA Mean	ACTGMHA SD
1	2	4	2099.91483	1437.33518
2	1	17	2328.69831	217.53871
2	2	11	1996.28586	570.71235
3	1	22	2359.42211	521.22268
3	2	17	2221.25947	538.59080
4	1	19	1963.35257	388.05420
4	2	31	1727.56893	577.75693

Level of CROPMDL	Level of LIVEMDL	N	EXPGMHA Mean	EXPGMHA SD
1	2	4	2314.24511	1598.07439
2	1	17	2588.08517	236.12121
2	2	11	2209.77583	581.47744
3	1	22	2519.87193	511.81310
3	2	17	2376.88099	510.48850
4	1	19	2246.81435	432.77735
4	2	31	1980.12670	633.06986

Level of CROPMDL	Level of LIVEMDL	N	REGGMHA Mean	REGGMHA SD
1	2	4	2569.30468	1727.08383
2	1	17	2747.37033	265.35930

Analysis of Variance Procedure

Level of CROPMDL	Level of LIVEMDL	N	REGGMHA Mean	REGGMHA SD
2	2	11	2349.66430	561.21108
3	1	22	2653.45551	511.12648
3	2	17	2506.90898	495.79792
4	1	19	2406.00268	453.05598
4	2	31	2129.45644	658.49027

APPENDIX 35

Analysis of Actual Output per Hectare Between Crop Model and Live Model

Analysis of Variance Procedure

Dependent Variable: ACTOUTHA (Actual Output per Hectare)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	13232324.6	2205387.4	6.23	0.0001
Error	114	40358744.4	354024.1		
Corrected Total	120	53591068.9			

R-Square	C.V.	Root MSE	ACTOUTHA Mean
0.246913	18.21048	594.999	3267.35

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	9367266.11	3122422.04	8.82	0.0001
LIVEMDL	1	5987420.96	5987420.96	16.91	0.0001
CROPMDL*LIVEMDL	2	0.00	0.00	0.00	1.0000

APPENDIX 36

Analysis of Observed Expected Output per Hectare Between Crop Model and Live Model

Analysis of Variance Procedure

Dependent Variable: EXPOUTHA **(Observed Expected Output per Hectare)**

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	11410004.8	1901667.5	4.82	0.0002
Error	114	44939893.2	394209.6		
Corrected Total	120	56349898.0			

R-Square	C.V.	Root MSE	EXPOUTHA Mean
0.202485	17.98754	627.861	3490.53

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	6923265.17	2307755.06	5.85	0.0009
LIVEMDL	1	6330896.43	6330896.43	16.06	0.0001
CROPMDL*LIVEMDL	2	0.00	0.00	0.00	1.0000

APPENDIX 37

Analysis of Regression Estimate Output per Hectare Between Crop Model and Live Model

Analysis of Variance Procedure

Dependent Variable: REGOUTHA (Regression Estimate Output per Ha)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	11205110.2	1867518.4	4.47	0.0004
Error	114	47622625.0	417742.3		
Corrected Total	120	58827735.2			

R-Square	C.V.	Root MSE	REGOUTHA Mean
0.190473	17.75694	646.330	3639.87

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CROPMDL	3	6464274.85	2154758.28	5.16	0.0022
LIVEMDL	1	6339712.75	6339712.75	15.18	0.0002
CROPMDL*LIVEMDL	2	0.00	0.00	0.00	1.0000

APPENDIX 38

Mean of Actual, Observed Expected and Regression Estimate Output per Hectare Each Crop Model and Live Model

Analysis of Variance Procedure

Level of CROPMDL	N	ACTOUTHA Mean	ACTOUTHA SD	EXPOUTHA Mean	EXPOUTHA SD
1	4	3151.78064	1442.02683	3366.11092	1602.67429
2	28	3415.39565	506.30688	3656.75159	532.69608
3	39	3576.86127	542.56839	3735.20645	529.93128
4	50	2952.26085	636.91959	3216.56214	690.87120

Level of CROPMDL	N	REGOUTHA Mean	REGOUTHA SD
1	4	3621.17049	1731.68834
2	28	3808.41662	539.51102
3	39	3867.24016	527.16862
4	50	3369.63814	713.53993

Level of LIVEMDL	N	ACTOUTHA Mean	ACTOUTHA SD	EXPOUTHA Mean	EXPOUTHA SD
1	58	3499.18312	507.307137	3728.92875	510.349480
2	63	3053.90812	728.831341	3271.05999	753.197227

Level of LIVEMDL	N	REGOUTHA Mean	REGOUTHA SD
1	58	3878.43331	521.312165
2	63	3420.24585	772.483836

Level of CROPMDL	Level of LIVEMDL	N	ACTOUTHA Mean	ACTOUTHA SD
1	2	4	3151.78064	1442.02683
2	1	17	3607.06016	233.35981
2	2	11	3119.18686	667.86339
3	1	22	3686.90551	511.83600
3	2	17	3434.45108	563.12598
4	1	19	3185.29879	550.33774
4	2	31	2809.43114	652.22019

Level of CROPMDL	Level of LIVEMDL	N	EXPOUTHA Mean	EXPOUTHA SD
1	2	4	3366.11092	1602.67429
2	1	17	3866.44702	267.82331
2	2	11	3332.67683	679.05766
3	1	22	3847.35534	506.29856
3	2	17	3590.07260	539.30176
4	1	19	3468.76057	596.24534
4	2	31	3061.98891	708.03809

Level of CROPMDL	Level of LIVEMDL	N	REGOUTHA Mean	REGOUTHA SD
1	2	4	3621.17049	1731.68834
2	1	17	4025.73219	303.63950

Analysis of Variance Procedure

Level of CROPMDL	Level of LIVEMDL	N	REGOUTHA Mean	REGOUTHA SD
2	2	11	3472.56530	658.80168
3	1	22	3980.93891	509.24993
3	2	17	3720.10059	528.08364
4	1	19	3627.94889	613.61267
4	2	31	3211.31865	733.15919

APPENDIX 39

Relationship Between Educational Level and Gross Margin per Hectare

Analysis of Variance Procedure
Class Level Information

Class	Levels	Values
EDC1	4	1 2 3 5

Number of observations in data set = 121

Analysis of Variance Procedure

Dependent Variable: ACTGMHA

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	616054.644	205351.548	0.60	0.6154
Error	117	39951081.084	341462.231		
Corrected Total	120	40567135.728			

R-Square	C.V.	Root MSE	ACTGMHA Mean
0.015186	28.22894	584.348	2070.03

Source	DF	Anova SS	Mean Square	F Value	Pr > F
EDC1	3	616054.644	205351.548	0.60	0.6154

APPENDIX 40

Mean of Actual Gross Margin per Hectare
Each Level of Education of Farmer

Analysis of Variance Procedure

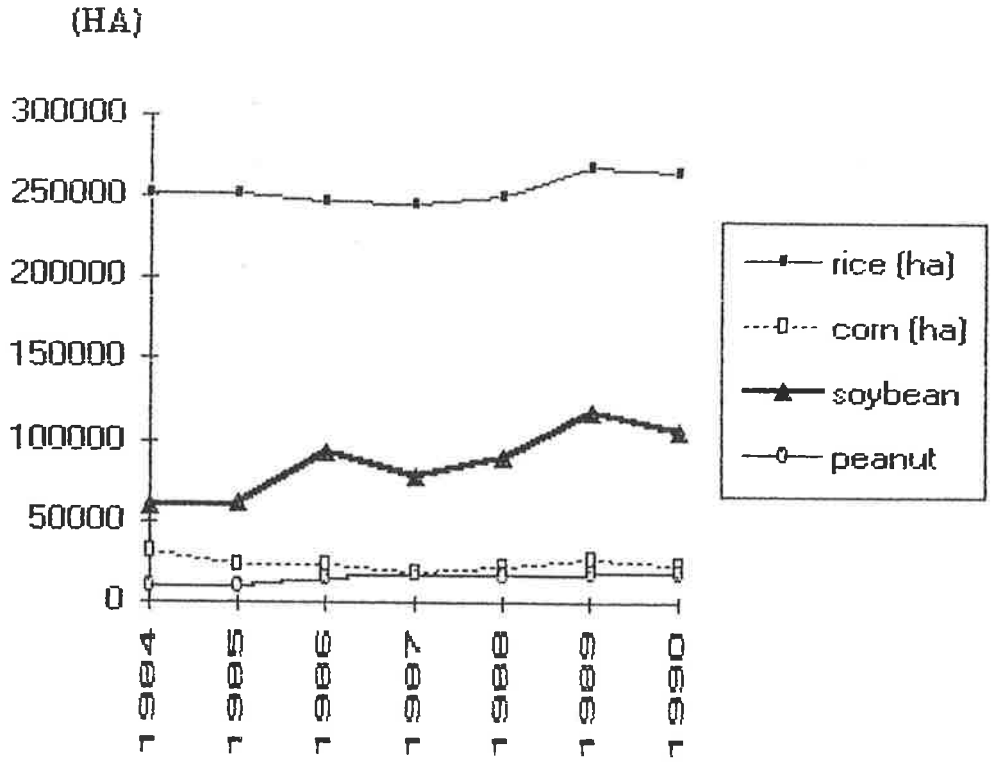
Level of EDC1	N	ACTGMHA Mean	ACTGMHA SD
1	59	2020.62523	517.536307
2	12	2008.21213	794.278517
3	6	2295.75344	768.877512
5	44	2122.35803	581.109882

Appendix 41

The Total Areas of Rice, Corn, Soybean and Peanut
West Nusa Tenggara Province, Period 1984 - 1990

	1984	1985	1986	1987	1988	1989	1990
RICE (HA)	251136	251266	246696	244289	249735	267610	265625
CORN (HA)	31654	22767	24097	18541	22459	26569	24012
SOYBEAN (HA)	59131	60981	92467	77749	89046	118316	106080
PEANUT (HA)	9749	10702	15485	18081	16640	19046	18930

The Areas of Rice, Corn , Soybean and Peanut
West Nusa Tenggara Province, Period 1984 à 1990
(in Hectare)



Source: Agricultural Department , West Nusa Tenggara Province
(1991).