SOME DETERMINANTS OF USE OF FERTILIZER A CASE STUDY WITH REFERENCE TO MEGHALAYA

BY
Ranjana Baruah
DEPARTMENT OF ECONOMICS

DISSERTATION
SUBMITTED
IN

Part fulfilment of the requirement of the degree of Master of Philosophy

TO

THE NORTH-EASTERN HILL UNIVERSITY
SHILLONG

March, 1985

Phone
Grams : NEHU

North-Eastern Hill University
LOWER LACHAUMIERE, SHILLONG-793001.

CERTIFICATE

Certified that the subject matter of this dissertation is the record of work done by Mrs Ranjana Baruah(Sharma), and that the dissertation has neither been submitted for any other degree in any other University nor published earlier in any other form.

She has done a commendable work in the field of agriculture economics and I sincerely believe that she deserves to be awarded Master of Philosophy.

(K. Bez)
Supervisor

Dated Shillong
The 30th March 1985

ACKNOWLEDGEMENTS

This work would not have been undertaken if the author was not inspired and encouraged by the members of the staff of the Department of Economics including the office staff. I am specially grateful to Dr. K. Bez, who has been my Supervisor and inexhaustible source of inspiration.

I am also thankful to Mr. S. Sharma, the Senior Cartographer and Mr. B. Mipun of the Department of Geography, who have assisted me in drawing the graphs. I have to add that my parents always offered me the unfailing encouragement in all the stages of my work.

Ranjana Baruah.
RANJANA BARUAH

Department of Economics
North-Eastern Hill University
Shillong 793 014

November, 1984.

ABSTRACT

The factors determining the use of fertilizers specially the chemical ones are numerous which encompass political spatial, economical and social spheres. The author has attempted to analyse only two socio-economic determinants namely size of family and the size of holding. We have used cross sectional data for the purpose of analysing the influence of these two determinants with the help of statistical techniques.

We found that there is a strong co-relationship between the two determinants which further enables us to apply the analysis of Variance techniques, Probit analysis, Regression analysis and Bez Reaction Function. We found that the size of family is rather a more stable and not so very strong determinant as compared to size of holding. Both Probit analysis as well as Reaction Function results support the preceding statement. However, both the determinants have influenced or motivated the farmers to use either organic or chemical fertilizers.

This analysis may be taken as an advanced stepping stone to analyse the prevailing situation in agriculture as exists in the present day in north-eastern states and specially in Meghalaya. These two factors cannot be

subjected to act upon as instruments of modernizing agriculture unless other socio-economic factors such as productivity of land, labour and capital and definitely the productivity of fertilizers are taken into consideration. However, the author believes that analysis embodied in this dissertation would be very useful to understand the problems of agriculture as well as rural economy.

INDEX

	Page No.
ABSTRACT	I - II
CHAPTER I	
INTRODUCTION	1 - 5
CHAPTER II	
PROBLEMS AND PROSPECTS	6 - 26
CHAPTER III	
DATA BASE	27 - 37
CHAPTER IV	
METHODOLOGY AND EMPIRICAL RESEARCH	38 - 75
CHAPTER V	
CONCLUSION	76 - 81
APPENDICES	
Appendix 1	82 - 83
Appendix 2	84 - 85
Appendix 3	86 - 87
Appendix 4	88 - 89
Appendix 5	90
Appendix 6	91
Appendix 7	92
Appendix 8	93
REFERENCES	93 - 96

CHAPTER - 1

INTRODUCTION

Fertilizer is one of the major inputs in agriculture. The use of organic fertilizer has long been practised by the farmers and it became a part of the system because the farmers have learnt the better use of organic wastes for growing more food. The use of chemical fertilizer is of recent past and it is gaining slowly momentum in some parts of the country. The rationality as to the use of organic manure is hardly a matter of academic interest whereas, the adaption of modern farming techniques including the use of chemical fertilizer to grow more food becomes the nucleus of the subjects concerning economic planners and the scientists alike.

The transition from rural agricultural craft to rural agricultural technology is not an easy task, nevertheless, we have seen that there is a great deal of change in agriculture specially in farming techniques. In the case of application of organic manure, the farmers are well acquainted with the procedures eventhough they may not be literate. The overdose of organic manure may not be hazardous, the potential fertility of soil need not necessarily be tested and also there is possibly no forbidden specific organic manure for any specified criteria of plant growth and yield, whereas, unless the farmers get advisory services of the experts or agriculture field workers, the use of chemical manures due to the lack of knowledge of potency of chemical mannures may prove to be harmful also uneconomical.

In this essay, we are, of course, interested in identifying some of the key determinants of the use of fertilizers. We confine ourselves to two of the numerous socio-economic determinants, namely 'size of holding' and the'size of family' and the fertilizer includes both the chemical and organic. Our objective is to analyse these two determinants barring all other socio-economic determinants of use of fertilizer, their covariance with respect to the type of fertilizer, equality of their between group mean with respect to the type of fertilizer, their functions as stimuli for the use of fertilizer and by type of fertilizer and finally a specific objective analysis considering one of the determinants say size of holding as "agent" and the other i.e. size of family as 'object' of their resulting function as Reaction Function - the realizable fertilizer matrix.

In chater 2, we have discussed about the problems and prospects of agriculture in general and of Meghalaya in specific. Therein, we have mentioned about land tenure system in Meghalaya, the characteristic of soils of Meghalaya and the popular method of manuring the land as prevailed in Meghalaya. We have also discussed about the number of economic, social, demographic and other determinants which could either promote or hinder the popularization of use of chemical manures. We have brought into focus the factors pertinent to Meghalaya that could be considered responsible to motivate the farmers to use fertilizers.

In chapter 3, we deal with the sources and problems of data collection. A brief description of the blocks and the selected villages therein, are given in this chapter. We have also mentioned about socio-economic conditions of the villages, specially as regards employment, education, transport facilities and market facilities. The data for the type of analysis mentioned above were collected by the author herself with the assistance of an interpreter provided by the Block Development Officers of the respective Blocks.

Chapter 4, is devoted to methodology and empirical analysis, we have considered the theoretical framework as precisely as possible and the justification of the use of statistical tools, the logical basis of analysis of the estimation. It may be mentioned that we have used a) Correlation technique using bi-variate frequency table, b) Analysis of variance technique using two way classification table taking 'size of holding' and the 'size of family' as the factors and the cell frequencies happen to be quantum of fertilizer used, c) Probit analysis - by considering 'size of holding' as stimuli and the response as quantum of fertilizer. Again similar analysis is performed by taking the 'size of family' as stimuli, d) Regression analysis - by using the probit as endogeneous variable and the stimuli as exogeneous variable, a regression equations were fitted and finally, e) the Reaction Function Approach as proposed by Bez, where one of the two determinants, i.e. 'size of holding' and the 'size of family'is taken as 'agent' and the other as 'object'. The theoretical basis of this analysis is fundamentally mathematical probability.

All the empirical results are given in this chapter together with appropriate and plausible conclusions. Some of the tables of data also description of statistical techniques are given in the appendices.

Finally, chapter 5 is devoted to conclusions and epilogue. The conclusions succeeding the empirical results are usually the resultant state of the statistical model or theory applied, in practice, these conclusions could have been sufficient. However, in our view in global look at the micro level can transpire new vista of analytical domain which may be left to the author to try in future research. It is sometimes felt that epistemological / boundary of economic corpus is invisible, un~~di~~distinct unlike that of physical sciences, yet our humble but sincere effort could break a way that could be continued further with some lapse of time - a cherished hope of the author.

CHAPTER - 2

PROBLEMS AND PROSPECTS

2.1. Introduction

Meghalaya is an agricultural state. About 80 per cent of the potential working population are engaged in agricultural activities. Although the land-population ratio is very large (59 persons per square kilometre according to 1981 population figure), unfortunately, only 15% of the land is useful for any type of the cultivation with the prevailing agricultural technology and another 8% of the total land area is covered by forests. It could, therefore, be said that from agricultural point of view the population density is 74 persons per squate kilometre.

The topography of the land provides scope for a variety of agricultural crops ranging from cereal, e.g. rice, maize and millets to various fruits which are grown in the state. The major crops grown by the farmers are paddy, potato, maize, cabbage, cauliflower, tumeric, ginger, short staple, cotton, black pepper etc.

In Meghalaya, there is a peculiar land tenure system. It is different from that of the plains area in the north east, where majority are non-tribals. The Garos, the Khasis, and the Jaintias have more or less a similar land tenure system. Here, in Meghalaya, the laws relating to the land tenure system and its accompanying ownership are primarily customary laws. According to the Meghalayan land tenure system, land may be classified into three categories signifying pattern of ownerships - these are

i) Community land;

ii) Private land;

iii) Government land.

2.2.1. Community Land

Under this category, land belongs to the community. Community land is known as Ri Raid, where Raid means community. According to the Report of Land Reform Commission for Khasi Hills (1974), every member of the community has the 'use' right and 'occupancy' right over land. No one has to pay land revenue in kind of cash for enjoying his rights. If anyone has to pay any amount, then it is generally for the improvement which the community would have made on the land or for services rendered in its use as occupant for cultivation. No person belonging to the community can be debarred from occupying any vacant plot of land. Similarly, no one can claim for more land than what he can actually cultivate. If a person vacates or does not make use of the land under his actual occupation for three consecutive years, the land reverts to the community (Mathew,). Generally, there is no proprietory, heritable or transferable right on the Ri Raid land. However, a person can acquire transferable right on the Ri Raid land, if he had made permanent improvement on it. The form of permanent improvement implies, e.g. cultivation of permanent crops and plants, fish pond, permanent building, etc.

Community land may be divided into forest land and non-forest land. There are mainly three kinds of forest land: a) land reserved for religious purposes; b) land reserved by the community; c) private land (Nair, 1983).

2.2.2. Private Land

Private land, which is known as Ri Kynti, is mostly divided into two categories. That is, a) ancestral and b) self-acquired.

The 'durbar-kur' (assembly of the clan) has control over the former, the person who has acquired it has full control over the latter. However, the 'self-acquired' land would be considered as an ancestral property when it passes to the children of the one who has acquired it, and then presumably it would be subjected to the jurisdiction of the 'durbar' (Mathew, 1981).

The states has no control over the Ri Kynti lands. Every individual can enjoy all the rights over their land.

The landed property may be of ancestral or purchased type. Ka Khadduh (youngest daughter of the family) gets larger share of land than the others. If the family does not have any daughter, then the family brings a Ka Khadduh from the sister's family, immediately elder to the mother. In absence of them, the family prefers 'a cousin' daughter of the mother's side (Mathew, 1981). This is how hereditary rights are preserved.

2.3.3. Government Land

Government land are those lands on which Government acquires ownership and gets the authority of control and management over the land.

The Land Reforms Commission for Khasi Hills, states that the British Government and the Indian Government have taken land in the Khasi Hills under various rules issued from time to time. Till today, the government have taken land on the basis of exchange, lease, purchase and of acquisition. According to the related rules the government enjoys all the rights over land.

2.3. Types of Soil

Soil of the North Eastern Region, specially the hilly areas is juxtaposed by many types of rocks.

This is among others, due to the variation of rainfall of this region. Monsoon starts generally during the month of May and continues till September, and rainfall varies from 1000 to 4450 mm. The soil reaction varies from 'strongly acidic' to 'acidic' in nature.

The soil Scientists classified land in Meghalaya into the following categories (Rajan and Rao, 1981).

Table 1

Soils classification unit (Traditional or popular nomenclature)	Equivalent name according to the 7th approximation classification
(1) Red loamy soils:	i) Paleustalfs ii) Phodustalfs iii) Halplustalfs
(2) Red and yellow soils:	i) Haplustults ii) Ochraquults iii) Rhodustults
(3) Lalerite soils:	i) Plinthaqults ii) Plinthustults iii) Plinthudults iv) Oxisole
(4) Brown hill soils: (on sandstone and shales)	i) Palehumults
(5) Old alluvial soils:	i) Paheustalfs ii) Haplaquents
(6) Terai soils:	i) Haplaquolls
(7) Alluvial soils (recent):	i) Haplaquents ii) Udifluuents

2.4. Problems Associated with the Use of Fertilizer

We shall briefly present the Indian picture first. Since at the initial stage of development, social, psychological and economic constraints may not be similar. Nevertheless, these constraints ~~paly~~ play a vital role as against the adoption of new techniques or means of production as in any other parts of the country, specially hill areas.

Organic fertilizer is important as they are used to improve the fertility of the soil as well as to keep the soil moist. But it is to be noted here that organic fertilizer is not enough for the production where it cannot possibly meet the full requirement for replenishing the soils for frequent use for cultivation and/or at higher level of production.

On the other hand, chemical fertilizer plays an important role in any scheme for boosting up the agricultural output. Chemical fertilizer consists of Nitrogen (N), Phosphorous (P_2O_5), and Potassium (K_2O) compound.

N.S. Shetty explains in a study that the use of fertilizers can be measured in three different ways (Shetty, 1969):

a) Total weight of different types of fertilizers used by the farmers.

b) Total weight of plant nutrients contained in different types of fertilizers need by the farmers.

c) Aggregated weight of plant nutrients contained in different types of fertilizers used by the farmers, where weight being assigned on the basis of soil text data of a particular region.

The first measure appears to be improbable, since construction of an index of use of fertilizers in terms of recommended doses vis-a-vis in terms of plant nutrients, needs a controlled agricultural operation.

In order to have a meaningful analysis of reaction of 3 types of nutrients, relating to soil, plant, and manure, bot independently of one nutrient from other and the synergic effect of all, plus the extraneous variables as temperature and rainfall, requies an elaborate methodology and that is to be done in a controlled situation.

It is found that a very few farmers used fertilizer more than half of the recommended doses. There is a seasonal variations in the use of fertilizer also (Borah, 1981). This may be due to number of reasons.

In a study by Nagaraj has shown a definite acceleration in aggregate fertilizer consumption, since the mid-sixties.

According to him, the acceleration is mainly due to slackening of demand. Nagaraj found that the consumption of fertilizers has consistently been falling short of the required target, since 1961-62. This is caused by any or all of three factors, that is, (i) supply constraint, (ii) absence of an efficient distribution network and (iii) deficiency of demand. Moreover, one of the principal reasons for non-fulfillment of agricultural production targets is the wide and increasing gap between the target and actual levels of fertilizers use.

There are certain factors affecting fertilizer demand too, they are, fertilizer price, acreage, farm income, capital, interest rates, education, experience, distance from town etc. These exogeneous variables divided into two broad categories: a) Economic variable, that is, size of the farm, irrigation facilities, farm and non-farm income, liquidity, availability of supplies and credit, profitability of change, attitude towards risks, price stabilization etc. b) Sociological and demographic variables, i.e., caste, education, age and contact with extension agencies.

Size of holding is covered by two variables: a) area of owned holding; and b) cultivation holding (Nagaraj, 1982.

In a study, sponsored by the Department of Agriculture of the Government of Assam carried out by Agro-Economic Research Centre, found that the factors influencing the use of fertilizers are: 1) location, 2) literacy, 3) economic condition of the farmer, 4) size of holding, 5) types of tenancy, 6) irrigation facilities, 7) distribution of fertilizer, 8) price of fertilizer, 9) marketing prospects of agricultural products, 10) technical guidance, 11) storage facility, 12) practice of HYV cultivation and 13) pesticides. However, this study is more exploratory and analytic. The study does not reveal which of these factors has a far bearing consequence or what drawbacks for the use of fertilizer be removed in precedence (Borah, 1981, Shetty, 1969, Vipin Chandram, 1982).

Illiteracy may be considered to be primarily responsible for rural poverty, though a programme for literacy driver has a long time lag to produce economic reult, nevertheless, the ignorance and communication gap between the farmers and the agricultural extension workers constitute a major hindrance in improving practice of agriculture and for that matter the rational use of fertilizer.

Since not so recent past, the use of chemical fertilizer has increased in our country in order to boost up agricultural production. Unfortunately, due to some reasons the primary step to test soil was not always carried out. So without knowing the nutritional standard of the soil, fertilizer may not yield the assumed positive result. Soil testing plays an important role of the "package and practice" of agriculture. The fertilizer recommendation depends on the fertility status of the soil along with other factors like slope gradient, plant variety, irrigation facility, climate, etc. In this matter, the extension workers as well as the Block Development officials have important role to play through their acting and co-operation in rendering the soil testing services available to the farmers. The basic objective is to guide the farmers for better economic use of soil-nutrient and other inputs.

Although India is an agricultural country, the conditions governing the agricultural operation in different parts of the country vary and these variations are not only inter-regional but also intra-regional. The so called green revolution can be felt in certain packets of the country, and it has not been able to make any headway even in a conceivable significant way in other parts of the country. The modern agricultural technology, inclusive of the seed-fertilizers combinations, has also met with varying degree of receptions in different corners of the country. Thus, it is but natural that a single well defined all-comprehensive and all-pervasive 'model' or formalization regarding the factor governing the pattern of demand for agricultural inputs, viz. fertilizer is hard to find which could be applied throughout the length and breadth of the country. We have studies on particular districts of a state or a region. However, they too provide us with important materials for our purpose.

Another fertilizer demand model used by Timmer, based on profit maximising behaviour of the farmer and knowledge of relevance of a single price of fertilizer in the market. It has considered both the short-term and long-term factors affecting the demand for fertilizers by the farmers. Following are the variables taken into account by Timmer: fertility price, crop price, acreage, farm income, capital assets, interest rates, education, experience, distance from town, time etc. (Timmen, 1974).

In this model, it is not only the demand for fertilizer, but also the supply of agricultural output that is to be induced for long-term analysis. If farmers can get more output, it leads to a decline in the prices of output. It, therefore, has a damaging effect on the farm income. He observes that, with the less income, farmers may not be able to afford to buy more fertilizers resulting in induced decrease in demand for fertilizer. Therefore, to keep up the growth in income a balance between demand and supply has to be maintained. This is necessary even for steady growth of income of farmer.

This model is an aggregative model and considers both the short run and long run situations. In the short run, price responsiveness of demand for fertilizer is higher than that in the long run. The phenomenon is, however, explained by farmers adjustment to new prices. The only mechanism in the model wby which equilibrium can be maintained in the product market, when consumer demand changes, is through fertilizer-induced changes in supply. If consumption demand for fertilizers will not change. The mechanism is that foodgrain price must rise to whatever level is necessary to call forth the additional fetilizers application. A supply shortage that decreases fertilizer demand because of higher prices will have as its longer run effect an increase in the price of foodgrains that will call forth additional fertilizer applications.

We can also question the assumption of profit maximisation, perfect knowledge etc. of the farmers. As we all know that, these are important characteristics of market economy. As pointed out earlier the price variable is taken to cover all these features. It would be simply repetition to state the assumptions of the market economy do not fit in to the aggrarian condition in most of the underdeveloped and the developing countries. It was pointed out by many researchers that socio-economic conditions over-ride all the equilibrium conditions both necessary and sufficient, yet, it must not be construed that price is insensitive to demand and supply even in a less sophisticated sector like Agriculture. In this context, the work by Krishna Bharadwaj is very explicit. She points out the peculiar features of the aggraian economy and explains why competitive market conditions cannot make much sense in describing the rural economy.

These peculiar features include the varied (non-uniform) "extent and type of involvement in the market of the different sections of the peasantry". "Local pattern of power" reflected in the 'relative' 'bargaining strength' (reinforced by forces of traditions, customs, social-moral) of different sections of the rural people, different access to resources the terms on which they can be obtained and the fields of reasible choices open to the individual producer in the various market" (Bharadwaj, 1980).

Therefore, we have the rural economy not the usual inter-linked markets of the competitive framework, but a system of interlocked markets which increase the exploitative power of the stronger sections. May be her findings are typical of rural agricultural economy even in regions of north-east.

Fertilizer is one of the most important inputs to increase the output level. But most of the rural farmers are not keen using of fertilizers. Through a Sample Survey for 1975-76 and 1976-77, NCAER has shown the reasons why farmers are not using fertilizers.

The most important reasons for not using fertilizer is non-availability of irrigation system. It varies from state to state, depending on the availability of water and higher exploitation. Sometimes, the pattern of irrigation is not uniform. This reason can be considered as a physical constraint. Secondly, rural small and marginal farmers are not using fertilizer due to unawareness of their use and some of them believe its use to be more harmful. Also there are some steps where the large farmers are sometimes ignorant of the use of fertilizers. Thirdly, some farmers cannot use it due to the lack of capital. Credit also is not available to them and it is the most important reason presently. Fourthly, the supply of fertilizer is not available to the farmer, and they cannot use it at the right time.

Here, we should discuss the importance of fertilizer in the context of modern technology, since, it is unavoidable in agriculture.

Improved quality of seeds is essential for increasing the agricultural output along with fertilizer. Without the best qualities of seeds; farmer cannot get good result out of their input.

During the mid-sixties, the High Yielding Varieties (HYV) of wheat were introduced to the farmers. Since then, a number of HYV seeds of wheat, paddy and other cereals have been developed and distributed throughout the country. " ... in 1966-67 only 1.88 million hectare of land has been brought under HYV seed; in 1978-79, 41.10 million hectares of land have been estimated to be covered by the HYV seeds programmes, i.e. the use of HYV seeds has multiplied by about twenty times in a short span". (Dhingra, 1981).

Oragnic manure was the traditional source of plant nutrient in India. Dhua, in a study, named 'Organic Mineral Fertilizers', says that there are four to five sources of organic fertilizers, that is (Dhua, 1975):

i) Urban compost;

ii) Rural compost;

iii) Cattledung and gobar gas plant;

iv) Urban sewage and sullage utilization;

v) Miscellaneous sources, like - slaughter house, plant resides, habitation wastes, farm wastes, etc.

On the other hand, chemical fertilizer is introduced from the beginning of the first five year plan, in our country. But with the application of primitive technology and low yielding varieties, the consumption of chemical fertilizer was very slow. After the evolution of HYV seeds, fertilizer consumption is increased from the year 1960 onwards, after the introduction of HYV of wheat, paddy and other cereals. In an article, named "Technological change in agricultural output", about the consumption of fertilizer, which we can see in Table below.

Table 2

Progress in consumption of chemical fertilizers

	Year					
	1950-51	1960-61	1966-67	1970-71	1979-80	1980-81
Quantity (Unit mtr. ton)	0.13	0.29	1.10	2.2	5.12	6.2

Source: Economic Survey 1980-81 and Fertilizers Association of India, Fertilizer Statistics.

During the Sixth Plan, importance has been given to the need for fertilizers consumption and production, and to make fertilizer available to the farmers at reasonable price at the right time.

Water is another important input of the package of new technology alongwith HYV seed and fertilizer. Most of the Indian small and marginal farmers will have to depend on monsoon due to the non-availability of irrigation system. But rainfall is mostly confined to certain states in our country and the worst of all is that there are great variation from year to year and not at right time of sowing. Therefore, there is an increased need of water through proper irrigation system (Dhawan, 1973).

In India, there are no proper HYV seeds for the higher altitude ranges. In these places, still primitive types of cultivation is practised with traditional local varieties. The essential co-ordinating system like crop management, water management etc. are inadequate. Modern implements for agriculture is unknown to the farmers. Irrigation system practised by the Meghalayan farmers is also very primitive. The most common irrigation system throughout the region is continuous flow irrigation of rice fields with the help of hollowed bamboo connected to a source of water in the hill tops, when such source is available. But it is operative mostly during monsoon.

An important aspect of agriculture in the hill areas of the North-Eastern Region of India is that the majority of the rural population is engaged in jhum cultivation, which is known as shifting cultivation.

For the jhum cultivation, land is selected during December-January by the village elders or community from the forest and jungles depending upon the fertility of the soil (Mathew, 1981).

The main crop grown in the hill are potato, cotton, tapioca, chillies, paddy, millets, beans, sweet potatoes. These are grown as a pattern of mixed cropping. Hill paddy is now being planted as a separate crop. The same jhum area is cropped for the period of two or three years at a time, depending upon its fertility. So after the land is abandoned, new sites are selected for the next cycle of jhuming.

In the hilly regions, where jhum cultivation is practised, the need of applying manures is not always appreciated, as a matter of practice. Jhum cultivation depend mainly on the natural fertility of the soil.

But in Meghalaya, organic mannures like cowdung, pigdung, and bonemeal etc. have become very popular among the farmers from a long time. The problems for use of chemical fertilizers are many, the price of fertilizer is not the only constraint. The constraints are mainly the lack of perennial irrigation facility, transportation problem and marketing of agricultural products.

Meghalaya alone cannot be singled out for the infra-structural lag for adopting more productive agricultural techniques. This is the case with the entire North-

Eastern Region (Nag, 1983). The small and medium size irrigation is yet to gather momentum, although every year an equitable amount of money is spent on this heading. Under surface water the ultimate potential has been estimated at 85,000 hectares of which, only 1900 hectares so far has been brought under irrigation upto 1980-81. Actual expenditure during 1978-79 was Rs. 63 lakhs and approved outlay for 1980-81 was Rs. 85 lakhs with target of irrigation for another 2300 hectares. By the end of the Sixth Plan it was envisaged that another 16,500 hectares will be brought under irrigation.

The use of chemical fertilizers mostly confined to potato growing area of the state. According to government statistics about 90 percent of fertilizer consumed in the State is used only for growing potatoes. The following table gives the trend of fertilizer consumption in the State (Directorate of Agriculture, Meghalaya, 1982).

Table 3

Year	Nitrogenous	Phosphatic	Potassic
1970-71	.54	.68	.08
1974-75	.90	.40	.05
1979-80	1.23	.68	.09

Unit in thousand tons.

The anticipated target for consumption is 9000 tons of chemical fertilizer of 5000 nitrogenous, 3000 phosphate and 1000 ton potassium in the year 1984-85.

Similarly the consumption pesticides is also negligible, its consumption is also limited to only potato crops. The ~~appointment~~ anticipated consumption of pesticide during the period from 1977-1981 is on the average of 25 metric tons.

There is every likelihood that the future for significant achievement in agriculture technology would likewise enhance the trend of fertilizer consumption. Nearly 48% of total Sixth Plan outlay i.e. Rs. 600 lakhs was for minor irrigation, taking into account of unit cost for irrigating 1 hectare of land and keeping in view of inflation about 25,000 hectares of land are expected to be already irrigated by 1983. Unfortunately, we could not get this data.

CHAPTER - 3

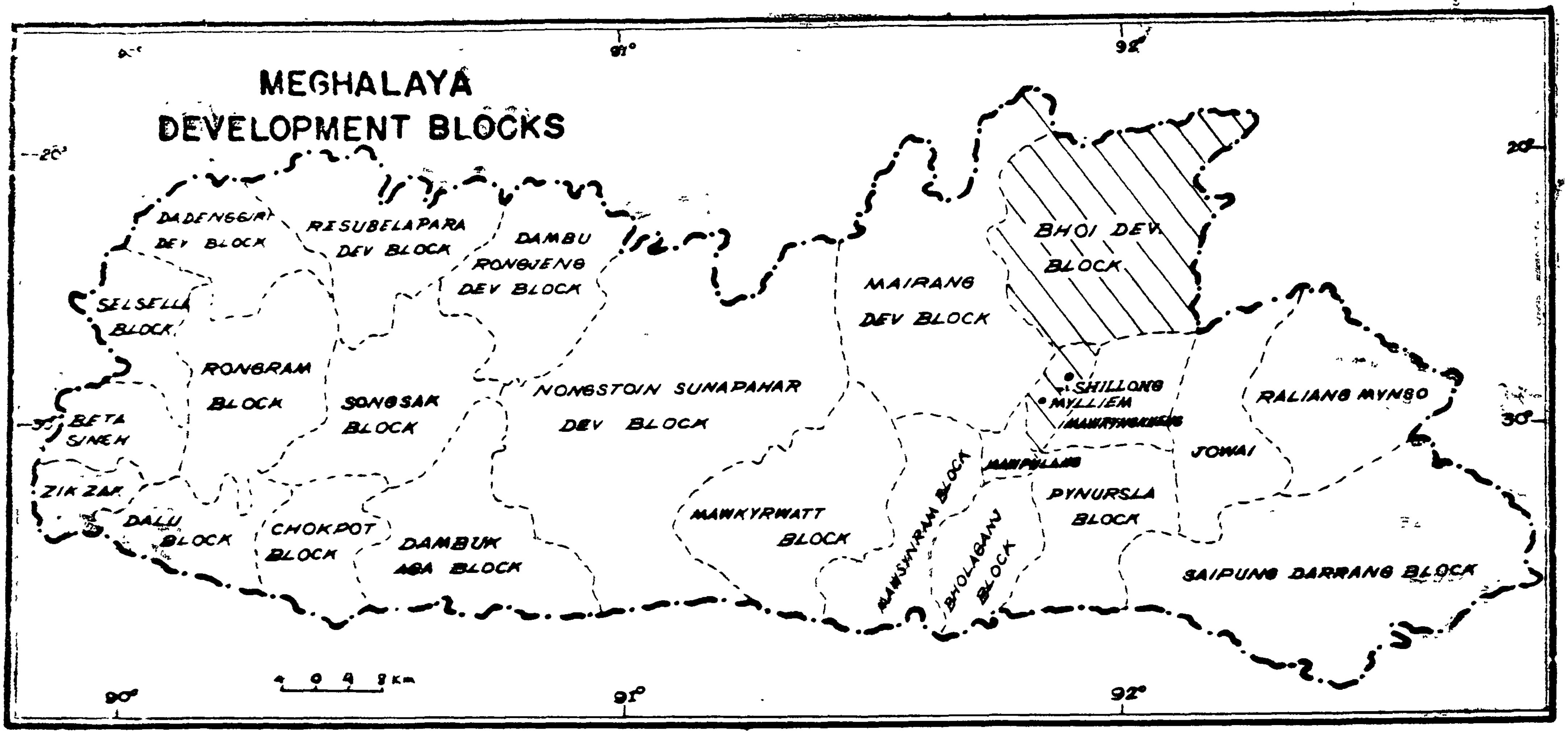
DATA BASE

3.1. Introduction

This chapter is devoted to Data source. In the absence of disaggregated data, e.g, according to farm size or family size, we have decided to collect primary data. The government statistics, concerning use of fertilizer is an aggregate and for the whole state. By aggregate we mean that the statistical data were given for the entire state in mln tons over the period of years. There is no data on fertilizer consumption according to the size of family of the farmers or the size of holding, in which we are primarily interested. However, there are plenty of short falls in collection of primary data. The pre knowledge about the intensity of use of fertilizer per unit of crop area in any particular village or block is not available in the government published statistics and not even in the Block Development office. It is also quite impossible on our part to take up a pilot survey due to among other difficultires, the time and money constraints preceeding primary data collection.

3.2. Choice of Blocks

In the absence of previous knowledge about the extent of use of fertilizer in any block in Meghalaya and


MEGHALAYA
DEVELOPMENT BLOCKS
DADENGGIRI DEV BLOCK
RESUBELAPARA DEV BLOCK
DAMBU RONGJENG DEV BLOCK
SELSELLA BLOCK
RONGRAM BLOCK
SONGSAK BLOCK
NONGSTOIN SUNAPAHAR DEV BLOCK
MAIRANG DEV BLOCK
BHOI DEV BLOCK
SHILLONG
MYLLIEM
JOWAI
RALIANG MYNSO
BETA SINEH
ZIK ZAK
DALU BLOCK
CHOKPOT BLOCK
DAMBUK AGA BLOCK
MAWKYRWATT BLOCK
MAWSYNRAM BLOCK
BHOLAGANJ BLOCK
PYNURSLA BLOCK
SAIPUNG DARRANG BLOCK
4 0 4 8 Km
90°
91°
92°

in particular in any village according to the size of holding or the size of family, the present author has approached some Block Development Officers as well as some extension officers, to gain some knowledge about the intensity of fertilizer use in the block concerned. According to them, the farmers in Bhoi Area Development Block in Naya Bunglow and in Mylliem Development Block in Upper Shillong use more fertilizer both organic and chemical. We have, however, no other alternative reliable counsels other than the Block Development officers who have thorough knowledge about his block and adequately familiar about the agro-economic situation prevailing in his block.

3.3. Choice of villages

After having a formal discussion with the respective Block Development Officers, we have selected two villages in each selected block mentioned above. We have adopted a location criterion in selection of villages in each block. Since, distance is considered as impediment, and more so due to lack of transport facility which is pre-requisite to any economic activities including agricultural. Therefore, we selected one village nearer to Block Development Office and the other which is lying about 15-20 kms. away from the Block Development Office.

Under this criterian, we have selected Syadheh and Umroi from Bhoi Area Development Block and Mawkhan and Nongpyur from Mylliem Development Block. The socio-economic conditions of these four villages are described briefly in the following sub-sections. These informations are collected by ourselves from the respondents and from the Block Development Officer in the course of investigation.

3.3.1. Umroi Village

This village is situated at a distance of about twenty kilometre from the Block Development Office in Naya Bunglow. A new airport has been constructed about three kilometre ahead from the village to facilitate the 'Vayudoot' planes to operate to and from Calcutta. Near the village military contonment is being constructed.

The village has a total population of 1305 persons with 238 households, giving an average size of family of 5.6 persons. The entire population of the village belong to schedule tribes (Khasi).

The main occupation of the people of the village is Agriculture. The principal crops grown by the villagers are paddy, maize, potato, and vegetables. A substantial area of the village is under ginger cultivation. The village falls under Bhoi Area Development Block to which the village farmers turn for seeking advice and assistance not only for problems relating to agriculture but also for other allied occupations. The village block headquarters is 27 kilometre away from the village.

The crops grown are mainly wet cultivation. The cultivation is done in the strecthed low lying areas between the hills where irrigation facilities are availed from the stream flowing through the village. Ginger also grown to a large extend and the cultivators are getting a good market for their produce. Chemical fertilizer used by the farmers are mainly urea, super phosphate and ammonium sulphate, which the cultivators procure from the selling agent from Shillong and retailers from ICAR. The cultivators of that particular village, are not so keen for application of chemical fertilizers but a few enthusiastic cultivators use chemical fertilizers to certain extent. This may be noted here that the village is too far from the centre of activity of that area, hence the problem of transportation impedes the incentive to use fertilizer.

On the other hand use of organic manure is predominant and is used almost by all farmers. The organic manures used mainly are cowdung and pigdung. Cowdung is procured from outside the village, at a very high rate. In the village there is only market known as Umroi market situated at a distance of two kilometre from the heart of the village. There is a weekly market commences after every eight days. Vegetables and other local crops grown in the village are taken to the market for sale. Paddy and ginger are often sold in large stocks in the market.

The only means of transportation to the market is private transport buses which connects the village with Shillong headquarters of East Khasi Hills districts, which is about 29 k.m. away from the village.

There is only one middle English School in the village, which is upgraded to high school standard recently. Besides that, there is one lower primary school.

The level of literacy of respondents is comprehensibly low, about 95% of the respondents are illiterate and the other 5% are just literate with a level of schooling from lower primary to Matriculation standard.

3.3.2. Syadheh Village

Syadheh is another village under Bhoi Area Development Office at Naya Bunglow. According to the 1981 census the village had a total population of size 318 with 54 households, this given an average size of household 5.8. The village is situated to the eastern side of the National highway (as well as B.D.O's office) at a distance of about two and a half kilometre. There is no motorable road to the village from the National Highway. The villagers, therefore, have to carry their goods for sale to the national highway on their heads. They either have to go to the Naya Bunglow market or to the Shillong market to sell their goods.

The use of organic manures, like cowdung, pigdung, and bonemeal are preferred to the use of chemical manures. About 29% of the farmers used chemical fetilizers too, for certain type of crops, such as potato and paddy. The chemical fetilizers are mainly urea, super phosphate, and ammonium sulphate which is procurable from the Shillong open market and from retail shops organised by MECOFED.

The villagers are all christian by regligion. Almost all the people of the village are illiterate, studying upto lower primary level. There is one lower primary school in the village. The main occupation of the people is cultivation, where all the family members capable of doing useful work are engaged in the field. Since there is no other source of alternative employment, the situation is the same as in any rural parts of the country.

3.3.3. Nongpyur Village

This village is under the Mylliem Development Block. It is located in the Upper Shillong and about 5 k.m. from the Air force headquarters. There is no vehicular means of transport to the village except on foot from the main road. The population of the village is 708 with 138 household giving an average household size of 5.1 persons. The village is a Khasi village. The village is covered by the Mylliem Development Block situating at a distance of about 8 k.m. from the Block headquarters.

The economic condition of the villagers is very poor. The villagers are mostly cultivators and during off time they look for manual jobs occasionally available in construction and building sites. The village is hilly and the main cultivation is paddy, potato, maize and vegetables. Vegetables are brought to Shillong market for selling their product by the farmers themselves. Paddy is grown to certain extent in between the slopes area where rain-fed water is available.

Fertilizer used for the crops, mainly for potato, are ammonium sulphate, and super phosphate. Urea is used for maize and vegetables. Fertilizers are available from the local dealer and from Shillong market. Organic manure like cowdung, pigdung are also used to allarge extent.

The people of this village like in any other villages mentioned herein are deprived of education facilities. About 50% of the people are illeterate. Others are half literate studying upto matriculate. There is one lower primary school in the village. For higher studies the students have to come to Shillong town, which is about 8 k.m. from the nearest bus point. In this respect, atleast, this village is not too remote from developed area and has accessibility to main academic stream of Shillong, one of the best in the country.

3.3.4. Mawkhan Village

This is another village under Mylliem Development Block. The village is situated at a distance of 12 k.m. from Shillong and 4 k.m. north-west of the headquarters of Mylliem Development Block. The distance to the village from the nearest motorable road is about 1½ k.m. to be covered on foot. The village is a bigger one and the household are distributed in different clusters around the village headman's house. The population of the selected clusters is 179 with a total household of 35 in the cluster which gives an average size of 5.1 persons, per household.

The population of the entire village, however, is 695 with 135 household in the village.

The main cultivation of the village is potato and vegetables. Potato is grown in commercial scale which is sold in the Shillong market through middleman. Vegetables like cabbage, couliflower, raddish, etc. are grown plentiful for sale which also find its way to the main Shillong market. There is no market in or around the village. The nearest market is about 5 k.m. away from the village.

Only organic manure is used for all types of crops. A huge amount of organic fertilizers, viz. cowdung, pigdung, and bonemeal is used in cultivation. Cowdung is procured from outside the village as well as local dealer from the village. It is not always the price of fertilizer, but the availability in time and space and the attitude to use are some of the causes for not using chemical manure. In fact, the people of this village have apparently earned from their agriculture produce, sufficient money income to buy fertilizer of chemical type.

The main occupation of the village is agriculture. Seventy percent of the people are illiterate, studying upto lower primary. A few educated youth are employed in the community Development Block office and other government offices away from the village.

There is one lower primary school in the village. For higher school education students are to go to Upper Shillong and to Shillong town daily.

All the above four villages are Khasi villages with cent percent Khasi speaking population and christian by religion.

3.4. Selection of Household

Due to certain unavoidable difficulties, we have to resort to simple random sampling in the selection of household. Had there been a systematic record of households, this could have been used as Sampling frame. The very genesis of this sampling based on the assumption that every element of the universe has an equally probable chances for occurance. We have approached the Block Development Officer for a list of household with the names of the householders to be used as the sampling frame. Unfortunately, we were told that such list is not available. We took 15% of the total households, that is, all together 70 household were taken into sample.

3.5. Questionnaire:

In the time of data collection, a specially designed questionnaire, including 45 questions on fertilizer, size of holding, family size and educational background is used.

3.6. Problems faced in Data Collection

In the time of data collection, we have to face certain difficulties in approaching the respondents by ourselves due to the language problem. The mother tongue of the respondents is Khasi, in which the author is not conversant. Also, the most of the respondents are illiterate. Only a few respondents could speak English or Hindi. For this purpose, the respective Block Development Officers had kindly provided us with interpreters to collect the data. Often we have to spend quite a large sum of money from our own pocket due to use of hired vehicle.

Secondly, the farmers do not keep a record of the exact amount of fertilizers used in the field. Whatever, they could remember about the amounts of fertilizer used for that season in 1983 were recorded by us. The data was collected from June to August in 1983.

CHAPTER - 4

METHODOLOGY AND EMPIRICAL RESULTS

4.1. Introduction

In this study, we have considered on the two determinants affecting or influencing the use of fertilizer, both chemical as well as organic. For this purpose, we adopted a number of statistical techniques, which we considered to be appropriate or adequate. The choice of technique of analysing data is very often beset with not only logical but also moral problem. If a logical set of solutions can be provided with the available data then it could give some degree of satisfaction to the researcher to absolve her of moral responsibility. Unfortunately, it becomes imperative on the part of applied economists to present models whose statistical soundness is not always beyond reproach. With the limited data, the author attempts some of the known statistical techniques, to explain the socio-economic phenomenon responsible for use of fertilizer. As Mukherjee* pointed out to defend Mahalanobis Model that "it is not possible, however, to comprehend all the complexities of real economy in a logical system".

---

*Ref.: A. Vasudevan, Strategy of Planning in India, Meenakhi Prakasan, Meerut, 1970.

4.2. Statistical Methods:

4.2.1. Bivariate Correlation

An attempt is made by using Bivariate frequency distribution of family size and the size of holding to study the extent and magnitude of relationship between these two important determinants.

4.2.2. Empirical Analysis

We have assumed that there is positive influence of the family size upon the use of fertilizer. Since, the use of fertilizer implied higher yield per acre than when fertilizer is not used. Assuming that a particular family does not have sufficient land and have to provide food for the household from the meagre production out of small plot of land. Here we have taken into consideration consumption approach i.e. "the end use of fertilizer" rather than productive approach. For this purpose, we want to establish a relationship between the sie of holding and the size of family.

On the other hand, chemical fertilizer if not the organic fertilizer when used agriculture becomes capital intensive with varying degrees. A farmer with a small plot of land may not find it economically efficient to improve his land by providing irrigation facilities necessary for yielding good result of fertilizer application. A big farmer has more financial capacity to introduce water supply system and his motive is not simply for own consumption and the lure of profit gives him incentive to use fertilizer.

Before we try to analyse the influence of these two variables e.g. size of family and the size of holding, on the application of fertilizer, we want to establish that they themselves are positively correlated. When this is established, we shall make attempts to analyse each individual variables' effect upon the fertilizer use. As we have pointed out earlier that one variable cannot be treated in isolation of the other. Their degrees of effect are inter-related and the resulting reaction may be the quantum of fertilizer used.

Consider

X = Size of holding

Y = Family size.

then, according to our assumption:

$$\mathcal{E}(X,Y) \neq 0$$

that is to say,

$$\text{COV }(X,Y) \text{ exist}$$

Our cell frequencies in the Bivariate frequency table, happen to be the number of households with respect to the size of holding and the size of family. We took both size of holding, that is X, as well as the size of family Y, in intervals. Bivariate frequency table, for example, for the analysis of chemical fertilizer is a five by five (5 x 5) table. The layout of bivariate frequency is as follows:

Table 4

	holding	
family	frequency matrix	

We used the well-known Pearson's formula, for correlation coefficient. The formula is us follows:

$$r = \frac{\sum fxy - \sum(fx)\ (\sum fy)/\sum f}{\sqrt{\sum fx^2 - (\sum fx)^2/\sum f)\ (\sum fy^2 - (\sum fy)^2/\sum f}}$$

For chemical fertilizer,

$$r = \frac{\sum fxy - \sum(fx)\ (\sum fy)/\sum f}{\sqrt{\sum fx^2 - (\sum fx)^2/\sum f)\ (\sum fy^2 - (\sum fy)^2/\sum f}}$$

$$= \frac{1417 - (1)\ (66)/34}{\sqrt{(1243 - (1)^2/34)\ (2024 - (66)^2/34}}$$

$$= \frac{1416.06}{(35.25)(43.54)} = 0.92$$

Hence, there is a very high correlation between the size of holding and the size of family with respective to the chemical fertilizer.

Similar analysis was carried out with respect to organic manure.

That is,

$$r = \frac{\sum fxy - \sum(fx)\ (\sum fy)/\sum f}{\sqrt{\sum fx^2 - (\sum fx)^2/\sum f)\ (\sum fy^2 - (\sum fy)^2/\sum f.}}$$

$$= \frac{2369 - (39)\,(279)/70}{\sqrt{(2617) - (39)^2/70)\,(4120 - (279)^2/70}}$$

$$= \frac{2213.56}{50.94 \times 54.84} = 0.79$$

It, therefore, confirms that the two socio-economic determinants are highly correlated for both the type of fertilizers.

We also carried out the same analysis for both chemical and organic fertilizers taken together, as follows, which is also highly correlated*.

$$= \frac{\sum fxy - \sum(fx)\,(fy)/\sum f}{\sqrt{(\sum fx^2) - (\sum fx)^2/\sum f)(\sum fy^2 - (\sum fy)^2/\ f}}$$

$$= \frac{3388 - (345 \times 56)/70}{\sqrt{(7357 - (345)^2/70)\,(3163 - (56)^2/70}}$$

$$= \frac{3112}{(75.21)\,(55.84)} = r = \underline{0.74}$$

* Tables for Bivariate correlation are given in the Appendices 1, 2, 3.

4.2.2. Test of Significance of Correlation Coefficient

In our case, we have only 70 pairs of observations which is sufficiently small. Usually a small value of r suggests that the sample is drawn from a normal distribution with population correlation coefficient f = 0, which means that r is not significant. This may be interpreted as that the bivariate sample yields an r by pure chance due to random sampling when the same bivariate population is not correlated. Starting from this ground, for given f, the distribution of r tends to t-distribution with $\nu = n - 2 = 70 - 2 = 68$ degrees of freedom, and t takes the form (Hoel, 1962, Goopta <u>et al</u>, 1962),

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \quad \text{with } n - 2 \text{ degrees of freedom.}$$

Now the null hypothesis to the tested Ho: f=0 against the other alternatives. We have found r = .79 for organic manure, therefore, n = 70, the t will be

$$t = \frac{.79\sqrt{68}}{\sqrt{1 - .79^2}} = \frac{5.514}{.613} = 10.62$$

for ·95% level of significance with 68 degrees of freedom the table value of t = 1.98. Therefore, r is very significant.

For chemical manure, we obtained r = .92 with n = 34.

So,

$$t = \frac{.92\sqrt{32}}{\sqrt{1 - .92^2}} = \frac{5.203}{.3919} = 13.27$$

again, we found r is significant.

For chemical and organic manures, combined, our r value is found to be .74.

So,

$$t = \frac{.74\sqrt{68}}{\sqrt{1 - .74^2}} = \frac{6.102}{.6726} = 9.07$$

Thus, for all the cases, r is found to be significantly different from zero ascerting the fact that there is a strong correlation between the size of family the size of holding.

4.3. <u>Analysis of Variance : Two Factor Analysis</u>

Having established close correlationship between the two determinants for the use of fertilizers, we are now turning to the problem, which of this two determinants, which are here size of family and the size of holding is exerting more influence upon the use of fertilizer.

We have considered that use of fertilizer whether chemical or organic is influenced by size of family and the size of holding simultaneously barring all other factors that might also influence the farmers to use fertilizer. There is no doubt that the application of fertilizer would yield more crops per unit of area under cultivation. The farmers with small size holdings can expect more output as a result of application of fertilizer and possibly derive sustenance which is otherwise impossible.

There may be other factors, e.g. socio-economic, psychological or traditional of which one or a combination of them could either be persuasive or dissuasive in deciding whether to use fertilizer or not. Hence we cannot possibly think that there will be no variation in the application of fertilizer for the groups of families with varying size, due to the joint or singular factor or factors mentioned herein.

Similarly, we think that the size of holding has its own impact upon the tendency to use fertilizers.

Specially, chemical fertilizers being expensive, the farmers must have an economic drive for its application to improve the quality and quantity of his crops. A farmer with a very small size holding may not find it attractive to use chemical fertilizer, but the same cannot be said in the case of organic manure which is locally available and less expensive than chemical manure. Nevertheless, we do not rule out that a small farmer is abhorrent to the use of chemical fertilizer. Assuming that both small and large farmer use manures and assuming further that there will be variations within the small, medium or large farmers, i.e. according to the size of their holdings.

These variabilities whether due to the size of family or due to the size of holding, assumed to be normal.

Finally, we would like to examine whether these variabilities may be attributed to the differences between the sizes of families or between the sizes of holdings and also whether a particular size of family with a particular size of holding has significantly different quantum of fertilizer application.

One of the fundamental drawbacks of socio-economic data is that they are not free from exogeneous influences, though, analysis of variance aimed at identification of key determinant, yet this is not possible, since each key determinant is subjected to social and economic process which is transitive and do not follow a pre-assigned path. It is the numerous extraneous forces which cannot be controlled, hence made the analysis exploratory and indecisive.

The two-way classification table used for this type of analysis is presented below:

	Size of family	Row total
Size of holding	Fertilizer Matrix	
Column total		Grand total

4.3.1. Computation Procedure for Analysis of Variance

The basic principle used in the Analysis of variance is that the group means have no sizeable or significant variation with respect to the determinant concerned. In our case, we have two determinants, one is size of family, the other is size of holding, We can represent the layout of the data as follows:

Table 1

Size of holding	Size of family n_1	n_2	n_3	n_4	Total of row
a_1	x_{11}	x_{12}	x_{13}	x_{14}	$x_{1.}$
a_2	x_{21}	x_{22}	x_{23}	x_{24}	$x_{2.}$
a_3	x_{31}	x_{32}	x_{33}	x_{34}	$x_{3.}$
a_4	x_{41}	x_{42}	x_{43}	x_{44}	$x_{4.}$
Total of column	$x_{.1}$	$x_{.2}$	$x_{.3}$	$x_{.4}$	

According to our previous statment, we would like to say whether $x_{1.}$ is equal to $x_{2.}$ and so on. There are the group means. If the size of family which is varying, this determinant in this instance has any effect upon the quantum of fertilizer used while keeping the all other factors constant; then we supposed to have,

$$x_{1.} = x_{2.} = \ldots\ldots\ldots\ldots = x_{4.}$$

Similarly, we obtained also group means of fertilizer for the size of holding which are given in the bottom row of the table. Here also, we assume that if the size of holding has no affect upon the use of fertilizer then we are suppose to have that the group means $x_{.1}$ is equal to $x_{.2}$ and so on. In order to analyse the equality of the group means for both the factors, we have used Analysis of Variance Technique (Paradine, 1966).

Method of Computation:

The total Sum of Squares can be expressed as sum of three components, one due to size of family, one due to size of holding and the other due to error, .e.g.

$$\sum_{i}\sum_{j}(x_{ij} - x_{..})^2$$
$$= \sum\sum(x_{i.} - x_{..})^2 + \sum\sum(x_{ij} - x_{..})^2 + \sum\sum(x_{ij} - x_{i.} - x_{ij} - x_{..})^2$$
$$= c_i\sum(x_{i.} - x_{..})^2 + r_j\sum(x_{ij} - x_{..})^2 + \sum\sum(x_{ij} - x_{i.} - x_{.j} - x_{..})^2$$

where c and r refer to column and row of the table and (.) signifies mean value e.g. x_{ij} is the mean of jth column.

$$\text{T.S.S.} = X_{11}^2 + X_{12}^2 + \cdots\cdots\cdots + X_{44}^2 - \text{c.f.}$$

$$\text{Correlation factor} = \frac{\sum\sum X_{ij}^2}{16}$$

where, i,j = 1, 2, 3, and 4.

$$\text{Column SS} = \frac{X_{.1}^2 + X_{.2}^2 + X_{.3}^2 + X_{.4}^2}{4} - \text{C.F.}$$

Similarly,

$$\text{Row SS} = \frac{X_{1.}^2 + X_{2.}^2 + X_{3.}^2 + X_{4.}^2}{4} - \text{C.F.}$$

Finally, the Error SS is given by

$$\mathcal{E}SS = (\text{TSS} - \text{SS due to Row}) - (\text{SS due to column})$$

The next step is to find the Mean Square (MS) or in other words, the variance of Row, Column and Error. This is done by dividing the sum of squares by the number of degrees of freedom. In the present illustration, given above, the degrees of freedom is 3, both for Row and Column, and the total degrees of freedom is 15. Therefore, the degrees of freedom by way of substration for the error is 8. Hence the test statistic F is constracted as

$$F = \frac{\text{MSS due to Row}}{\text{MSS due to Error}}$$

for testing the variability of group means due to Row and for testing the variability of group means due to column F is given by

$$F = \frac{\text{MSS due to column}}{\text{MSS due to Error}}$$

Then finally our null hypothesis is to be tested that there is no difference in group means against the alternative by comparing calculated F with that of tabulated value of F, as it was here.

4.3.2. Empirical Analysis

Two way classification of Data of manures used, for both chemical and organic, classified according to the size of family and the size of holding.

Table 2

Size of holding	Size of family					Total
	0-2	3-5	6-8	9-11	12 & above	
0-2	11	3	0	10	87	111
3-5	2	3	7	9	40	61
6-8	0	5	8	10	16	39
9-11	2	5	7	10	38	62
12 & above	0	5	7	9	19	40
Total	15	21	29	48	200	313

Throughout the analysis, we are maintaining the assumption that there is variations of mean within the size of families as well as for the size of holdings. The appropriate hypothesis for testing the means with F-test would be:

$$Ho : Mi = Mj \quad \text{for } i \neq j$$
$$Hi : Mi \neq Mj \quad \text{for } i \neq j.$$

Now, the resultant ANOVA table is given below:

Table 3

ANOVA TABLE*

SS due to	SS	d_f	MS	F
Between size of holding	663.5	4	165.8	$\frac{165.8}{168.7} = 0.982$
Between size of family	4868.4	4	1217.1	$\frac{1217.1}{168.7} = 7.21$
Error	2699.3	16	168.7	
Total SS	8231.2	24	342.9	

The table value of F at the 95% level of significance with 4 and 16 degrees of freedom is 3.01, but we found that F = 0.982. Hence F is not significant. Thus, this means that there is no significant variability within row, i.e. size of family. Therefore, our influence at this

*Mathematical notes on analysis of variance is given in the Appendix 'D'.

instance suggest that the size of family is not necessarily an important determinant. Again, for the size of holding, our calculated F happens to be 7.21 with 4 and 16 degrees of freedom, when the table value is 3.01. Therefore, we found that there is no significant difference in the use of fertilizer with respect to holding.

4.333. <u>Conclusion</u>

The analysis reveals another very interesting fact. The mean consumption of fertilizer is 12.5 quintals for the 25 cells, whereas, in some cells there are zeros meaning no use of fertilizer. The quantum of fertilizer used ranged from minimum of 2 quintals to maximum of 87 quintals, this is, of course, due to the aggregation at both ends of family size and the size of holding. Taking the estimate of S.E. of population mean as $\sqrt{342.9} = 18.5$, we can compute the 95% confidence interval as $12.5 \pm (1.96)(18.5)$ or 12.5 ± 36.1, showing that population mean lies between - 23.6 and 48.6. This shows that group means inter-alia population mean is not stable. Evidently data shows the same.

Further significance of F, the ratio between size of holding variance to the variance of the residual implies that the group means are not unequal, whereas, the group means between size of family are unequal. This is rather very interesting, that the size of family turns out to be more dominant factor than the size of holding. Though, the economic considerations prevent us to think likewise. We may also point out here that instability of between group means of size of holdings rather suggests that the practice of use of fertilizer is mostly influenced by necessity rather than by the motive for economic prospcerity.

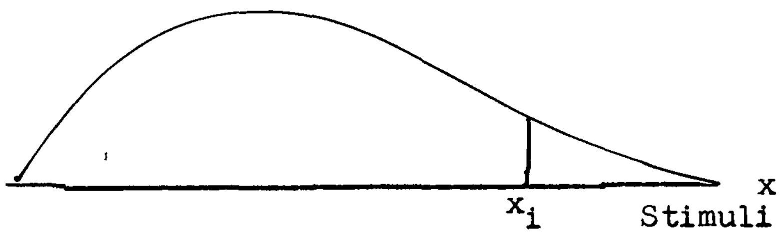
4.4. Probit Analysis

The technique of probit analysis is an offshoot of maximum likelihood estimation which has first been applied by physicists and biometricians. Recently, its application is found also in explaining socio-economic phenomenon specially in demography (Stene *et al*., 1969). Probit analysis is based on the ligic of reaction occurred when a particular agent is applied to an object (Paradine, 1966). The principle of probit analysis is intuitively considered to be appropriate to explain away the impact of the two determinants of use of fertilizers. However, this part of analysis amay be treated as explanatory rather than decisive.

Here, we try to imagine a situation that although fertilizer use itself induce more agricultural output provided other necessary requisites are not wanting, nevertheless, the farmer would incline to use more fertilizers if he has a large family to support. Land itself has a limited amount of potentiality for agricultural output, but this potentiality could be activated by using fertilizer. Thus, giving an impulse through fertilizer, potentiality of land could be increased, which could be considered as a source of motivation for a farmer to use fertilizer. We have also reason to believe that size of family itself could be a stimulus and quantum of fertilizer against that stimulus may be called a response. We have considered this analysis with size distribution of the family as well as for the size distribution of holdings as the respective stimuli, both for chemical and organic manures.

Before going further, with the theoretical aspects of the problem; we would like to make a confession that such type of analysis was not carried earlier and hence may invoke criticism.

Consider x_i, (i = 1, 2, ...n) agents applied to objects of size nj then our objective is to find the percentile distribution of x_i, the stimuli. This can be obtained by finding first the proportion of agents responding to stimuli, as follows (Paradine, 1966).



where Proportion function is

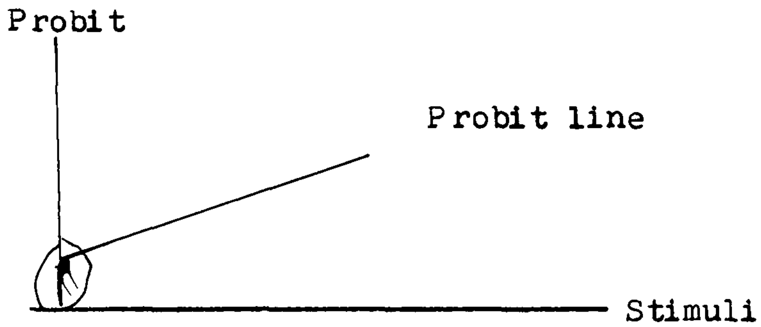
$$P = \int_{-\infty}^{x_i} g(x)\ dx \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

In general, it is expected that proportion responding increases with the impulse.

The next step is known as Pribit Transformation, which transform the normal curve into a straight line. The probit corresponding to a proportion P can be represented by a distribution function.

$$P = \frac{1}{\sqrt{2\,\text{II}}} \int_{-\infty}^{C-5} e^{-x^2/2}\ dx \quad \ldots\ldots \quad (2)$$

where t = abscinsa and 5 is purely an arbitrary number to ensure that t is always positive. The probit values corrsponding to (2) can be obtained from the table. The probits is then plotted against stimuli. The nature of the curve will be indicative of the effectiveness of stimuli.



For our analysis purpose, we have to re-tabulate the data to facilitate the necessary calculations for probit analysis. For example, we have originally classified the size of family into five class intervals. But due to some empty cell and also to ensure positive values we have combined them into four class intervals. Naturally, this kind of re-arrangement of data might, to some extent, lead to loss of information. We arrange the data as follows:

Table 4

Size of family	0-5	6-8	9-11	12 & above
Quantity of organic manure used (total)	510	964	362	320
No. of household	17	32	15	6
Average of manure used	30	30.12	24.13	53.33
Proportion	.21	.21	.17	.38
Probit (obtained from table)	4.99	4.19	4.05	4.69

Now, here we have to explain a few things about the data. Total manures in each cell against each size of family is obtained by totaling for all the households in each size group. The unit of manure is in quintals. Then we have calculated the simple arithmatic mean of manure used by each size of family. In the next step we have obtained the proportion for each family by dividing each group mean of each size of family by the grand arithmatic mean of the manure for all the sizes of family, Then, in the last stage, we obtained the table values of Probit for each proportion. Finally, we have ploted the probit values against the size of family, i.e. the stimuli.

The above table relates to organic manure alone. Similarly, we have done for other manures.

Table 5

Size of family	0-5	6-8	9-11	12 & above
Quantity of chemical manure used	50	102	65	48
No. of household	8	16	8	2
Average	6.25	6.39	8.12	24
Proportion	.13	.14	.18	.53
Probit	3.87	3.92	4.08	5.07

As we have mentioned in the beginning of our study that the size of holding is also another determinant of use of fertilizers and in this instance it is to be regarded as the stimuli. The procedure for getting the proportion is similar to that of size of family. However, we have kept five class intervals of the size of holding. One reason for doing this is that a smaller farm is less sensitive than a larger farm or we can say it is more economical to use fertilizer in a big farm than in a small farm.

Now we present the tables (both organic and chemical) below:

Table 6

Size of holding	0-2	3-5	6-8	9-11	12 & above
Quantity of organic manure used	1341	603	35	97	80
No. of household	25	22	5	7	7
Average	53.64	27.40	7	13.85	11.42
Proportion	.47	.24	.06	.12	.10
Probit	4.92	4.29	3.45	3.82	3.72

And for chemical manure -

Table 7

Size of holding	0-2	3-5	6-8	9-11	12 & above
Quantity of chemical manure used	130	69	11	11	27
No. of household	15	8	2	5	4
Average	8.66	8.62	5.5	5.6	6.75
Proportion	.24	.24	.15	.15	.19
Probit	4.29	4.29	3.96	3.96	4.12

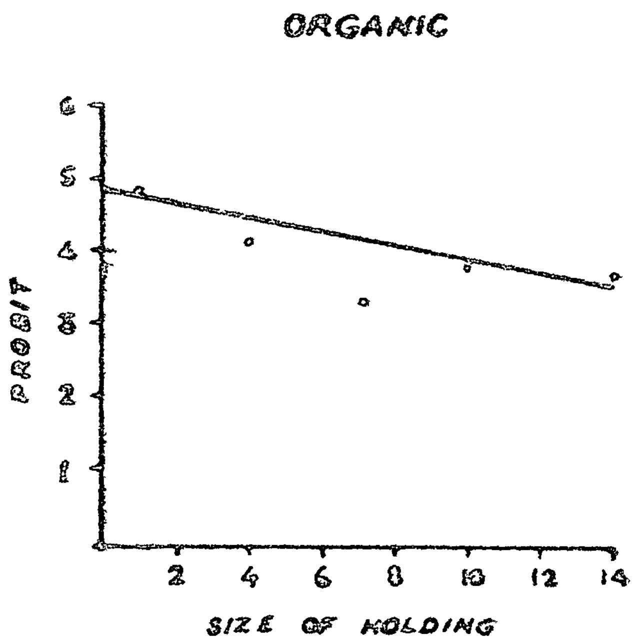

ORGANIC
PROBIT
6
5
4
3
2
1
2
4
6
8
10
12
14
SIZE OF HOLDING

Fig. 3.

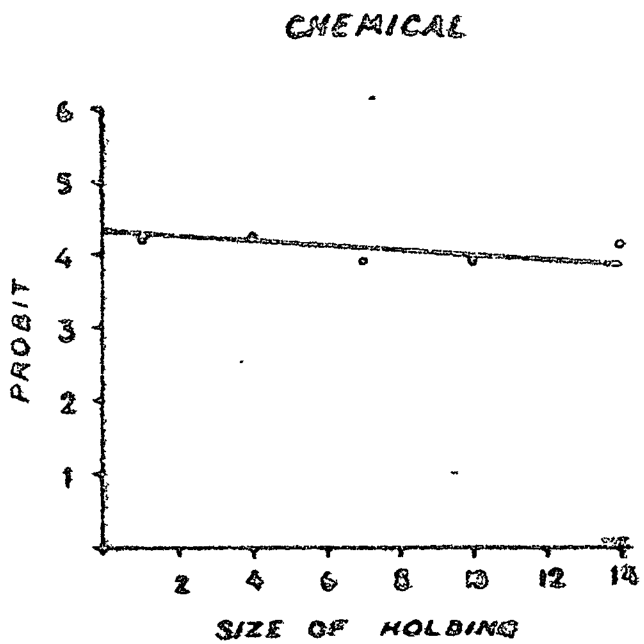

CHEMICAL
PROBIT
6
5
4
3
2
1
2
4
6
8
10
12
14
SIZE OF HOLDING

Fig. 4.

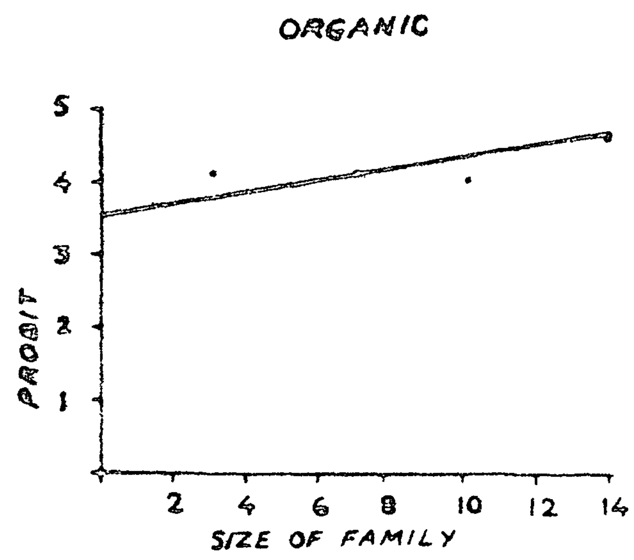

ORGANIC
5
4
3
2
1
PROBIT
2
4
6
8
10
12
14
SIZE OF FAMILY

Fig. 1.

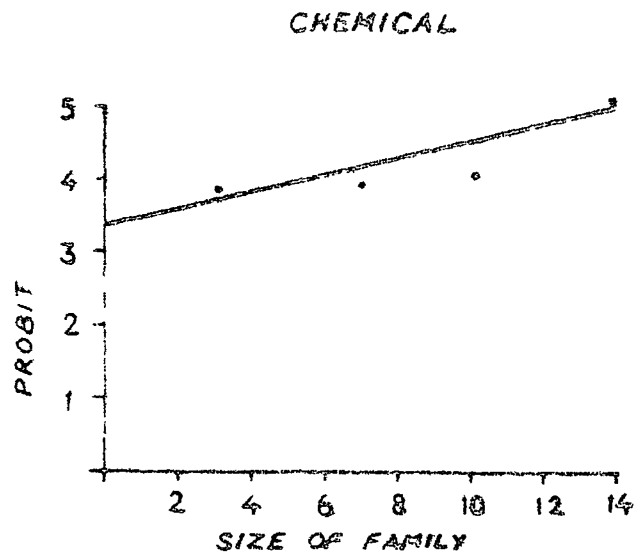

CHEMICAL
5
4
3
2
1
PROBIT
2
4
6
8
10
12
14
SIZE OF FAMILY

Fig. 2

4.4.2. Conclusion:

Looking at the Graph 1, we can possibly conclude that the proportion of response increases with the increase in the size of family. However, we expected that the line will be having a slope of higher magnitude making the line more steep. This may be due to the reason that there is some mis-representation of quantity of manure used as reported by the farmers.

Looking at the Graph 2, we may reliably conclude that the size of family is a determinant of use of chemical manures. Although, we do not have a very steep line but there is a tendency for it. Hence, for application of chemical manure is influenced more and more by the increase in the size of family.

Whereas, the Graph 3 gives a surprising result, but this may be interpreted quite easily. This graph indicates that the size of holding is not truely the determinant of the use of organic fertilizer and is not influenced by the size of holding. Since, we have not considered any other criteria at present, other than the size of holding, we can at this stage, may infer from the graph, that use of chemical manure probably is more economical than the use of organic manure as the size of holding increases.

Now, we shall come to the last graph, i.e. graph 4, where we have analysed for chemical manure against the size of holding. At the instance the result is similar to that of organic chemical (graph 3) with a little bit of improvement. Here we can see from the graph that Probit is decreasing with the size of holding.

Finally, we may ask one question, why the size of holding gives similar results, both for organic and chemical manure, and the size of family also is giving similar result, both for organic and chemical? First thing we have to note is that the tendency of increase in Probit is felt very much when size of family also increases, whereas, this is not so with the size of holding. Thus, it means that size of holding is a less important determinant than the size of family for the application of fertilizer. Then, how do we explain the economic criteria for application of fertilizers by the large farmers?

From this we can possibly draw only one conclusion that the necessity to gain sustenance from land is a more important criteria when the size of family increases. May be the extranious causes like feasibility of marketing, excess products due to lack of demand or due to other essential services like transportion even and/or due to the lack of marketable organization.

4.5. Regression Analysis

The next objective is to examine whether there is any definite relationship between Probit and the size of holding as well as to smoothen the data and for predictability of criterian. Of course, we have already seen in the graphical analysis that it is so. But due to our inadequate data or due to statistical sampling error may be we have not found exact relationship in probit analysis. On the other hand, socio-economic variables are not controlled variables. Therefore, we expect some diversion. In the section, we are analysing the performance of probit analysis with the help of regression.

4.5.1. Empirical Analysis:

Consider,

$$\hat{C} = \hat{\alpha} + \hat{\beta} Y$$

where,

C = Probit values

Y = Size of family

and α, β = Parameters of the Regression Model.

By application of the Method of Least Squares we obtain the estimates $\hat{\alpha}$ and $\hat{\beta}$ of the parameters α and β.

The data is taken from the previsous analysis, which we present here again:

Table 8

C	Y
4.19	2.5
4.19	7.0
4.05	10.0
6.09	13.5

Using deviations from the respective means, we obtain $\hat{\beta}$ by the application of OLS method

$$\hat{\beta} = \frac{\Sigma cy}{\Sigma y^2} = \frac{11.17}{60.67} = .18$$

and $\hat{\alpha} = \bar{C} - \hat{\beta}\bar{Y}$

$= 4.63 - .18\ (8.12)$

$= 3.17.$

Hence the empirical equation

$\hat{C} = 3.17 + 0.18Y^*$

This analysis is for the size of family (Y) with respect to organic manure. Similarly, the respective data and empirical equations of the other determinants for all types of manures presented below:

For chemical manure, with respect to size of family:

Table 9

C	Y
3.87	2.5
3.92	7.0
4.08	10.0
5.07	13.0

Using OLS method

$$\hat{\beta} = \frac{\Sigma cy}{\Sigma y^2} = \frac{6.73}{60.17} = 0.111$$

and $\hat{\alpha} = \bar{C} - \hat{\beta}\bar{Y} = 4.23 - .11\ (8.12) = 3.34.$

ORGANIC

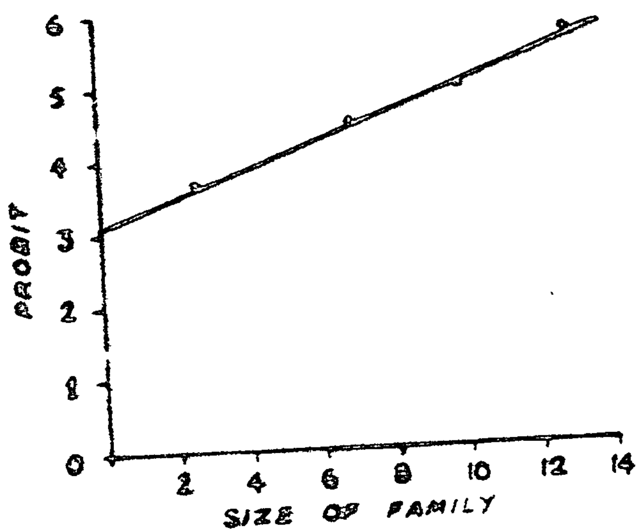


Fig. 5.

CHEMICAL

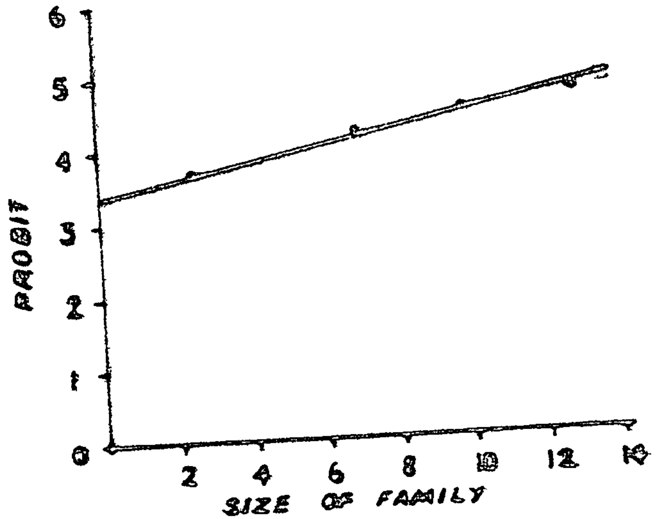


Fig. 6.

Hence, the empirical equation -

$$\hat{C} = 3.34 + 0.111Y.$$

These are shown in graphs 5 and 6.

Similarly, for organic manure, with respect to size of holding (X).

Table 10

C	Y
4.92	1.0
4.29	4.0
3.45	7.0
3.82	10.0
3.72	13.0

By using OLS method -

$$\hat{\beta} = \frac{\Sigma cx}{\Sigma x^2} = \frac{9.29}{90} = 0.10$$

and $\hat{\alpha} = \bar{C} - \hat{\beta}\bar{X} = 4.4 - 0.10\ (7.0) = 3.7.$

Hence, the empirical equation is

$$\hat{C} = 3.7 + 0.10X.$$

And finally, for chemical manure, with respect to the size of holding -

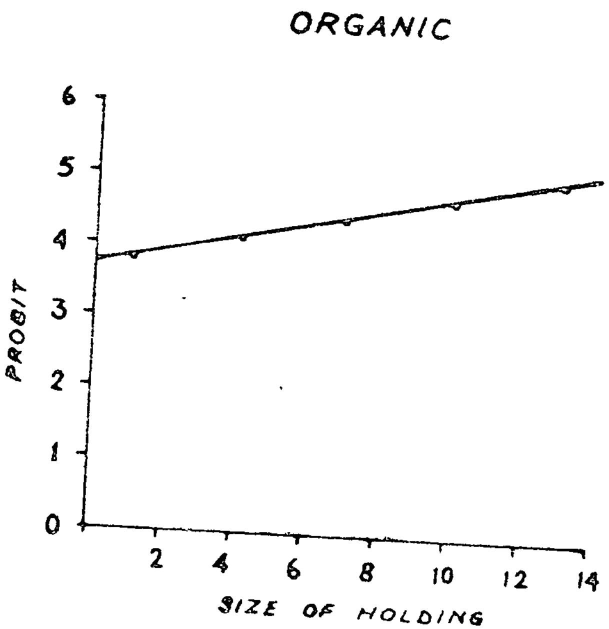

ORGANIC
PROBIT
0
1
2
3
4
5
6
2
4
6
8
10
12
14
SIZE OF HOLDING

Fig. 7.

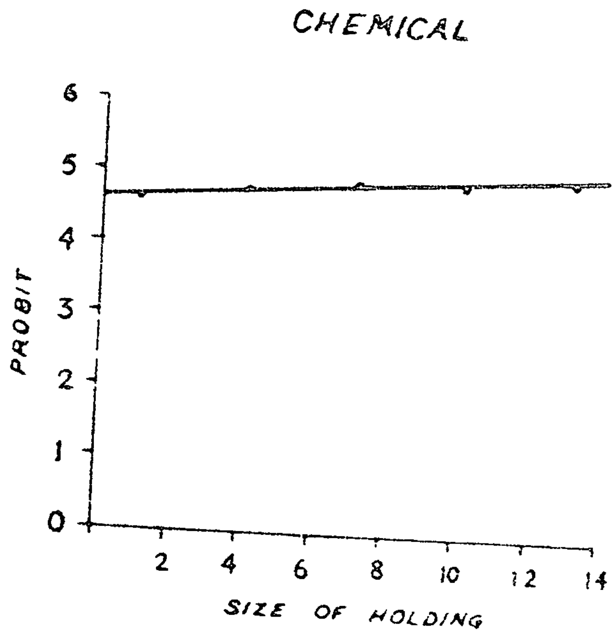

CHEMICAL
PROBIT
0
1
2
3
4
5
6
2
4
6
8
10
12
14
SIZE OF HOLDING

Fig. 8.

Table 11

C	X
4.29	1.0
4.29	4.0
3.96	7.0
3.96	10.0
4.12	13.0

By using OLS method -

$$\hat{\beta} = \frac{\sum cx}{\sum x^2} = \frac{9.27}{90} = -.022$$

and $\hat{\alpha} = \bar{C} - \hat{\beta}\bar{X} = 4.12\ (-.22)\ (7) = 5.67.$

Therefore, the empirical equation:

$\hat{C} = 5.67 - .022X.$

These are shown in graphs 7 and 8.

4.5.2. Conclusion

These graphs have evidently shown that there is a linear functional relationship between Probit and the size of family for all types of manures. Had we have more data) collected from a wide range of size of holding and the size of family and from diversified regions, then probably we would have had a better picture of the situation. This analysis confirmed to a certain extent that size of family and the size of holding influence the use of fertilizers, whether it is organic or chemical.

4.6. Reaction Function Approach:

4.6.1. Introduction

Next in the line of our analysis is the Reaction Function approach developed by Bėz. In his model, he considers as object and an agent, when agent is applied to the object, a reaction occurs (Bez, 1980). Consider the reaction function

$$R = U\ (O,\ A)$$

where,

R = Reaction,

O = Object,

A = Agent.

whose frame of reference is given by

$\overset{O}{\diagdown}\, A$	$O_1 \ldots O_i \ldots O_n$	total
$A_1 \vdots A_j \vdots A_n$	$R = U\ (O_i, A_j)$	$\downarrow A_j \uparrow$
Total	$\longrightarrow O_i \longleftarrow$	

4.6.2. Theory:

We can write down the reaction functions for agent A_1 against the object O_j and that of agent A_i against O_1 as follows:

$$\begin{aligned} R_{1j} &= U_{1j}\,(A_1, O_j) \\ &= U_{11}\,(A_1O_1) + U_{12}(A_1O_2) + \ldots + U_{1n}\,(A_1O_n) \end{aligned}$$

and

$$\begin{aligned} R_{i1} &= U_{i1}\,(A_iO_1) \\ &= U_{11}\,(A_1O_1) + U_{21}(A_2O_1) + \ldots + U_{ni}\,(A_nO_1) \end{aligned}$$

Translating these ideas to the problem at hand, we can, very well propose that the reaction i.e. the amount of fertilizer used is the result of reaction of size of family of the farmer to the size of holding or vice-versa. These two determinants of use of fertilizer acts jointly upon what amount of manure is to be applied. Thus,

$$F = R(N,\ L)$$

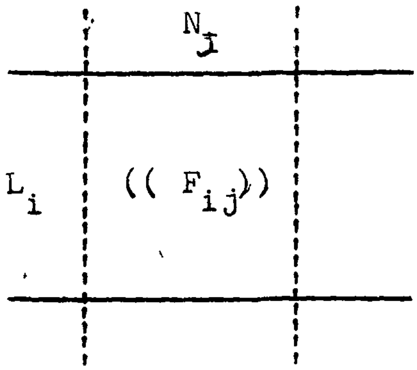
where

F = the reaction i.e. the amount of fertilizer used

N = Size of the family

L = Size of holding.

The mathematical deductions are very sophisticated, we shall only use some of the final results of the Bez model, using our own notations. The fertilizer matrix is conceived to be the reaction of size of holding i.e. L and the size of family i.e. N, then the realizable matrix is



It may logically be held that not any two of F_{ij}, the cell values of fertilizer matrix be equal, since a family with the same size with differing sizes of holding would have used differing amount of fertilizers. Thus,

$$F_{11} \neq F_{12} \neq \dots \neq F_{1n} \text{ and}$$
$$F_{21} \neq F_{22} \neq \dots \neq F_{2n} \text{ etc.}$$

He defined a conditional probability function

$$P\,(F_{ij}/L_i,\ N_j,\ F) = \sum p\,\{F_{ij}^{(r)}/L_i,\ N_j,\ F\}$$

where

F = unrealizable universe of F_{ij}

r = 0, when there is no reaction

r = 1, when there is reaction

p = associated probability for each consecutive reaction.

The sum of the probabilities should add up to one i.e. certainity, which never happens in empirical case.

Now considering 2 different sets of $f^{(r)}$ and $f^{(q)}$ of responses i.e. fertilizer applied in the realizable set of F_{ij}, we may write

$$P\left\{f^{(r)}/F_{ij}\right\} = \frac{P\left\{f^{(r)}/F^{(1)}\right\} P\left\{F^{(1)}\right\}}{P\left\{F^{(1)}/F_{ij}\right\}}$$

and

$$P\left\{f^{(q)}/F_{ij}\right\} = \frac{P\left\{f^{(q)}/F^{(1)}\right\} P\left\{F^{(1)}\right\}}{P\left\{F^{(1)}/F_{ij}\right\}}$$

Finally, Bez defined the 'plausible' probility function,

$$P\left\{f^{(r)}/F_{ij}\right\} = \frac{P\left\{f^{(r)}/F^{(1)}\right\}}{P\left\{f^{(r)}/F^{(1)}\right\} + P\left\{f^{(q)}/F^{(1)}\right\}}$$

$$= \frac{P\left\{f^{(r)}/F^{(1)}\right\}}{\sum P\left\{f^{(r+q)}/F^{(1)}\right\}}$$

The last relation in terms of probability can be interpreted as relative share for any of the determinants with respect to the one fixed value of the other determinant. This last relation is used to translate probability to proportionality,

$$\sum_j F_{ij} = \frac{f_{ij}}{\sum_j f_{ij}}$$

$$\sum_i F_{ij} = \frac{f_{ij}}{\sum_i f_{ij}}$$

4.6.3. <u>Empirical Analysis</u>

For the purpose of empirical analysis, the reference matrix is written in terms of logarithmic values,

β	n_1	n_2	n_3	n_4	n_5	Total
l_1	f_{11}	f_{12}	f_{13}	f_{14}	f_{15}	$f_{1.}$
l_2	f_{21}	f_{22}	f_{23}	f_{24}	f_{25}	$f_{2.}$
l_3	f_{31}	f_{32}	f_{33}	f_{34}	f_{35}	$f_{3.}$
l_4	f_{41}	f_{42}	f_{43}	f_{44}	f_{45}	$f_{4.}$
l_5	f_{51}	f_{52}	f_{53}	f_{54}	f_{55}	$f_{5.}$
Total	$f_{.1}$	$f_{.2}$	$f_{.3}$	$f_{.4}$	$f_{.5}$	

The data on f_{ij} are given below:

(1) Marginal Probability and Cell Probability

Size of holding	Size of family					Total
	n_1	n_2	n_3	n_4	n_5	
l_1	5.3	7.4	10.3	17.0	70.9	110.9
l_2	3.0	4.1	5.7	9.4	38.9	61.1
l_3	2.0	2.6	3.6	6.0	24.9	39.1
l_4	3.0	4.2	5.7	9.5	39.6	62.0
l_5	2.0	2.7	3.7	6.1	25.6	40.1
Total	15.3	21.0	29.0	48.0	199.9	313.2

(Derived from Table 2 in Section 4.3.2).

(2) Logarithmic values of Table (1)

	n_1	n_2	n_3	n_4	n_5	Total
l_1	.724	.869	1.013	1.2301	.850	5.686
l_2	.477	.612	.756	.973	1.589	4.407
l_3	.301	.415	.556	.778	1.396	3.446
l_4	.477	.623	.755	.977	1.597	4.429
l_5	.301	.431	.568	.765	1.408	3.473
Total	2.280	3.819	3.648	4.729	7.834	

LOG VALUES OF COLUMNS RELATING TO EACH FAMILY SIZE IS PLOTTED AGAINST COLUMN TOTAL

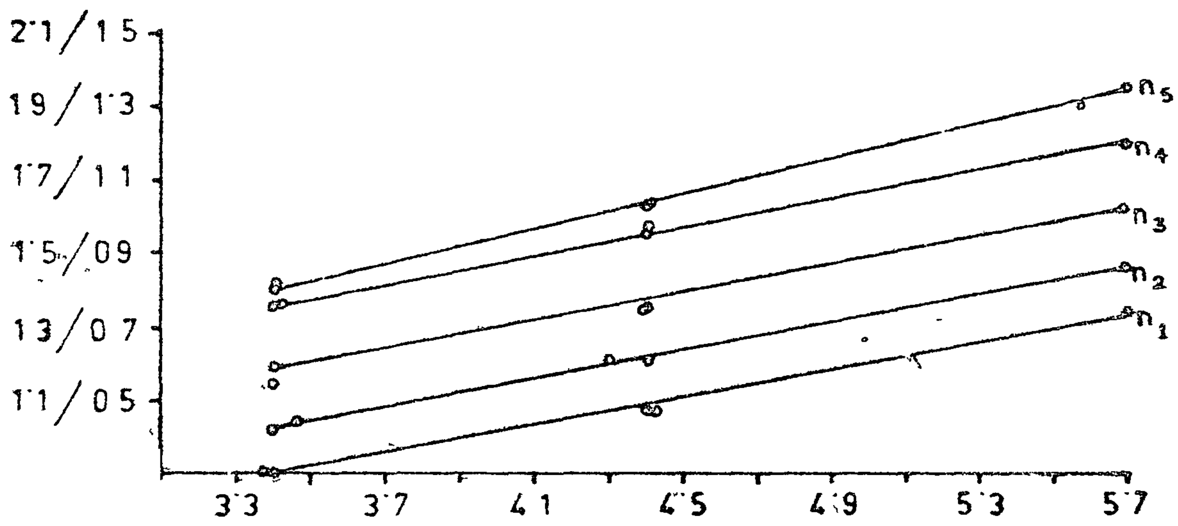


Fig. 9

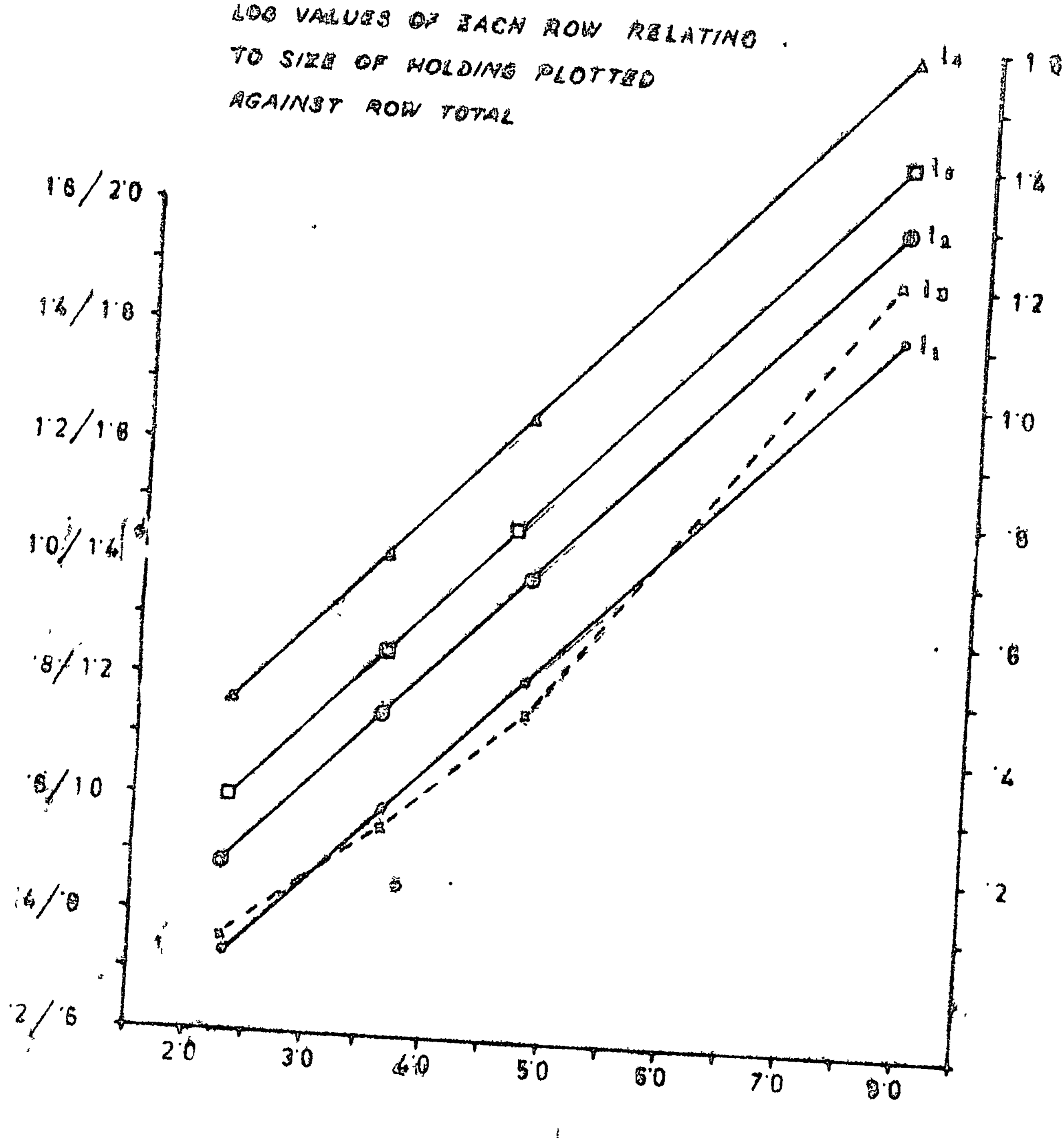

LOG VALUES OF EACH ROW RELATING
TO SIZE OF HOLDING PLOTTED
AGAINST ROW TOTAL

Fig. 10

Then f_{ij}, f_{2j} etc. are plotted against $f_{1.}$, $f_{2.}$ etc. and again f_{i1}, f_{i2} etc. are plotted against $f_{.1}$, $f_{.2}$ etc. These graphs are shown below.

4.6.4. Conclusion

Following the nature of laws of proportionality, we expect straight lines with unit slopes. However, it can be seen from the graphs that the trend in all the cases, whether for the respective size of family or for the respective size of holding, is found to be linear. There is proportionate relation between the amount of fertilizer used and the size of family or the size of holding.

One interesting outcome of this graphical analysis is that the trend in fertilizer consumption is linear in relation to the determinants and we may voice for this linearity with freedom from all other extraneous variables. Since the model is designed in such a way that there is no interference from other socio-economic variables. Bez model has earlier been used also for analysing growth in agricultural production in the seven north-eastern states to isolate whether the growth is linear in time or linear in space i.e. states (Dutta, 1983).

CHAPTER - 5

CONCLUSION

The specific objective of scientific analysis is 'comparing' and 'diseriminating', this is recognized and persued fervently by the Rishis of Naimisaranya, the womb of Brihad Aranyak Upanishad. The power to descriminate through analysis is the core of the theory of knowledge. The supposedly homogeneous micro elements characterize~~s~~ the universe about which our knowledge is constrained finite, thus, within that limit of our intellectual and material capacity, we have to work out our analysis with the finite set of material information.

The Samkhya Concept of sample within a subset of the universe of population is a probabilistic mystery still to be exhaustively explored within the frame of parametric reference by the mathematical statisticians. With these words, we admit our short comings of analysis, a consequent derivative of the micro-nature of our data used for this study.

We took two of the socio-economic determinants of use of fertilizers, these are size of family and the size of holding. We have used a number of statistical ~~tools of the~~ empirical results given in Chapter 4. It was one of our objective to analyse which one of the two determinants is more sensitive to the motivation for use of fertilizers. Although, organic manure is conventional, yet the perception of farming might give equal weight as to its end results of its use.

We have seen that both the determinants are highly correlated either for chemical or organic manure of for both. The significance test of 'r' the correlation coefficient shows that each r is highly statistically significant. The apparent correlationship measure given us further evidence that the size of holding, the size of family are linearly related and thus, provides evidence of proportionately to one another. Although, in Meghalaya each farmer is supposed to be able to acquire from the community as much land as he desires to cultivate, his constraints then to acquire more than sufficient for the purpose of sustenance - capital and labour or atleast one of them. The present analysis gives support to the view that atleast the majority of the farmers are satisfied with what he needs for his livelihood. We may also note that an egalitarian society with poor education has its distinct values and characteristics even in the field of material welbeing, which any other society other than tribals would have transgressed equality concept.

In our next analysis, i.e. analysis of variance our aim is to identify which one of the two determinants of use of fertilizer behave sensitively. The effect of the size of holding and the size of family upon the use of fertilizer may be a synergic effect, yet one is to be distinguished from the other as statistical analysis of variance permits. It is found that 'between' size of holding variance against the error variance does not yield a statistically significant F. This leads us to opine that the group means of fertilizer in the domain of size of holding are more or less equal to each other, implying some kind of stability. Consequantly, it may be argued that the determinant 'size of family' is not as less sensitive as the 'size of holding' which is highly significant. The economic interpretation just on the basis of analysis of variance with limited data, will not be truely appropriate, nevertheless, we maintained that the farmers with large holding have strongly been motivated to use fertilizer as compared to the farmers with small holdings, which is not found to be quite true.

Logically speaking probit analysis is more an appropriate tool had there been controlled situation. The stimuli either that size of holding or the size of family exerts influence or acts as motivating factor for the use of fertilizer. We expected straight lines with positive slopes for both the stimuli if not with respect to both types of fertilizers. We obtained straight lines in all the four cases. Here again each stimuli (determinant) behaves differently. We had straight lines for the size of family with positive slopes both for organic and chemical fertilizer whereas, for stimuli, size of holding we have straight lines with negative slopes both for organic and chemical manures. We have already seen, in the analysis of variance that the size of holding is supposed to be moderate stimuli in comparison to size of family. We may have to search for the reason of irregularity, it may be that farmers with large size of holding in the absence of profit motivation may not use the 'adequate' quantum of manure. As in the analysis of variance, it is the size of family which is more reliable determinant.

The regression analysis on the basis of probit values and stimuli is not supposed to bring new light into our thinking. Because, these regression lines were fitted to smooth out the lines given by probit analysis.

The Bez Reaction Function gives results similar to probit analysis for the determinant - size of family. This type of analysis is supposed to yield straight lines for the respective sizes of family and for the respective sizes of holding with slopes nearly equal to one. The size of family as determinant is appeared to be quite reliable but not as sensitive as the size of the holding. This analysis taken together with probit analysis and inferences therefrom, persuade us to think between the two determinants, it is the size of family which is more effective than the size of holding. Although, Bez model detects that size of holding is more effective determinant between the two but the probit analysis failed to confirm it. It is also to be noted that while applying Bez Reaction Function we have taken both the fertilizers together and not separately as in the case of probit analysis.

Finally, we would like to say that the tendency to use fertilizer is not motivated by profit through increase in land productivity as a result of application of fertilizer but for sustenance through increase in land productivity. If profit is the sole motivation then definitely the farmers with large holdings would be inclined to use fertilizer on a rational basis. Here we have to make a compromise with an alternative hypothesis. The exact potentiality of fertility content of each type of fertilizer paripasu the fertility content of the soil is never theoretically examined by the farmer. A huge quantity of organic manure may be substituted by a very small quantity of chemical manure, therefore, combining both the fertilizers to analyse to diserimimate the two determinants may not be always advisable.

It is hoped that the future course of analysis will be to diserimimate those determinants that could not be taken into consideration in this dissertation. Also any such analysis should be confined to capital intensive chemical manure and its productivity could be taken as a determinant vis-a-vis land or labour productivity.

APPENDICES

APPENDIX - 1

Correlation Coefficient
(CHEMICAL)

Family size \ Size of holding	0-2	3-5	6-8	9-11	12 & above	f	fx	fx^2
0 - 2	1	0	0	0	0	1	1	15
3 - 5	4	1	2	0	0	7	0	128
6 - 8	9	4	0	1	1	15	0	392
9 - 11	0	3	0	3	2	8	0	500
12 & above	1	0	0	1	1	3	0	208
f	15	8	2	5	4	$\sum f=34$	$\sum fx=1$	$1243 = \sum fx^2$
fy	15	32	18	0	1	$= \sum fy=66$		
fy^2	1	112	735	500	676	$= \sum fy^2 = 2024$		

Family size \ Size of holding	0-2	3-5	6-8	9-11	12 & above	fxy
0 - 2	1	0	0	0	0	1
3 - 5	16	16	56	0	0	88
6 - 8	63	112	0	70	91	336
9 - 11	0	120	0	300	260	680
12 & above	13	0	0	130	169	312
fxy	93	248	56	500	520	$1417 = \sum fxy$

$$r = \frac{\sum fxy - \sum(fx)\ (fy)/\sum f}{\sqrt{(\sum fx^2 - (\sum fx)^2/\ f)\ (\sum fy^2 - (\sum fy)^2/\ f}} = \frac{1415.06}{\sqrt{(1242.97)(1895.89)}}$$

$$= \frac{1417 - (1)\ (66)/34}{\sqrt{(1243 - (1)^2/34)\ )2024 - (66)^2/34}} = \frac{1415.06}{(35.25)\ (43.54)}$$

$$= \frac{1417 - 1.94}{\sqrt{(1243 - .0294)\ (2024 - 128.11)}} = \frac{1415.06}{1534.78}$$

$$r = 0.92.$$

APPENDIX - 2

Correlation Coefficient
(ORGANIC)

Family size \ Size of holding	0-2	3-5	6-8	9-11	12 & above	f	fx	fx^2
0 - 2	2	0	1	0	0	3	6	25
3 - 5	6	4	2	1	1	14	0	384
6 - 8	14	14	2	2	1	33	33	294
9 - 11	1	6	1	5	3	16	0	900
12 & above	2	0	0	1	1	4	0	1014
f	25	24	6	9	6	$\sum f=70$	$\sum fx=39$	2617 $=\sum fx^2$
fy	30	144	84	9	12	$\sum fy=279$		
fy^2	3	224	1617	1600	676	$\sum fy^2=4120$		

Then we have compared the fxy matrix below:

Family size \ Size of holding	0-2	3-5	6-8	9-11	12 & above	fxy
0 - 2	2	0	7	0	0	9
3 - 5	24	64	56	40	52	236
6 - 8	98	392	98	140	91	819
9 - 11	10	240	70	500	130	950
12 & above	31	0	0	155	169	355
fxy	165	696	231	835	442	

$$r = \frac{\sum fxy - \sum(fx)\,(fy)/\sum f}{\sqrt{(\sum fx^2 - (\sum fx)^2/\sum f)\,(\sum fy^2 - (\sum fy)^2/\sum f}} = \frac{2213.56}{\sqrt{(2595.28)(3007.99)}}$$

$$= \frac{2369 - (39)\,(279)/70}{\sqrt{(2617) - (39)^2/70)\,(4120 - (279)^2/70}} = \frac{2213.56}{50.94 \times 54.84}$$

$$= \frac{2369 - 155.44}{\sqrt{(2617 - 21.72)\,(4120 - 1112.01)}} \qquad r = 0.79$$

APPENDIX - 3

Correlation Coefficient

(ORGANIC & CHEMICAL)

Size of holding \ Amt. of fertilizer used	0-2	3-5	6-8	9-11	12 & above	f	fx	fx^2
0 - 2	5	1	0	2	18	26	130	7
3 - 5	1	7	3	2	6	19	19	192
6 - 8	0	2	1	2	2	7	0	343
9 - 11	1	1	2	2	2	8	16	900
12 & above	0	1	1	1	7	10	180	5915
f	7	12	7	9	35	$\sum f=70$	$\sum fx=345$	$7357 = \sum fx^2$
fy	35	12	0	9	0	$= \sum fy = 56$		
fy^2	26	304	343	800	1690	$= 3163 = \sum fx^2$		

finally, the fxy matrix is calculated,

Size of holding \ Amt. of fertilizer used	0-2	3-5	6-8	9-11	12 & above	fxy
0 - 2	5	4 4	0 0	20	234	263
3 - 5	4	112	84	80	312	592
6 - 8	0	56	49	140	182	427
9 - 11	10	40	140	200	260	650
12 & above	0	52	91	130	1183	1456
fxy	19	264	364	570	2171	$3388 = \sum fxy$

$$r = \frac{\sum fxy - \sum(fx)\ (fy)/\sum f.}{\sqrt{(\sum fx^2) - (\sum fx)^2/\sum f)\ (\sum fy^2 - (\sum fy)^2/\sum f)}} = \frac{3112}{\sqrt{(5656.65)(3118.2)}}$$

$$= \frac{3388 - (345 \times 56)/70}{\sqrt{(7357 - (345)^2/70)\ (3163 - (56)^2/70}} = \frac{3112}{(75.21)(55.84)}$$

$$= \frac{3388 - 276}{\sqrt{(7357 - 1700.35)\ (3163 - 44.8)}} = \frac{3112}{4199.72}$$

$$r = \underline{0.74}$$

APPENDIX - 4

MATHEMATICAL NOTE ON COMPUTATION PROCEDURE FOR 2-WAY CLASSIFICATION

1. Data: Classified according to the size of family and the size of holding:

Size of holding (in acres)	Size of family: 0 - 2	3 - 5	6 - 8	9 - 11	12 & above	Total
0 - 2	11	3	0	10	87	111
3 - 5	2	3	7	9	40	61
6 - 8	0	5	8	10	16	39
9 - 11	2	5	7	10	38	62
12 & above	0	5	7	9	19	40
Total	15	21	29	48	200	313

(The units of manure is quintal)

2. Procedure of computation of sum of squares: for this purpose we made the following tabular arrangement:

	X_{ij}					$\sum_j X$	$(\sum_j X)^2$	$\sum_j X^2$
	11(121)	3(9)	0(0)	10(100)	87(7569)	111	12321	7799
	2(4)	3(9)	7(49)	9(81)	40(1600)	61	3721	1743
	0(0)	5(25)	8(64)	10(100)	16(256)	39	1521	445
	2(4)	5(25)	7(49)	10(100)	38(1444)	62	3844	1622
	0(0)	5(25)	7(49)	9(81)	19(361)	40	1600	520
$\sum_i X$	15	21	29	48	200	313		
$(\sum_i X_i)^2$	225	441	841	2304	40000		12129	
$\sum_i X^2$	133	93	211	462	11230			

Now we calculate

$$\text{Between Size of Holding S.S.} = \frac{\sum_i (\sum_j x)^2}{c} - \frac{(\sum_i\sum_j x)^2}{rc}$$

$$\text{Between Size of Family S.S.} = \frac{\sum_j (\sum_i x)^2}{r} - \frac{(\sum_i\sum_j x)^2}{rc}$$

and

$$\text{T.S.S.} = \sum\sum x_{ij}^2 - (\sum\sum x_{ij})^2/rc$$

where r = no of rows
c = no of columns.

The Residual S.S. = T.S.S. - Size of holding S.S.
- Size of family S.S.

The total no o- degrees freedom = rc-1 = 24.
The L.f. for the between size of holding and the between size of family is 4 respectively and the L.f. for residual is 16 (by substraction).

APPENDIX - 5

FOR ORGANIC MANURE WITH RESPECT TO SIZE OF FAMILY:

C	Y	$(c-\bar{c})=c$	$(y-y)=y$	cy	c^2	y^2	$\hat{C}=\hat{\alpha}+\hat{\beta}\,Y$
4.19	2.5	-.44	-5.62	2.47	.1936	31.58	$\hat{C}_1=3.17+.18(2.5)=3.62$
4.19	7.0	-.44	-1.12	0.49	.1936	1.25	$\hat{C}_2=3.17+.18(70)=4.43$
4.05	10.0	-.58	1.88	1.09	.3364	3.53	$\hat{C}_3=3.17+.18(10)=4.97$
6.09	13.0	1.46	4.88	7.12	2.1316	23.81	$\hat{C}_4=3.17+.18(13)=5.51$
18.52	32.5			11.17	2.8552	60.17	

C = Probit

Y = Family size.

$$C = \frac{18.52}{4} = 4.63$$

$$Y = \frac{32.5}{4} = 8.12$$

$$\hat{\beta} = \frac{\sum cy}{\sum y^2} = \frac{11.17}{60.67} = .18$$

$$\hat{\alpha} = \bar{C} - \hat{\beta}\,\bar{Y} = 4.63 - .18\ (8.12)$$
$$= 4.63 - 1.46$$
$$= 3.17.$$

APPENDIX - 6

FOR CHEMICAL MANURE WITH RESPECT TO SIZE OF FAMILY

C	Y	$(c-\bar{c})=c$	$(y-y)=y$	cy	c'^2	y^2	$\hat{C} = \hat{\alpha} + \hat{\beta} Y$
3.87	2.5	-.36	-5.62	2.02	.1296	31.58	$\hat{C}_1 = 3.34+0.11(2.5) = 3.61$
3.92	7.0	-.31	-1.12	0.34	.0961	1.25	$\hat{C}_2 = 3.34+0.11(70) = 4.11$
4.08	10.0	-.15	1.88	0.28	.0225	3.53	$\hat{C}_3 = 3.34+0.11(10) = 4.44$
5.07	13.0	.84	4.88	4.09	.7056	23.81	$\hat{C}_4 = 3.34+0.11(13) = 4.77$
16.94	32.5			6.73	0.9538	60.17	

C = Probit

Y = Family size.

$$\bar{C} = \frac{16.94}{4} = 4.23$$

$$\bar{Y} = \frac{32.5}{4} = 8.12$$

$$\hat{\beta} = \frac{\Sigma cy}{\Sigma y^2} = \frac{6.73}{60.17} = 0.111$$

$$\hat{\alpha} = \bar{C} - \hat{\beta}\bar{Y}$$

$$= 4.23 - .11\ (8.12)$$

$$= 4.23 - 0.89$$

$$= 3.34.$$

APPENDIX - 7

FOR ORGANIC MANURES WITH RESPECT TO SIZE OF HOLDING:

C	X	$(c-\bar{c})=c$	$(x-\bar{x})=x$	cx	c^2	x^2	$\hat{C} = \hat{\alpha} + \hat{\beta} X$	
4.92	1.0	.52	-6	3.12	0.27	36	$\hat{C}_1 = 3.7 + .10(1)$	= 3.8
4.29	4.0	-.11	-3	.33	0.01	9	$\hat{C}_2 = 3.7 + .10(4)$	= 4.1
3.45	7.0	-.95	0	0	0.90	0	$\hat{C}_3 = 3.7 + .10(7)$	= 4.4
3.82	10.0	-.58	3	1.74	0.33	9	$\hat{C}_4 = 3.7 + .10(10)$	= 4.7
3.72	13.0	-.68	6	4.08	0.46	36	$\hat{C}_5 = 3.7 + 0.10(13)$	= 5.0
20.20	35.0			9.27	=.97	90		

$\bar{C}$ = Probit

$\bar{X}$ = Size of holding

$$\bar{C} = \frac{20.20}{5} = 4.4$$

$$\bar{X} = \frac{35.0}{5} = 7.0$$

$$\hat{\beta} = \frac{\Sigma cx}{\Sigma x^2} = \frac{9.27}{90} = 0.10$$

$$\hat{\alpha} = \bar{C} - \hat{\beta}\bar{X} = 4.4 - 0.10\ (7.0)$$
$$= 4.4 - 0.7$$
$$= 3.7.$$

APPENDIX - 8

CHEMICAL MANURE WITH RESPECT TO SIZE OF HOLDING:

C	X	$(c-\bar{c})=c$	$(x-\bar{x})=x$	cy	c^2	y^2	$\hat{C}=\hat{\alpha}+\hat{\beta}X$
4.29	1.0	0.17	-6	-1.02	.0289	36	$\hat{C}_1=5.67+.02(1)=5.69$
4.29	4.0	0.17	-3	-0.51	.0289	9	$\hat{C}_2=5.67+.02(4)=5.75$
3.96	7.0	-0.16	0	0	.0256	0	$\hat{C}_3=5.67+.02(7)=5.81$
3.96	10.0	-0.16	3	-0.48	.0256	9	$\hat{C}_4=5.67+.02(10)=5.87$
4.12	13.0	0	6	0	0	36	$\hat{C}_5=5.67+.02(13)=5.93$
20.62	35.0			-2.01	0.1090	90	

C = Probit

X = Size of holding

$$\bar{C} = \frac{20.62}{5} = 4.12$$

$$\bar{X} = \frac{35}{5} = 7.0$$

$$\hat{\beta} = \frac{\Sigma cx}{\Sigma x^2} = \frac{-2.01}{90} = -.022$$

$$\hat{\alpha} = \bar{C} - \hat{\beta}\bar{X} = 4.12 - (-.22)(7)$$
$$= 4.12 - (-1.54)$$
$$= 4.12 + 1.55$$
$$= 5.67.$$

REFERENCES

Bara, D. Factors Affecting the Use of Fertilizers and Pesticides in Hilly Regions of Meghalaya, Agro. Econ. Res. Centre, Jorhat, 1981.

Bez, K. "Reaction Function and Econometric Models", paper presented to Indian Science Congress, 1980.

Braradwaj, K. On Some Issues of Method in the Analysis of Social Change (Prasaranga, University of Mysore, 1980).

Bhatty, I.Z. Why Farmers Shun Fertilizers in Eastern Economics. January 1, 1982.

Dhawan, B.D. "Demand for Irrigation - A Case Study of Government oTube Wells in U.P.", in Jour. Ind., Jour. Agr. Econ., No. 3, 1973.

Dhingra, I.C. The Indian Economy, Sultan Chand and Sons Publishers, N. Delhi, 1981.

Dhua, S.P. Organo Mineral Resources - A Necessity for Indian Agricultures in E.P.W., April 12, 1975.

Directorate of Agriculture. Agriculture in Meghalaya, Direct. of Agr. Meghalaya, Shillong, 1982.

Dutta, A. "Agricultural Growth in the North Eastern States", unpublished M.Phil diss., NEHU, 1983.

Fertilizer Association of India. Economic Survey 1980-81, Fertilizer Statistics, New Delhi.

Gupta, M.K. _et al_.. Fundamental of Statistics, Vol. 1 & 2, Published by Bhattacharjee for World Press Private Limited, Calcutta, 1962.

Hoel, P.G. Introduction to Mathematical Statistics, New York: Wiley, 1962.

Mathew, T. "Report of Land Reform Commission for Khasi Hills, 1975" in Tribal Economy of NER (ed.) by Mathew, T. (ed.) - Agricole Publisher, 1981.

Nagaraj, R. Trend Deceleration in Fertilizer Consumption - A Preliminary Exploration in E.P.W., Sept. 25, 1982.

Nair, M.K.S. Agrarian Relation and Transition in Meghalaya. Ph.D. Thesis, NEHU, 1983.

Paradine, G. _et al_., Statistics for Technologists, English University Press, Aylesbury, 1966.

Rajan, G. _et al_.. Soil Testing Management in N.E.H. Region, I.C.A.R. Complex, Res. Bull., 1981.

Shetty, N.S. A factor analysis of use of fertilizers by farmers in Indian journal of Agricultural Economics, 24(1), 1969.

Stene, J. <u>et al</u>.. Text Book of Statistics, Vol, I & II, Copenhugen University Press, 1969.

Timmen, S. "Demand for Fertilizers in Developing Countries" in FRIS, 1974.

Vasudevan, A. Strategy of Planning in India, Meenakhi Prakasan, Meerut, 1970.

Vipinachandram, C.V. "Role of NABARD in Financing Procurement of Chemical Fertilizer' in Commerce Vol. 145, No. 3733, Bombay, 1982.