Research Methods and Techniques in Agricultural Economics

Edited by

Dr. R. HARIDOSS

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UGC - DRS PROGRAMME

Madurai Kamaraj University

Madurai - 625 021

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Typesetted & Printed By
SANTHOSH BHARATHI Systems & Graphics,
Nagamalai, Madurai - 19
✆ 458093, Cell: 98421-58093

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FOREWORD

Indian agriculture, in the pre-independence era yielded too little to live on but after independence Indian farmers started adopting agriculture on a commercial basis due to the advent of green revolution and better planning. The share of agriculture in national income is often taken as an indicator of economic development. After the initiation of national planning the share of agriculture in GDP declined steadily from 59.2 percent in 1950-51 to 34.9 percent in 1990-91 and further 27.5 percent in 1999-2000. It seems that as the country progresses, the dependence on agriculture declines. With rapid increase in population, the absolute number of people engaged in agriculture has become exceedingly large. Development of the other sectors of the economy has not been sufficient to provide employment to the increasing population. A growing surplus of agriculture produce is needed in the country to increase supplies of food and agricultural raw materials, widen the domestic market for industrial goods through increased purchasing power within the rural sector, facilitate intersectoral transfers of capital needed for industrial development including infrastructure and to increase foreign exchange earning through agricultural exports.

In India, research has played a significant role in the development of agricultural sector since independence. However agricultural sector needs much more concentration for research and development and still a number of areas remains unexplored in the agricultural sector.

Increasing overall productivity, optimum utilization of labour and other factors; distribution of water and other resources, removal of disguised unemployment, land reforms, modernization of agricultural sector, improvement in technology and efficiency, fixation of prices, storage and marketing problems are some important areas of research in Agricultural Economics.

Agricultural Economics has been given a top priority by the researchers in Economics. However, the changing conditions of the economy demand periodical research in the various aspects of the agricultural economy. Moreover, to investigate the unexplored areas and to learn the new dimensions of the agricultural sector, new techniques of research become necessary.

This book contains a number of research techniques developed by various scholars in Economics and I sincerely hope that this book will induce the researchers in Economics to devise many more techniques for the development of agricultural research and encourage them to contribute more for the development agricultural sector.

P. K. Ponnu

(P.K. PONNUSWAMY)

PREFACE

Agriculture is a predominant sector in India. It is the source of livelihood for over 70 percent of population in the country. Agriculture is the source of supply of raw materials to various industries of national importance. The entire range of food processing industries depends on agriculture. National Agricultural Policy announced by the Government of India, on July 2000 seeks to "actualize the untapped growth potential of Indian Agriculture, strengthen rural infrastructure to support faster agricultural development, promote value addition, accelerate the growth of agro-business, create employment to rural areas, secure a fair standard of living for the farmers and agricultural workers and their families, discourage migration to urban areas and face the challenges arising out of economic liberalization and globalization".

The introduction of new and improved varieties of crops, increase in irrigation potential coupled with other crucial have given respectability to Indian Agriculture. At the same time, output of the different crops fluctuates widely in varying degrees between states, between farms in the same state and between years due to fluctuations in the weather conditions. To achieve higher growth with stability, it is essential to analyse the source of growth and fluctuations in the output of the crops both at Micro and Macro levels. At this juncture, it is the duty of the Researchers particularlly Economists to bring out the pros and corns of agricultural development in the state and the National level inorder to undertake research works in the agriculture sector.

This book contains papers related to Research Methods and Techniques in Agricultural Economics contributed by various experts and eminent personalities. I am sure that this book will be very useful and beneficial to scientists, scholars and researchers in the field of Agricultural Economics. The editor is indebted to the authors for their valuable contribution to bring out this book in on useful manner. I express my sincere thanks and deep sense of gratitude to Prof. P.K. Ponnuswamy, Vice-chancellor of Madurai Kamaraj University for his sustained encouragement and enriched support for the book by giving foreword. I am extremely thankful to scrutinizing committee including Dr. S. Kombairaju, Professor and Head, Department of Agricultural Economics, Tamil Nadu Agricultural University College, Madurai, Dr. N. Manonmoney, Dr. S. Vijayalakshmi, Dr. M.S. Subrmanian and Dr. S.V. Hariharan, School of Economics, Madurai Kamaraj University. My grateful thanks are also due to scholars and K. Sundarapandian, DRS Technical Assistant in the School of Economics in bringing out this book in time.

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SAMPLING TECHNIQUES FOR AGRICULTURAL RESEARCH

K. Deivamani

Our knowledge, our attitudes and our actions are generally based on samples, in every day life as well as in scientific research. In agricultural research, the focus is generally on problem oriented research in which the objectives are clearly defined and sample carefully chosen to meet these objectives. Sampling investigations are undertaken to provide information on various types of problems which otherwise are difficult to be probed through census surveys for obvious reasons. Agricultural research also concentrates on case studies of farms that would be representative of size and type in the operational area of study.

The practice of making guesses about the whole on the basis of observing a part is as old as the history of human civilization. However, the practice of collection of data for a sample, and using them for drawing certain conclusions or making decisions about the whole is, relatively a modern development. The application of sampling theory and methods to Indian agriculture and allied fields has a history of about 60 years with the pioneering role of Indian Statistical Institute and Indian Council for Agricultural Research. Presently, the field of Indian agriculture and allied activities is a field which has found wide applicability of various techniques of sample selection. In their turn, these applications have also contributed to the enrichment of theory and methods of sampling.

The concept of randomisation due to Fisher has an important role in sample surveys. Only after the advent of Tippet's Random Number Tables (1927), the scientific methods of selecting random

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sample were evolved. It gave a historical turning point to the practice and reliability of sample surveys. Random selection of units in sample surveys provides valid unbiased estimates of parameters.

Selection of items at random does not refer to haphazard selection of items from the population. If the sample is selected in an arbitrary, haphazard, subjective or purposive manner or using crude methods of randomization the quality of data collected will be quite poor. Random sampling assumes each item in the population an equal chance of being selected. A random sample is more suitable in relatively homogenous and comparatively large groups. Lottery method and Tippet's random number method are the popular methods of taking a random sample. Tippet's numbers have been subjected to numerous tests and used in many investigations and their randomness has been well established for all practical purposes. From the point of view of field survey it has been claimed that items selected by random sampling tend to be too widely dispersed geographically and that the time and cost of the collecting data become too large. Moreover, if the universe consists of many heterogeneous groups of different size, random sampling method becomes unsuitable.

In a land holding enquiry, 10 percent of households possess about 50 per cent of land. Such rich households are often missed in simple random sampling. Also higher sampling fraction is desired from statistical point for such class of units which can be ensured by putting them together in a separate stratum. Particularly, in crop estimation surveys and in experiments on cultivator's fields, stratified multistage sampling is used.

Many large scale sample surveys have been built around a stratified sampling scheme with multistage selection in each stratum. India being a Federation of States, each state is naturally taken as a domain of study and is divided into several strata of compact areas. Within a stratum, a two-stage design is generally adopted with villages as first stage units in the rural sector and farms as the second stage units. As regards sampling of units, villages and blocks are usually selected with probability proportional to population and farms are selected systematically with prescribed intervals after appropriate stratification. Advent of computer has made it possible to divide the farms into a number of stratum and thereby attain greater precision of the estimates.

In fact, the village as a unit is a source of variety of information. The village directories of the census provide a wealth of information about each and every village of the country. The village records provide still more detailed information. As such the farms are easily stratified according to pre-determined criteria such as the type of the land, size of farm and ownership. Ultimately the farms are chosen proportional to the actual number of farms in that group.

In agricultural research, the most exploited sampling designs are simple random sampling, systematic random sampling, multistage random sampling and stratified random sampling. Very little effort has been directed to make effective use of some other sampling designs such as cluster sampling approach even in studies where such designs are most appropriate. For instance, if the interaction of some social variables from farm to farm or village to village is important, cluster sampling could be used for greater precision.

The various methods of sampling techniques may pose the question regarding the selection of any particular technique. It should be noted that no one method can be regarded as the best under all circumstances - each method has its own speciality. A number of factors such as nature of the problem, size of universe, size of sample, availability of time and finance would decide the choice of a particular method of sampling.

The size of the sample depends on the population under study and the method adopted for data collection. Physical observation being intensive and time consuming, relatively much smaller sample can be canvassed as compared to collection of data by enquiry. Clustering of sampling units has generally to be resorted to in order to ensure that the enumerators are able to reach the respondents for recording of data through physical observation.

In planning of sample survey, cost is an important consideration. In fact, the determination of sample size depends heavily on cost and desired precision. Besides, the cost of acquisition also determines to a large extent the quality of data that is generated. The cost of data collection in a survey depends upon the type of enquiry, the frequency of visits, periodicity of enquiry and method of data collection.

The various types of errors likely to be committed in sampling are

(i) Omission, duplication or imprecise definition of sampling units or their wrong identification.

(ii) Incomplete or overlapping sampling frames or gaps in coverage.

The sampling units which are fundamental to survey sampling need to be properly and clearly defined as the final outcome of the survey would depend upon their proper identification. For example, in surveys of estimating the production of cereals alternative units of sampling, data on a number of food grains can be obtained by contacting fewer persons. However this approach has its own limitations in not providing adequate data on specific food grains. Thus, if estimates of production of specific food grain are required, fields under those food grains will have to be taken as the ultimate units. Under a deeper investigation, production estimates may be required according to variety of a specific food grain are identified with one and only one variety as also no plot is left unidentified with a variety to avoid errors of duplication and omission, as also wrong identification.

The incomplete frame is commonly called as listing error. When some units are omitted from the list of units for one reason or the other, the frame is said to be incomplete. Some times units may be listed several times and even non-existent units may be listed. Listing errors are also caused due to misclassification. For example, a single operated agricultural holding may be classified as a joint holding on the basis of ownership of more than one person of the same holding, whereas all operations of the holding are atually managed by single person. On certain occasions, a particular area will remain uncovered due to some administrative reason and this will lead to gaps in coverage.

Undoubtedly, there has been constant improvement in resolving the problems related to the choice of suitable sampling frame, ultimate units of selection and sampling procedure. However, there is a good scope for improving the quality and reliability of sample surveys in the field of Indian agricultural and allied activities.

REFERENCE:

1. Bajpai, S.R., **Methods of Social Survey and Research**, Kitab Ghar, Kanpur, 1990.

2. Cochran, W.G., **Sampling Techniques**, Wiley Eastern Limited, New Delhi, 1987.

3. Gupta, S.P., **Statistical Methods**, Sultan Chand & Sons, New Delhi, 1995.

4. Kahlon, A.S. and Karam Singh, **Economics of Farm Management in India**, Allied Publishers Ltd., New Delhi, 1992.

5. Prem Narain et al., (Eds.), **Recent Advances in Agricultural Statistics Research**, Wiley Eastern Limited, New Delhi, 1991.

A STUDY OF SUPPLY RESPONSIVENESS, INPUT DEMAND ELASTICITIES AND RETURNS TO SCALE - A PROFIT FUNCTION APPROACH

*R. Haridoss**

I. INTRODUCTION :

This paper aims at to discuss the estimation of supply responsiveness, input demand elasticities and returns to scale in Agriculture production by profit function approach. Conventionally, supply response is studied on the basis of time series data and the quantity supplied is regressed on price. The static and distributed lag models in this respect are different forms of the supply response. Estimation of output supply alone may be inadequate and provide inefficient estimates of the underlying supply relationship. Hence it is more appropriate to estimate simultaneously the interlinked output supply and factor demand equations. For this, the conventional approach using time - series data is replaced by profit function approach to estimate input demand elasticities and supply responsiveness in the present discussion.

II. THE ANALYTICAL FRAMEWORK :

In the profit function approach, real profit is expressed as a function of real prices of various inputs and quantities of real factors of production. The profit function is to be analysed interms of various aspects like price responsiveness, economies of scale, efficiency in allocation of variable factors of production and relative efficiency.

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The profit function approach popularised by Lau and Yotopoulos, accounts for the fact that resource endowments, prices and technology vary from farm to farm. It expresses a farm's profit in terms of output price, prices of variable factors and quantities of fixed factors of production.

The advantages of using a profit function model based on competitive principle are as follows:

By partially differentiating 'real' profit with respect to real wage rate, it is possible to obtain a theoretically and economically efficient demand function for labour.

The assumption of profit maximisation can be verified by jointly considering the variable factor demand functions and the profit function.

The assumption of competitive model explaining the labour market behaviour can be satistically verified, examining the equality between the wage rate and marginal product of labour.

The elasticity of labour and other variable inputs and their cross price elasticities can be readily obtained, and

Above all, the demand for input is not derived independently, but jointly as a system of output supply and factor demand equations which incorporate the interdependent nature of output and input decisions made by farmers.

The normalised profit function corresponding to Cobb-Douglas Production Function is used in the estimation of policy parameters in relation to absorption of labour and other related issues. The normalised profit function with the input demand equations is given below.

$$\text{Log}\,\Pi^* = \alpha_0 + \beta_1^* \log W + \beta_2^* \log F + \beta_3^* \log P + \beta_4^* \log R + \alpha_1^* \log A + \alpha_2^* \log C \quad \text{---(1)}$$

$$\left.\begin{array}{l}\frac{-WX_1}{\Pi^*} = \beta_1^* + U_1 \\ \frac{-FX_2}{\Pi^*} = \beta_2^* + U_2 \\ \frac{-PX_3}{\Pi^*} = \beta_3^* + U_3 \\ \frac{-BX_4}{\Pi^*} = \beta_4^* + U_4\end{array}\right] \quad \text{--- (2)}$$

where,

Π^* = Real profit in rupees (that is total revenue minus total variable cost normalised by price of output)

W = Real wages for labour, (Dividing the sum of total wages paid to hired Labour and imputed family labour by the total number of labour mandays then dividing this ratio by the unit price of output)

F = Real fertilizer price, (Dividing total expenditure by total quatity of fertilizers in kgs and dividing this ratio by unit price of output)

P = Real pesticides price, (Dividing total amount spent on pesticides by total quantity of pesticides and divide this ratio by price per unit of output)

B = Real bullock-pair day price, (Dividing the total expenditure on bullocks by the total bullock pair days then divide the ratio by price per unit of output)

A = Total area cultivted,

C = Capital flow (calculated as the sum of depreciation, Maintenance and opportunity cost of capital stock)

X_1 = Total labour mandays utilized,

X_2 = Total quantity of fertilizers used,

X_3 = Total quantity of pesticides used,

X_4 = Total bullock pair days and

U = Random disturbances.

The equations (1) and (2) have been estimated jointly by Zellner's seemingly unrelated regression which provides asymptotically more efficient estimates than the production function estimated by ordinary least squares. In the estimation of profit function and factor demand functions using Zellner's method, the coefficients in profit function and factor demand function should be treated as equal. Therefore, the present study attempts to estimate jointly profit and factor demand functions with imposing restrictions of equality of parameters β_1^*. The own and cross price elasticities of demand for factor inputs and supply responsiveness are calculated by using the formulae given in Table. 1.

Table 1

Formulae to estimate output supply and input demand elasticities from CObb-Douglas profit function

Description	Parameters of Profit Function
a) Supply Elasticities :	
(i) With respect to real price of ith variable input, X_i	β_i^t
(ii) With respect to fixed input, Z_j	α_j^*
(iii) With respect to output price, P_y	$-\Sigma \beta_i^*$
b) Input Demand Elasticities :	
(i) Own price elasticity of X_i	$\beta_i - 1$

(ii) Cross price elasticity for X_i with respect to real price P_j	β_j^*
(iii) Variable input X_i with respect to fixed factor Z_j	α_j^*
(iv) Demand elasticity of X_i with respect to output price	$-\Sigma \beta_i^* + 1$

Source : Lawrence J. Lau and Pan A. Yotopoulos, "Profits, Supply and Factor Demand Function", **Americal Journal of Agricultural Economics**, Vol.54, No.1, February 1972, p.17.

The simultaneous equation bias in the direct estimates is eliminated in the indirect estimates of production elasticities. The indirect estimates are found to be statistically consistent and asymptotically efficient. In order to obtain the direct production elasticities, Cobb-Douglas type production function was estimated with yield as the dependent variable and human labour, fertilizer, pesticides, bullock labour, land and capital as the independent variables.

DIRECT AND INDIRECT PRODUCTION ELASTICITIES

The Lau and Yotopoulos form of profit function is used to derive the indirect estimates of production elasticities

$$\left.\begin{aligned} \alpha_j &= \alpha_j^* (1-\mu^*)^{-1}; \qquad j = 1, 2, ... m \\ \beta_j &= \beta_j^* (1-\mu^*)^{-1}; \qquad j = 1, 2, ... m \end{aligned}\right] \quad \text{---- (3)}$$

$$\mu^* = \sum_{j=1}^{n} \beta j^*$$

where

α_j = Indirect estimates of produciton elasticities of the fixed inputs.

β_j = Indirect estimates of produciton elasticities of the variable inputs.

α_j^* = Coefficients of fixed inputs in the profit funciton, and

β_j^* = Coefficient of variable inputs in the profit funcitons.

III. STUDY AREA AND SAMPLE :

The study relates to Madurai district in Tamil Nadu. Agriculture is a dominant sector in this district and it is one among the major rice producing districts in Tamil Nadu. The district was selected because of relatively higher productivity of rice in the state. The area under irrigation and adoption of modern technology in rice cultivation are also comparatively greater. Among the workers, agricultural labourers constitute a higher percentage of 43.72 in the district. The cultivators in the district are 17.17 per cent of the total workers. Hence, out of the total working population, more than 60 per cent are engaged in agriculture. These are the main reasons for selecting Madurai district as the study area for the present discussion.

Purposive sampling method was adopted to select educated and uneducated farmers in the district. For this, 150 farmers - 75 each from educated and uneducated and those who cultivated rice - were chosen randomly from the selected villages in Madurai district. In the present illustration, the educated farmers are those farmers or any member of the farmers household participating in the farming activities who have attained secondary level education and above.

IV. RESULTS AND DISCUSSION :

The estimated results of join estimation of profit and input demand functions (1) and (2) for educated and uneducated farmers are presented in Table. 2.

Table 2

Estimated results of profit and input demand functions for educated and uneduated rice cultivating farms

Variables	Parameter	Estimates	
		Educated	Uneducated
Intercept	α_0	9.5203 *	7.6494 *
Log W	β_1*	-0.5001 (-27.769) *	-0.5376 (-21.761) *
Log B	β_2*	-0.1566 (-22.864) *	-0.1659 (-21.761) *
Log F	β_3*	-0.2989 (-13.876) *	-0.3013 (-17.432) *
Log P	β_4*	-0.0769 (-9.762) *	-0.0580 (-10.917) *
Log A	α_1*	0.9294 (8.146) *	1.0174 (0.488) *
Log C	α_2*	0.804 (0.890) *	0.0819 (0.488) *
Labour Demand	β_1*	-0.5001 (-27.769)	-0.5376 (-21.761)

		*	*
Bullock labour Demand	β_2*	-01.1566	-0.1659
		(-22.864)	(-16.436)
		*	*
Fertilizer Demand	β_3*	-0.2989	-0.3013
		(-13.876)	(-17.432)
		*	*
Pesticides	β_4*	-0.0769	-0.0580
		(-9.762)	(-10.917)

* Indicates that the co-efficients are statistically significant at 5 per cent level.

Figures in brackets represent t-values.

The own and cross price elasticities of demand for labour and output supply for educated and uneducated rice producing farms are given in Table.3.

Table 3

Own And Cross Price Elasticities of demand for labour for educated and uneducated rice cultivating farms

Varibale	Labour Demand	
	Educated	Uneducated
Rice Price	2.0325	2.0628
Real Wage	-1.5001	-1.5376
Real Bullock pairs Price	-0.1566	-0.1659
Real Fertilizer Price	-0.2989	-0.3013
Real Pesticides price	-0.0769	-0.0580
Land	0.9294	1.0174
Capital	0.0804	0.0819

It is observed from Table 3 that in the case of educated farmers the change in labour demand to a change in rice price is 2.0325 which means a 10 percent change in rice price, accompanied by a 20.325 per cent increase in labour demand. A 10 per cent increase in the price of variable inputs namely human labour, bullock pairs, fertilizers and pesticides is followed by a fall in labour demand by 15.001 per cent 15.6 per cent, 29.89 per cent and 7.69 per cent respectively. Of all the variable inputs, a change in wage rate leads to a 13.61 per cent fall in the labour. It shows that the highly elastic nature of labour demand with respect to its price.

In the case of uneducated farmers, the demand for labour with respect to rice price is 2.0628 per cent. The labour demand with respect to its own price is -1.5376 which implies that a 10 percent increase in wage effects a fall in labour demand by 15.376 per cent. The changes in labour demand to a 10 percent increase in bullock pairs, fertilizer and pesticides were 16.59 per cent 30.13 per cent and 5.80 per cent respectively.

In the case of land and capital, land exerts greater variation in demand for labour compared to capital flows both in the case of educated and uneducated farmers. A 10 per cent increse in land under rice cultivation is accompanied by 9.294 per cent increase in demand for labour in the case of educated farmers and 10.174 per cent increase in the case of uneducated farmers. It may be observed that the educated farmers have followed more new farm strategy and machanisation in farming activities than the uneducated farmers. The impact of 10 per cent increase in capital flows on demand for labour is found to increase 8.04 per cent and 8.19 per cent in labour demand for educated and uneducated farmers respectively.

Thus it may be observed from the above analysis that demand for labour is likely to increase with an increase in prices of rice, land and capital for both educated and uneducated farmers. It is also inferred that the uneduated farmers utilise more human labour in their farming activities compared to educated farmers.

The demands for variable inputs with respect to their own prices for educated and uneducated farmers producing rice are shown in Table.4.

Table 4
Demand for variable inputs with respect to their own prices for educated and uneducated rice cultivating farms

Particulars	Elasticities	
	Educated	Uneducated
Demand for Labour with respect to real wage	-1.5001	-1.5376
Demand for Bullock labour with respect to real bullock price	-1.1566	-1.1659
Demand for Fertilizer with respect to real Fertilizer price	-1.2989	-1.3013
Demand for Pesticides with respect to real Pesticides price	-1.0769	-1.0580

It is found from Table 4 that a 10 per cent increase in the prices of labour reduces its own demand by 15.001 per cent for educated farmers and 15.376 per cent for uneducated farmers. Similarly an increase in prices by 10 per cent of the variable input namely bullock labour, fertilizer and perticides, reduces the demand for the source by 11.566 per cent, 12.989 per cent and 10.769 per cent respectively for educated farmers. In the case of uneducated farmers, reduction in demand for the variable inputs is elastic and sensitive to changes in the own price for both group of farmers.

The demands for variable input is found to be negative to changes in their own prices and greater than one. Adulavidhaya, netal. And Nirmala arrived at similar findings in this studies. It may also be inferred from the analysis that among the variable inputs real wage seems to be a more important factor input which affects the agricultural employment to a considerable extent for both groups of farmers.

The own and cross price elasticities of demand for variable inputs for educated and uneducated rice producing farms are presented in Table.5.

Table 5

Own and cross price elasticities of demand for variable inputs for educated and uneducated rice cultivating farms

Particulars	Price of Labour	Price of Bullock	Price of Fertilizer	Price of Pesticides
Educated				
Demand for Labour	-1.5001	-0.1566	-0.2989	-0.0769
Demand for Bullock pairs	-0.5001	-1.1566	-0.2989	-0.0769
Demand for Fertilizer	-0.5001	-0.1566	-1.2989	-0.0769
Demand for Pesticides	-0.5001	-0.1566	-0.2989	-0.1769
Uneducated				
Demand for Labour	-1.5376	-0.1679	-0.3013	-0.0580
Demand for Bullock Pairs	-0.5376	-1.1679	-0.3013	-0.0580
Demand for Fertilizer	-0.5376	-0.1679	-1.3013	-0.0580
Demand for Pesticides	-0.5376	-0.1679	-0.3013	-1.0580

It is observed from Table 5 that the cross price elasticities of the variable inputs for both educated and uneducated farmers were negative and low, that is, less than unity. It indicates that the variable inputs were complements rather than substitutes. The low value of the cross price elasticities shows that their relationship is weak. Comparing educated and uneducated farmers, except in the case of pesticides, the cross price elasticities of all other inputs were found to be low for educated farmers than for uneducated farmers.

The supply elasticity of rice with respect to its own price and prices of other variable inputs are furnished in Table.6.

Table 6
Own and cross price elasticities of output supply for educated and uneducated rice cultivating farms

Variables	Output supply	
	Educated	Uneducated
Rice Price	1.0325	1.0628
Real Wage	-0.5001	-0.5376
Real Bullock Paris Price	-0.1566	-0.1659
Real Fertilizer Price	-0.2989	-0.3013
Real Pesticide Price	-0.0769	-0.0580
Land	0.9294	1.0174
Capital	0.0804	0.0819

Table 6 reveals that the supply elasticity of rice with respect to its own price is 1.0325 for eduated farmers and 1.0628 for uneducated farmers. It indicates that a 10 per cent increase in price of rice leads to 10.325 per cent and 10.628 per cent increase in supply of rice for educated and uneducated farmers respectively. It indicates that the output price change does not have any impact on its supply for both types of farmers. It could be observed that the increase in rice price policy may not be an effective one in order to increase output supply in the study area.

The magnitude of fall in output is 5.001 per cent, 2.989 per cent and 0.769 per cent for a 10 per ent increase in price of labour, bullick pairs, fertilizer and pesticides respectively for educated farmers. In the case of uneducated farmers, the fall in supply of rice to a 10 per cent increase in price of human labour, bullock paris, fertilizer and pesticides is 5.376 per cent, 1.1659 per cent, 3.013 per cent and 0.580 percent resepctively. It is inferred that an increase in the real prices of the variable inputs negatively affected rice supply for both educated and uneducated farmers.

DIRECT AND INDIRECT PRODUCTION ELASTICITIES

The estimates of production elasticities derived from the estimated elasticities from the estimated elasticities of real profit function are called indirect production elasticities. These estimates are consistent and are not strictly comparable to the direct estimate, which are obtained by estimating the production function directly. The indirect estimates are free from simultaneous equation bias as they are derived from the joint estimation of the profit and factor demand functions. Further it is not possible to test whether the direct and indirect estimates of production elasticities are signiifcantly different because the indirect estimates have no standard error.

The direct estimates obtained form the conventional Cobb-Douglas Production Function by using ordinary least squares method with yield per farm as a dependent variable and human labour, bullock labour, fertilizer, pesticides land and capital as the independent variables. The indirect estimates are obtained by using the formulae(3) derived from real profit function.

INDIRECT ESTIMATES OF PRODUCTION ELASTICITIES

The computed direct and indirect estimates of production elasticities are shown in Table.7.

Table 7
Direct and Indirect Estimates of Production Elasticities

Variables	Educated		Uneducated	
	Direct	Indirect	Direct	Indirect
Human Labour	0.2801 * (3.7121)	0.2461	0.2511 * (3.5711)	0.2606
Bullock Labour	0.0384 (0.4317)	0.0770	0.0431 (0.9142)	0.0804

	*		*	
Fertilizer	0.3084	0.1471	0.2971	0.1461
	(3.4713)		(2.3317)	
	*		*	
Pesticides	0.0912	0.0378	0.0618	0.0281
	(4.0791)		(0.1194)	
	*		*	
Land	0.2112	0.4573	0.2347	0.4932
	(3.4101)		(4.7213)	
	*		*	
Capital	0.1431	0.0396	0.1145	0.0397
	(2.4214)		(3.7213)	
Sum of Elasticities	1.0724	1.0049	1.0271	1.0481
R^2	0.7812		0.7437	

Figures in brackets represent t-values.

* indicates that the co-efficient are significant at 5 per cent level.

Table 7 shows that the indirect production elasticities reveal the co-efficient of land to be the highest for both educated and uneducated farmers. The co-efficients are 0.4573 for educated and 0.4932 for uneducated. It is followed by labour and it is the next important factor, with an elasticities of 0.2461 for educated and 0.2606 for uneducated. It is observed from the results that the shares of land and human labour in the total output are found to be higher for uneducated farmers than for educated farmers. The production elasticity of fertilizer is also more responsive in both the cases of farmers. The elasticities of educated and uneducated farmers are 0.1471 and 0.1461 respectively. The shares of bullock labour, pesticides and capital in total output are low for both groups of farmers. Thus it may be concluded from the analysis that the production elasticities estimated indirectly seem to be quite logical and consistent with the prior expectations of economic theory. It is also observed that land and labour are important factors of production for both educated and uneducated rice producing farmers.

RETURNS TO SCALE

The concept of 'Retuns to Scale' emphasises the proportional change in output due to an equi-proportional change in all the input factors.

The nature of scale in farm management studies has gained momentum during 1960s. The controversy has served as a basis for and against the important issue of ceiling on land holding.

The indirect estimates of production elasiticities for educated and uneducated farmers presented in table 5.7. show that the sum of elasticities are 1.0049 and 1.0481 for educated and uneducated farms. Hence, constant returns to scale is found to prevail with respect to rice production for both groups of farmers. This result is in confirmity with the findings fo K. Kalirajan and R.T. Shand, Tamin and Nirmala.

CONCLUSIONS

The land and capital are more important factors and they are highly sensitive to change in rice price for both educated and uneducated farmers. The demand for labour is likely to increase with the increase in the prices of variable input factors. The cross price elasticities show that the factors of production are complements and not substitutes for both groups of farmers. The indirect estimates of two groups revealed that land and labour were dominant factors of production. In both cases, there was evidence of constant returns to scale.

REFERENCES

1. Lawrence J. Lau and Pan A. Yotopoulos, "Profits, Supply and Factor Demand Function", American Journal of Agricultural Economics, Vol.54, No.1, February 1972, pp.11-18.
2. Arnold Zellner, "An Efficient Method of Estimating Seemingly Unrelated Regression and Test of Aggregation Bias", Journal of American Statical Association, Vo.57, No.2, June 1962, pp.348-375.
3. L.J. Lau and P.A. Yotopoulos, "Profits, Suply and Factor Demand Functions", American Journal of Agricultural Economics, Vol.54, No.1, February 1972, pp.11-18.
4. Kamphol Adulavidhaya et al, "A Mirco Economic Analysis of the Agriculture of Thailand", (Eds) Food Research Institute Studies, Vol.XVII, No.2, 1979, pp.79-89.
5. V. Nirmala, Economics of Rice Cultivation - A study of Tamil Nadu, Concept Publishing Company, New Delhi 1992, p.135
6. L.J. Lau, Wuu-long Lin and P.A. Yotopoulos, "Efficientcy and Technology Change in Taiwan", (Eds) Food Research Institute Studies, Vol.XVII, No.2, 1979, pp.23-50.
7. E.O. Heady, "Realationship of Scale Analysis to Productive Analysis" in Heady et al, (Eds) Resource Productivity, Returns to Scale and Farm Size, IOWA, State University Press Avenue, IOWA, 1956, pp.238.
8. A.S. Kahlon, Economics of Farm Management in India: Theory and Practice, Allied Publishers Pvt. Ltd., New Delhi 1980, p.238.
9. K. Kalirajan and R.T. Shand, "Labour Absorption in Tamil Nadu Agriculture: A Mirco Analysis", The Developing Economies, Vol.XX, No.3, September 1981, pp.89-98.

A TEST FOR RELATIVE ECONOMIC EFFICIENCY IN AGRICULTURAL PRODUCTION

*R. Haridoss**

I. INTRODUCTION

The term efficiency refers to the ability of farmers to make optimal decision with regard to resource use. The concept of efficiency has three interpretations, in general which can be stated as technical efficiency, price/allocative efficiency and economic efficiency. Technical efficiency means the highest amount of output with given amounts of input. The conventional measurement of technical efficiency concentrates on the neutral shift in the production function either between groups of farms or over a period of time. Allocative efficiency on the otherhand, is concerned with allocation of the resources in the profit maximising sense. Economic efficiency deals with cost-price relationship of input and output. The relative economic efficiency may arise due to the differences in technical and/or allocative efficiency by comparing two or more farms.

In recent contributions, lawrence Lau and pan Yotopoulos applied profit function concept to the analysis of Indian agriculture. They developed an operational model to measure and compare economic efficiency and its components of technical efficiency and allocative efficiency for groups of farms. In order to test the hypothesis that size of holding education enhance the farmer's economic efficiency and its components of technical efficiency and price efficiency, the profit function formulatin used by Lau and Yotogpoulos seemed to be an ideal tool.

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II. PROFIT FUNCTION APPROACH

In order to examine the economic efficiency of farm groups namely eduated and uneducated farmers, the following Cobb-Douglas form of the normalised restricted profit funciton and factor input demand functions are to be used:

$$\text{Log } \delta\ \pi = \log A^{*E} + \alpha^*_0 E_1 + \delta_{EX}{}^* D + \beta^*_1 \log W$$

$$\beta^*_2 \log B + \beta^*_3 \log F + \beta^*_4 \log P + \alpha^*_1 A$$

$$\alpha^*_2 \log C + U \text{ .... (1)}$$

$$\frac{-WX_1}{\pi^*} = \beta^*{}_1^{UE} E_1 + \beta^*{}_1^{E} E_2 + V_1$$

$$\frac{-WX_2}{\pi^*} = \beta^*{}_2^{UE} E_1 + \beta^*{}_2^{E} E_2 + V_1$$

$$\frac{-WX_3}{\pi^*} = \beta^*{}_3^{UE} E_1 + \beta^*{}_3^{E} E_2 + V_1$$

$$\frac{-WX_4}{\pi^*} = \beta^*{}_4^{UE} E_1 + \beta^*{}_4^{E} E_2 + V_1$$

Where,

π^* = Normalised (or real) profit in rupees. (Total Revenue minus total variable cost, divided by the prevailing price per kilo of rice gave normalised profit).

W = Real wage for labour (mandays). (Total labour cost for both hired and imputed family labour divided by total mandays worked by them, divided by the prevailing price per kilo of rice gave normalised or real wage rate)

B = real wage for bullock pair day (total expenditure on bullock pairs divided by bullock pair days empoloyed, divided by the prevailing price per kilo of rice gave normalised or real bullock per day).

F = Real fertilizer price (Total expenditure on Fertilizer divided by its total quantity purchased divided by the prevailing price per kilo of rice gave normalised or real Fertilizer price)

P = real pesticide Price (Total amount spent on pesticides divided by total quantity purchased in Kilo grams divided by the prevailing price per kilo of rice gave normalised or real pesticide price)

A = total area cultivated.

C = Capital flows (It was measured as the sum of depreciation, opportunity cost and maintenance cost of the capital assets used for rice cultivation. Depreciation cost was obtained using the straight line method, while the opportunity cost was estimated at the prevailing rate of interest of the co-operative society in the study area)

X1 = Total Labour Mandays used
X2 = Total bullock pair days employed
X3 = Total quantity of fertilizer used
X4 = Total quantity of pesticides used

E1 = 0 for Educated Farmers
1 for uneducated Farmers.

E2 = 0 for educated farmers
1 for uneducated Farmers

D = 0 for extension contact.
1 for otherwise.

U = random disturbances.

V1, V2, ... V4 = divergence between expected and realised price and stataistical errors.

The above models (1) and (2) jointly estimated by using the method of Zellner's Seemingly Unrelated Regression Estimate (SURE)

III. STUDY AREA AND SAMPLE

The study relates to Madurai district in Tamil Nadu. Agriculture is a dominant sector in this district and it is one among the major rice producing districts in Tamil Nadu. The district was selected because because of relatively higher productivity of rice in the state. The area under irrigation and adoption of modern technology in rice cultivation are also comparatively geater. Among the workers, agricultural labourers constitute a higher percentage of 43.72 in the district. The cultivators in the district are 17.17 per cent of the total workers. Hence, out of the total working population, more than 60 per cent are engaged in agriculture.

Purposive sampling method was adopted to select educated and uneducated farmers in the district. For this, 150 farmers - 75 each from educated and uneducated and those who cultivated rice - were chosen randomly from the selected villages in Madurai district. In the present study, the educated farmers are those farmers or any member of the farmers' household participating in the farming activities who have attained secondary level education and above.

IV. RELATIVE ECONOMIC EFFICIENCY:

The hypothesis testing procedures for both educated and uneducated farmers are shown below:

(i) Test for Absolute Allocative Efficiency: (Restriction I)

Farmers are absolute allocative efficient if they maximise profits (i.e. equate marginal value products of variable inputs to their respective opportunity costs). The null hypothesis that absolute allocative efficiency of both educated and uneducated farmers (Restriction I) was tested as:

$$H_0 = \beta_1{}^* = \beta_1{}^{*UE} = \beta_1{}^{*E} \quad ....(3)$$

Acceptance of null hypothesis implies that both educated and uneducated farmers have absolute allocative efficiency.

Rejection of null hypothesis implies that either one or both groups fail to maximise profits. To identify the group which was allocatively inefficient, the following two hypotheses were tested.

(ii) Test for Absolute Allocative Efficiency of Educated Farmers: (Restriction II)

Absolute allocative efficiency of educated farmers may be written as:

$$Ho: \beta_1{}^* = \beta_1{}^{*E}, \beta_2{}^* \ , \ \beta_2{}^{*E}$$

$$Ho: \beta_3{}^* = \beta_3{}^{*E} \text{ and } \beta_4{}^* = \beta_4{}^{*E} \quad .... (4)$$

(iii) The Hypothesis that Uneducated Farmers have absolute Allocative Efficiency: (Restriction III)

Absolute allocative efficiency of uneducated farmers is given by

$$Ho : \beta_1{}^* = \beta_1{}^{*UE} = \beta_2{}^* = \beta_2{}^{*UE}$$

$$Ho : \beta_2{}^* = \beta_3{}^{*UE} = \beta_4{}^* = \beta_4{}^{*UE} \quad ....(5)$$

(iv) Test for equal relative Economic Efficiency of both Educated and Uneducated Farmers :

In order to test the equal relative economic efficiency of both educated and uneducated farmers, the coefficient of education dummy variable in the profit function should be zero. Therefore, the null hypothesis is

$H_0: \alpha^*_0 = 0$

If the above hypothesis is not true, then the difference in economic efficiency between the groups is due to difference in technical efficiency and/or difference in allocative efficiency. The following hypotheses are formulted for the allocative and technical efficiency.

(v) Test for equal Relative Allocative Efficiency of both Educated and Uneducated Farmers:

Equal relative allocative efficiency is given by

$$H_0: \beta_1^{*E} = \beta_1^{*UE}, \beta_2^{*E} = \beta_2^{*UE}$$

$$H_0: \beta_2^{*E} = \beta_3^{*UE}, \beta_4^{*E} = \beta_4^{*UE} \quad ....(7)$$

(vi) Test for equal Allocative and Technicial Efficiency of both Educated and Uneducated Farmers:

The following joint restrictions are given for testing the hypothesis for equal technical and allocative efficiency of both educated and uneducated.

$$H_0: \alpha_0^* = 0 \text{ and } \beta_1^{*E} = \beta_1^{*UE}, \beta_2^{*E} = \beta_2^{*UE}$$

$$\beta_3^{*E} = \beta_3^{*UE}, \beta_4^{*E} = \beta_4^{*UE} \quad .... (8)$$

(vii) Test for Constant Returns to Scale:

This test is for examining the assumption that production function exhibits constant returns to scale. The following restriction is given as

$$Ho: \alpha_1^* + \alpha_2^* = 1 \quad .... (9)$$

that is, the sum of the parameters of the fixed factor inputs is equal to 1.

V. Estimated Regression Results:

The results of joint estimation of profit function (1) and input demand functions (2) by using Zellner's Seemingly Unrelated Regression estimates are presented in Table 1.

Table 1
Joint estimation of cobb-douglas profit function and input demand equations for rice production

Variables	Parameters	Un restricted	Restriction I	Restriction II	Restriction III
Profit function constant	Log A*	0.6873	8.8130	8.8546	8.7881
Normalised Wage	β_1^*	0.0406	-0.5196*	-0.5310*	-0.5001*
		(0.220)	(-34.020)	(-24.670)	(-23.266)
Normalised Bullock Labour	β_2^*	1.8877	-0.1618*	-0.1654*	-0.1580*
		(1.164)	(-26.528)	(-19.183)	(-18.320)
Normalised Fertilizer Price	β_3*	-0.4144*	-0.3025*	-0.2990*	-0.3048
		(-2.112)	*(-21.896)	(-15.349)	(-15.647)
Normalised Pesticides Price	β_4*	-0.0921	-0.0676*	-0.0577*	-0.0773*
		(-0.159)	(-14.229)	(-8.590)	(-11.505)
Land	α_1*	0.9754*	0.9451*	0.9443*	0.9465*
		(8.913)	(8.769)	(8,761)	(9.781)
Capital	α_2*	0.0173	-0.003	0.009	-0.003
		(0.189)	(-0.0002)	(0.001)	(-0.003)
El = Education Dummy	α^*0	-0.2521*	-0.1576*	-.1820*	-0.1899*
		(-2.421)	(-1.9741)	(-1.9851)	(-1.981)
Ex = Extension Dummy	δ *EX	-0.0843	-0.1225	-0.1223	-0.1219
		(-0.708)	(-1.040)	(-1.043)	(-1.034)
Labour Share Function	β 1*E	-0.5081*	-0.5196*	-0.5081*	-0.5007*
		(-23.438)	(-34.020)	(-23.438)	(-23.266)
	β_1^{*UE}	-0.5387*	-0.5196*	-0.5310*	-0.5387*
		(-25.850)	(-34.023)	(-18.334)	(-18.320)

Bullock Labour Share Function	β_2^{*E}	-0.1582*	0.1618*	-0.1582*	-0.1580*
		(-18.334)	(-26.523)	(-18.334)	(-18.320)
	β_2^{*UE}	-0.1657*	-0.1618*	-0.1654*	-0.1657*
		(-15.320)	(-21.896)	(-15.616)	(-15.647)
Fertilizer Share Function	β_3^{*E}	-0.3061*	-0.3025*	-0.3061*	-0.3048*
		(-15.616)	(-21.896)	(-25.616)	(-15.647)
	β_3^{*UE}	-0.3003*	-0.3025*	-0.2990*	-0.3003*
		(-15.320)	(-21.896)	(-15.349)	(-15.320)
Pesticides Share Function	β_4^{*E}	-0.0775*	-0.676*	-0.0775*	0.0773*
		(-11.532)	(-14.229)	(-11.532)	(-11.505)
	β_4^{*UE}	-0.0579*	-0.0676*	-0.0577*	-0.0579*
		(-8.618)	(14.224)	(-8.590)	(-8.618)

Figures in brackets represent t- values. * Indicates significant at 5 per cent level.

The results of Table 1 reveal that the estimated coefficients of normalized variable input prices are negative while the coefficients of fixed, factors, capital and land, are positive in accordance with a priori economic theory. The coefficient of education dummy is statistically significant and is negative. It indicates that farmers' education has a positive effect on profit of rice production. Further it implies that educated farmers are economically more efficient than uneducated farmers. Therefore, the educated farmers have used proper way of production practices, commodity mix and economically useful information about inputs. It is observed from the result of Table 1 that extension service contact dummy coefficient does not exert a statistically significant influence on profit. The coefficient of land is found to be significant at 5 per cent level while the effect of another fixed input capital flows on the normalized profit is not statistically significant. This may be due to the measurement of capital flows from capital stock for a single crop.

VI. TESTS OF RELATIVE ECONOMIC EFFICIENCY:

The hypothesis of reltive economic efficiency of educated and uneducated farmers discussed from (i) and (vii) in Section IV are tested by computing F-test. The results are reported in Table 2.

Table 2

Tests of hypotheses of technical and allocative efficiency of education

NullHypothesis	Computed F-ratio	Critical F-ration at 5% level	Inference
1. Absolute allocative efficiency of both educated and uneducated	$F_{(6,725)} = 7.69$	$F_{(6\alpha)} = 2.10$	Rejected
2. Absolute allocative efficiency of educated	$F_{(3.725)} = 2.32$	$F_{(3,\alpha)} = 2.60$	Accepted
3. Absolute allocative efficiency of educated	$F_{(3,725)} = 2.32$	$F_{(3,\alpha)} = 2.60$	Rejected
4. Equal relative economic efficiency of both educated and uneducated	$F_{(1,725)} = 9.17$	$F_{(1,\alpha)} = 3.84$	Rejected
5. Equal relative allocative efficiency of both educated and uneducated	$F_{(3.725)} = 6.01$	$F_{(3,\alpha)} = 2.60$	Rejected
6. Equal relative and allocative Technical efficiency of both eduated	$F_{(4,725)} = 3.61$	$F_{(3,\alpha)} = 2.37$	Rejected
7. Constant Returns to scale	$F_{(1,725)} = 2.72$	$F_{(1,\alpha)} = 3.84$	Accepted

Table 2 shows that the educated farmers of rice production have absolute allocative efficiency while the uneducated farmers do not have it. Both educated and uneducated are not equal in relative economic efficiency and realtive allocative and technical efficiencies. It indicates that the educated farmers and technically more efficient than uneducated farmers. As per F-test, both educated and uneducated farmers are operating under constant returns to scale.

CONCLUSION

Thus it may be concluded from the analysis that the educated farmers are both technically and allocatively more efficient than the uneducated farmers. Further, the results show that the effect of extension service contact on normalised profit is not significant.

REFERENCES:

1. Arnold Zellner, "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests of Aggregation Bias", Journal of Americal Statistical Association, Vol. 57, pp 348-368.
2. Kahlon, A.S. and Karam singh, "Economics of Farm Management in India, Theory and Practice", Allied Publishers, New Delhi, 1992, pp 344-45.
3. Kalirajan, K. "The Economic Efficiencies of Farmers Growing High-yielding Irrigated Application to Indian Agriculture, February 1972, pp 11-18.
5. L.J. Lau and P.A. Yotopoulos, "A test for Relative Efficiency and Application to Indian Agriculture", American Economic Review, Vol.61, March 1971, pp 94-109.
6. L.J. Lau and P.A. Yotopoulos, (Eds), "Resource-use in Agriculture, Application of the Profit Function to selected Countries", Food Research Institute Studies, Vol.17, No.1, October 1980.

DETERMINANTS OF SUPPLY OF WOMEN LABOUR

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In general, a number of factors influence the supply of women labour in the agricultural sector. At micro level, the household income, income earned through assets, household investment, size of the family and the number of children going to the school are a few factors on which the supply of women labour depends in the households of the rural areas.

The factors which are significant in determining the supply of women labour in the agricultural sector at micro level (for instance at village level or at district level) can be identified by employing regression technique with a dummy dependent variable. This article explains an elementary approach to identify the significant factors influencing the supply of women labour at micro level in an uncomplicated labour market.

DATA REQUIREMENTS

Depending on the size of the population and the level of accuracy desired, select sample households through sampling technique, according to requirements. Each household is to be treated as an unit of populaiton. From each sample household, collect the following data:

Annual Household Income

Income from Assets

Household Investment

Size of the family

No. of children going to school

Details of women workers going for agricultural work and whether each woman worker goes for full work whenever

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work is available or goes for work occasionally or partially or doesnòt go for work at all.

Literacy level

Wages paid to women worker.

SPECIFICATION OF THE MODEL

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5$$

where Y is to be included as dummy, trichotomous variable for the supply of women labour.

Y = 2, when the women labour goes for full time work whenever work is available.

Y = 1, when the women labour goes for work occasionally or partially

Y = 0, when the women labour does not go for work at all

X_1 = Annual Household Income (in thousands of rupees)

X_2 = Income from Assets (in thousands of Rupees)

X_3 = Size of the family

X_4 = Number of children going to the school

X_5 = Age of the women labour.

Each household will have a set of values for the variables Y, X_1, X_2, X_3, X_4, and X_5. For the sample households, these values may be used to obtain the regression coefficients and other required results.

INTERPRETATION OF THE RESULTS

The results of the regression will suggest the variables which are statistically significant in influencing the supply of women labour. If necessary, regressions may be run after excluding the insignificant variables. The value of the coefficient of determination will indicate howfar the selected independent variables can help to explain the variations in the supply of women labour at household level.

The values of the regression coefficients will help to identify the extent to which the respective variable influence the dependent variable. For instance, b_1 will measure the extent by which women labour supply would change when the household income increases by Rs.1000/-. Similar interpretations may be given for other variables also.

VALIDITY AND RELIABILITY OF THE RESULTS

The reliability of the results depends on the validity of the various assumptions of the regression model and also the assumptions about the disturbance term. If these assumptions do not hold good, the results obtained may not be reliable and the prediction will be biased. Besides, we have also impliedly assumed in this case that employment is readily available whenever women labour comes for work. If such assumptions are not satisfied, the results are likely to be biased.

In case, if the selected variables donot help to explain adequately the variations in the supply of women labour, some other varibles which we consider as significant can also be included in the regression. For instance, wage and literacy level may be some other variables which may influence the supply of women labour, in the study area. Such variables may also be included in the regression for analysis to get more reliable results and also to improve the explanatory power of the model.

APPLICATION OF THE MODEL

In this section, a hypothetical example is used to explain the application of the model and interpretation of the results. Assume that we are given the data on the different variables required as in Table.1., for 25 sample households.

The supply of women labour (we assume that there exists one woman worker in each sample household), measured as dummy variable, as explained earlier, household annual income, income earned from assets, family size, number of children going to school and age of the women worker are given in Table 1. Income is expressed in thousands of Rupees.

If regression is run with dummy variable as the dependent variable and other variables as the independent variables, we obtain the following results:

$$Y = 2.8230 - (0.0313)^{**} X_1 - (0.0134)X_2$$

$$[0.791] \quad [0.017] \quad [0.018]$$

$$+ (0.1020)X_3 - (0.0399)X_4 - (0.0315)^{*} X_5$$

$$[0.111] \quad [0.115] \quad [0.011]$$

Adjusted $R^2 = 0.872$

* Significant at one per cent level.

** Significant at ten per cent level.

The estimated values of the coefficients reveal that except family size, all other independent variables influence the supply of women labour, negatively. As such any increase in household income, income from assets, number of children going to school and the age of the women worker reduces the supply of women labour. Only family size has a positive impact on the supply of women labour. However, test of significance suggests that only two independent variables are influencing the supply of women labour significantly. Age is significant at one per cent level and household income is significant at ten per cent level. Hence, age seems to be the most important variable affecting the supply of women labour for the sample data. Household income becomes the next important variable affecting the supply of women labour.

The value of adjusted R^2 is 0.872. Hence the selected independent variables helped to explain 87 per cent of variations in the supply of women labour at household level.

In the example we have used, the correlation between household income and income from assets may be positive and high. Presence of high correlation among the independent variables leads to multicollinearity problem. Therefore, when we exclude the income from assets and other insignificant variables (namely, family size and the number of children going to school) and run the regression with the remaining two independent variables. We obtain the following results:

$$Y = 3.718 - (0.0495)^{*} X_1 - (0.0346)^{**} X_5$$
$$[0.299] \quad [0.011] \qquad\qquad [0.011]$$

Adjusted $R^2 = 0.876$

* Significant at one per cent level

** Significant at five per cent level

Now, household income and age are significantly influencing the supply of women labour. An increase in household income or in age will reduce the supply of women labour significantly. Dropping of three independent variables did not reduce the explanatory power of the model. Rather, it has improved the explanatory power marginally. We can, therefore, infere that household income and the age of the women workers are the two important variables in determining the supply of women labour at household level for the sample data we have used.

Table 1
Sample Data

S.No.	Y (HHI)	X_1 (IA)	X_2 (FS)	X_3 (CGS)	X_4 (AGE)	X_5
1	2	15	0	7	2	24
2	2	16	2	6	2	31
3	1	23	7	5	1	46
4	0	30	18	3	1	58
5	1	24	6	4	2	49
6	2	13	3	7	3	33
7	0	34	15	4	2	55
8	2	14	4	6	3	25
9	1	22	8	5	2	47
10	1	20	7	6	3	49
11	0	40	17	4	2	56
12	1	21	6	6	4	49
13	2	15	3	6	3	34
14	0	37	2	3	1	57
15	1	19	9	6	3	41
16	2	16	1	8	4	35
17	2	12	3	7	3	36
18	2	11	4	8	4	38
19	1	21	8	5	2	43
20	0	42	19	2	1	54
21	1	20	7	5	2	42
22	1	24	8	6	3	48
23	0	41	18	3	2	56
24	2	15	3	8	3	47
25	0	32	20	2	0	57

HHI - Household Income
IA - Income from Assets
FS - Family Size
CGS - Number of Children going to school
AGE - Age of the women worker

AGROFORESTRY BASED RESOURCE IN FARM HOUSEHOLDS: AN APPLICATION OF ALMOST IDEAL DEMAND SYSTEM

*C. Kailasam * and D. Suresh Kumar***

INTRODUCTION

Government in both developing and developed economies actively pursue various forms of policy interventions, but the effect of many of the most important policies is ultimately determined by the response of eocnomic agents, whether households or enterprises, in the private sector. This is particularly so far policies designed to alleviate poverty and to foster economic growth in the developing countries, because the relevant economic agent in this instance is both a household and an enterprise. Thus, the effect of any policy intervention must be traced through changes in the consumption behaviour of the households.

METHODOLOGY

The present study aims to estimate household demand for the resource poor farm households in Western zone of Tamil Nadu. The Western zone was purposively selected as agroforestry enterprise is more prominent in this region as compared to other regions. Further, the region practice highly differentiated agroforestry systems which have evolved over longer time. The Western zone comprises of Erode and Coimbatore districts, Udayarpalayam and Sendurai taluks of Perambalur district,

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Tiruchengode taluk of Namakkal district, Karur and Aravakurichi taluks of Karur district, Theni district, Dindigul district (excluding Dindigul and Natham) and Madurai district (excluding Madurai South, Madurai North, Melur and Thirumangalam). The agroforestry system and practices in the region was examined. The distincy agroforestry practices followed in the Western zone are silvipastroal and agrisilvipastoral systems. In silvipastoral system trees like velvel (Acacial leucophloea) are allowed to grow inside the farm lands and grasses like kolukattai (Cenchrus celiaris) are raised in the interspace of trees. Cattle are allowed to graze the grasses and goats are allowed to feed the nutritious dried fallen pods of Acacia trees. In agrisilvipastoral system, along with trees and grasses, the agricultural crops such as sorghum, gingelly, naripairu, horsegram and groundnut are grown. In order to cover these different agroforestry systems Erode district of Western zone was selected . Onle block where the practice is followed intensively was selected purposively. One block where the practice is followed intensively was selected. Since the block wise details for area under agroforestry are not available, the selection of block was done based on the discussion with officials of Department of Agriculture and the Scientists of Tamil Nadu Agricultural University. Kangeyam block of Erode district was selected purposively to represent silvipastoral and agrisilvipastoral systems. From the selected block, five revenue villages were selected randomly. This was done by listing out all the revenue villages in each block in alphabetical order selecting randomly the villages. Resource poor farm households in the selected villages constituted the sample units. One can define resource poor farmers based on the access to various resources like land, water, fertile soils and other infrastructural facilities. For the present study, the land was considered as the major criterion to define resource poor farmers.

Given the limited water resources in the study region, farm households with less than 2 hectares of land (small and marginal farmers) were considered as resource poor farm households. Thus, a sample of 75 tree growers were studied.

EMPIRICAL MODEL

The demand system for the resource poor farm households was studied by estimating household demand functions for consumption of farm produced agricultural commodities, milk and fuelwood, market purchased commodities and leisure. The Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980) was used in the present analysis to estimate the system of demand functions for leisure, farm produced agricultural commodities, milk, fuel wood and market purchased commodities[1]. For the purpose of analysis dependents were assumed to consume all their available time in the form of leisure and to consume the same quantities of other goods as do working family members. It is further assumed that the household utility function is identical for each member and additive across individuals.

Following Deaton and Muellbauer[2], the linear approximate AIDS model used for the present study is written was

$$S_i = a_i + \Sigma\, b_{ij}\, LnP_j + c_i\, Ln\left(\frac{E}{P}\right) + d_i\, LnN_1 + f_i LnN_2 \qquad (1)$$

Where,

S_i = Average budget share of the i^{th} commodity
P_j = Price of j^{th} commodity (Rupees per kg)[3]
E = Per capita expenditure on all seven commodities (Rupees)
N_1 = Number of workers
N_2 = Number of dependents
$LN\, P^* = \Sigma\, S_j\, Ln\, P_j$, the general price index[4]
i, j = 1,2 ...7

For the AIDS to be consistent with the properties of consumer demand theory, the structural parameters of LA/AIDS model in equation (26) must satisfy the following conditions.

Engel aggregation : $\Sigma a_i = 1$ (2)

$$\Sigma c_i = 0$$

$$\Sigma d_i = 0$$

$$\Sigma f_i = 0$$

Homogeneity restriction:

$$\Sigma b_{ij} = 0 \qquad (3)$$

Symmetry restriction:

$$b_{ij} = b_{ij} \quad \forall i \text{ and } j \qquad (4)$$

These restrictions ensure that the system satisfies engel aggregation, homogeneity in prices and income and Slutsky symmetry. The per capita expenditure funciton estiamted in equation (1), are then used to derive househodl expenditure funciton by multiplying the leisure function by N_1(the number of workers) and the all other expenditure functions by the total number of workers and dependents.

The AIDS system permits a fairly simple interpretation of the estimated coefficients. The constant term or intercept term a_i represents an average budget share when all logarithmic prices and real expenditure are equal to one. The expenditure coefficient (c_i) represents the change in the i^{th} expenditure share with respect to a change in real income, all else held constant. A negative expenditure coefficient implies that the commodity is a necessity while positive ones indicates the commodity is a luxury. Thus the expenditure share S_i will increase with an increase in total expenditure for $c_i > 0$, while the opposite will be true for $c_i < 0$. The price coefficients (b_{ij}) represent the change in the i^{th} budget share for a given proportional change in price with real income held constant.

The demand elasticities corresponding to linear version of the AIDS model were worked out as follows.[5]

Own price elasticity:

$$e_{ij} = (b_{ij} - c_i S_i)/S_i - 1$$

Cross-price elasticity :

$$e_{ij} = (b_{ij} - c_i S_j)/S_i$$

Expenditure elasticity :

$$e_{iE} = c_i / S_i + 1$$

Elasticity with respect to number of workers:

$$e_{iN1} = (d_i - c_i) / S_i$$

Elasticity with respect to number of dependents:

$$e_{iN2} = (f_i - c_i) / S_i$$

Totally seven commodities[6] commodities including the inputed expenditure were identified in the present study. Household expenditure on each group were the money value of food purchased or consumed from farm produced outputs. Total consumption expenditure consists of the sum of expenditure on all on leisure. Imputed expenditure on leisure was computed by w.L., where, $L = N_i L^* - F_1$. Where F_1 is the family labour worked in man days. L^* is the maximum feasible leisure per worker, is defined as 365 man days per year less time spent in household activities. w is the wage rate in rupees. An implicit assumption here is that the leisure time of the dependents has zero value.[7]

The LA/AIDS model was estimated with engel aggregation, homogeneity and symmetry restrictions imposed. To ensure that the covariance matrix is non-singular, only six budget share equations were estimated and the estimates for the left out equation were then derived from the estimated equations using the already imposed restrictions. The field survey data were computerised using Microsoft EXCEL 5.0. The Almost Ideal Demand System (AIDS) was estimated by using SHAZAM 7.0.

RESULTS AND DISCUSION

The household demand system was studied by estimating household demand functions for consumption of leisure, farm produced agricultural commodities, milk, fuelwood and market purchased commodities. The farm produced agricultural commodities include sorghum, groundnut and gingelly.

The structural parameter estimates are of interest largely for technical comparisons, as number of estimated parameters are statistically significant. The statistical significance of these coefficients suggest that demand for commodities are responsive to prices, the total expenditure and household specific characteristics like number of workers and number of dependents. The estimated parameters based on the Almost Ideal Demand System (AIDS) for the selected commodities are given in Table 1. It could be seen from Table.1 that the expenditure coefficient is significant for all the commodities. The analysis reals that the co-efficient of expenditure on leisure, groundnut, milk and market purchased commodities are positive implying the expenditure share on these commodities will increase with an increase in real income with prices held constant. The expenditure coefficients for sorghum and fuelwood are negative and indicate that the expenditure share on these commodities decrease as real income increases confirming these commodities as necessities.

The nature of demand for commodities can be directly inferred from the sign of the AIDS parameters. Commodities with negative expenditure parameters are income inelastic and those with positive parameters are income elastic. Thus, the commodities leisure, groundnut, milk and market purchased commodities are income elastic and the commodities sorghum and fuelwood are income inelastic and confirm that these two commodities are inferior goods. The household specific characteristics like number of workers and number of dependents are found to be significant for most of the commodities. Number of workers significantly influence leisure, groundnut, milk and market purchased commodities on the expected positive line. The variable number of dependents is found to be significant for leisure and groundnut. The sign of the coefficients is positive for all commodities except for leisure. This implies that as the number of dependents increases the household has to decrease consumption of leisure and supply more labour. The positive influence of numberof workers indicate that the expenditure share on consumption of various commodities increases with increase in number of workers. It is evident that the own price coefficients for all the commodities are significant and with the expected negative sign except for sorghum. This confirms the neo-classical theory of demand. This implies that as price increases the expenditure share on these commodities decreases.

Commodities with positive own price parameters are price inelastic and those with negative parameters are price elastic. The nature of relationship between commodities could be inferred from the sign of the cross price coefficients. Commodities with negative cross price coefficients are complements and those with positive coefficients are substitutes. It is seen that leisure is having complementary relation with all other commodities. Similarly, fuelwood is found to be complement for all commodities except for market purchased commodities for which it is a substitute. All the farm produced commodities (sorghum, goundnut, milk and fuelwood) are found to be substitutes for market purchased commodities. This implies that as prices of own farm produced commodities increase, the household would get additional income throuh sale and enable the household to purchase more of market purchased commodities.

Based on the estimated parameters of AIDS model, the own price, cross price, expenditure (income) elasticities and elasticity with respect to number of workers and number of dependents were calculated and presented in Table 2. The expenditure elasticities for leisure, groundnut, milk and market purchased commodities are greater than unity and positive. This implies that as income increases the household is sufficiently responsive to increase its consumption of these commodities. For example, a 10 per cent increase in income leads to around 13 per cent increase in consumption of leisure. The expenditure elasticity is negative for sorghum (but greater than unity) and fuelwood and confirms that these two commodities are inferior goods. A 10 per cent increase in household income will decrease consumption of sorghum by 11 per cent and 6 per cent reduction of fuelwood consumption. This implies that increase in income induces the households to consume superior commodities purchased from market. Similarly, with higher income, the household may reduce the use of fuelwood and use substitutes like kerosene or gas.

The elasticity with respect to number of workers appear to be greater than unity for sorghum and fuelwood. The elasticity of consumption of leisure is nearing unity. The elasticities for other commodities, though inelastic, they have some influence. Similarly, demand elasticity with respect to number of dependents show that it is greater than unity and positive for sorghum and fuelwood. It is less than unity but negative for leisure demand implying that with a 10 per cent increase in number of dependents there will be around 9 per cent reduction in demand for leisure. The own price elasticities are negative for all commodities, that is, changes in own price have inverse impact on quantities demanded. For leisure, goundnut, milk, fuelwood and market purchased commodities, the estimated elasticities are greater than unity whereas rather less elastic for sorghum. Less elastic response to price changes may be due to high negative expenditure elasticities for sorghum. The cross price elasticities for most of the commodities show less than unity and negative showing the existence of complementary relationship between commodities. Cross price elasticities of demand for market purchased commodities with respect to prices of other commodities indicate that these are substitutes. The analysis reveals that the resource poor farm households increase their consumption as real income increases. Increase in real income reduce the consumption of inferior goods like sorghum and fuelwood. Household specific characteristics have positive effects on consumption expenditure. The study also reveals that increase in prices of farm produced commodities enable the households to purchase more market purchased commodities.

REFERENCES

Deaton Angus and John Muellbauer (1980), **Economics and Consumer Behaviour**, (Cambridge: Cambridge University Press, 1980, pp:75-78.

Deaton Angus and John Muellbauer, (1980), "an Almost Ideal Demand System", **American Economic Review**, 70(3) : 312 -326.

Lau Laurence J., Wuu Long Lin and Pan A. Yotopoulos, (1978), "The Linears Logarithmic Expenditure System: An Application to Consumption - Leisure Choice", **Econometrica**, 46(4) : 843 -868.

Suresh Kumar .D, (2001) "Food, Fodder and Fuelwood: An Economic inquiry into Agroforestry in Resource Poor Farm Households of Tamil Nadu, Ph.D. Thesis submitted to Tamil Nadu Agricultural University, Coimbatore.3.

Teklu Tesfaye and S.R. Johnson, (1988), "Demand Systems for Cross-Section Data : An Application to Indonesia", **Canadian Journal of Agricultural Economcis**", 36(1) : 83-101.

Table 1
PARAMETER ESTIMATES OF AIDS MODEL WITH RESTRICTIONS

Particulars	Price of							Expenditure	Number of workers	Number of dependents
	Constant	Leisure	Sorghum	Groundnut	Milk	Fuelwood	Market purchased commodities			
Leisure	1.3919	-0.1794*	-0.0145*	-0.0754*	-0.0581*	-0.0217*	-0.0346*	0.1565*	0.5226*	-0.1936*
	(4.1267)	(-3.4159)	(-1.1908)	(-5.5738)	(-4.7363)	(-2.6514)	(-1.0658)	(3.2027)	(16.4110)	(-5.4163)
Sorghum	-0.3772	-0.0145	0.0231*	0.0029	0.0034	-0.0099**	0.0216*	-0.1539*	0.0003	0.0016
	(-4.2836)	(-1.1908)	(3.0258)	(0.3939)	(0.5844)	(-2.0154)	(2.3744)	(-11.5680)	(0.0379)	(0.3785)
Groundnut	-0.1636	-0.0754*	0.0029	-0.1858*	0.0646*	-0.0054	0.0489*	0.0421*	0.0749*	0.0196*
	(-1.7791)	(-5.5738)	(0.3939)	(-11.1590)	(7.2762)	(-0.8306)	(4.7268)	(2.9334)	(8.4990)	(4.8259)
Milk	-0.7551	-0.0581*	-0.0034	0.0646*	-0.1780*	-0.0080***	0.0459*	0.0359*	0.0484*	0.0611
	(-9.2125)	(-4.7363)	-(0.5844)	(7.2762)	(-17.3410)	(-1.4763)	(4.6121)	(6.9938)	(6.1053)	(0.2928)
Fuelwood	0.1259	-0.0217*	-0.0099**	-0.0054	-0.0080***	-0.0414*	0.0080**	-0.0189**	0.0056	0.0048
	(1.7725)	(-2.6514)	(-2.0154)	(-0.8306)	(-1.4764)	(-7.9285)	(1.8745)	(-1.7091)	(0.8241)	(0.7162)
Market purchased commodities	0.7728	-0.0346	0.0216**	0.0489*	0.0459*	0.0080**	-0.1211*	0.0268*	0.2935*	0.0621
	(3.6854)	(-1.0658)	(2.3744)	(4.7268)	(4.6121)	(1.8745)	(5.0788)	(6.8440)	(14.2740)	(0.8105)

(Figures in parentheses indicate estimated 't' values)

NOTE: * = P < 0.01, ** = P < 0.05, *** = P < 0.10.

: The value of the unrestricted and restricted log-likelihood function is 354.2508 and 330.0895 and the log-likelihood ratio is worked out to 48.3226.

Table 2
MATRIX OF ELASTICITIES BASED ON AIDS MODEL

Particulars	Price of							Expenditure	Number of workers	Number of dependents
	Leisure	Sorghum	Groundnut	Milk	Fuel wood	Market purchased commodities	Gingelly			
Leisure	-1.6101	-0.0644	-0.2372	-0.1669	-0.0595	-0.2252	0.9676	1.3957	0.9256	-0.8852
Sorghum	0.6615	-0.5166	0.2995	0.1597	-0.1156	1.0723	-0.3654	-1.1954	2.1997	2.2183
Groundnut	-0.7829	-0.0004	-2.6227	0.5314	-0.0501	0.2913	1.2753	1.3581	0.2790	-0.1914
Milk	-1.4170	0.0174	1.1918	-4.5494	-0.1662	0.6594	2.5654	1.7086	0.2467	0.4974
Fuelwood	-1.2176	-0.7341	-0.2721	-0.6028	-4.5269	1.2479	6.7214	-0.6178	2.0972	2.0287
Market purchased commodities	-0.1299	0.0567	0.1314	0.1279	0.0221	-1.3746	0.0894	1.0770	0.7662	0.1014

"FOOD SECURITY OF FARM HOUSEHOLDS OF DIFFERENT PRODUCTION ENVIRONMENTS IN NAMAKKAL DISTRICT"-AN APPLICATION OF ALMOST IDEAL DEMAND SYSTEM

*M. Kalamani and R. Sundaresan**

The most importnat challenge facing mankind in the new millenium is to ensure that all people have access to enough food for a healthy and productive life. About 1.3 billion people accounting for 30 per cent of the population live in absolute poverty with only a dollar a day or less per person to meet food, shelter and other needs (Andersen and Pandya-Lorch, 1999). Nowadays food production, distribution and consumption is an important issue for developing countries. The dimensions of food problem in Asia have been changing since the food crisis of sixties and seventies. Although remarkable progress has been made during the last two and half decades with the share of chronically under nourished persons in total population falling by almost half, still progress has been very uneven. The possibility of impending world food crisis looms largely from increasing pressure on national agricultural sector to meet the demands triggered by rising population, growth in people's income, change in expenditure and consumption pattern and commerical requirements in the back drop of the progressive deterioration of the quality of different production environments. (Ghosh, 2001)

Analysists projected that the supply of food grains will be lower than the demand for food grains by 36to 64 million tonnes by 2020, if demand for food grains continueto grow as in the past.

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This simply meant that India's food security is likely to be worsen given that growth of demand would incipiently outstrip the growth of domestic supply (Kannan et al., 2000). Food security is now becoming a complex issue and ticklish too. The issue of food security has in recent years become emotional and political. Since food security concerns the mass of people and involves a variety of conflicting interests it has significant economic and social inplications (chung et al., 1997). Even though agricultural policy of the country envisages the attainment of self sufficiency and food security, our country has not yet attained food security at the household level. One important question that should be given consideration at this point is that whether the producer of food grains (farmres) have adequate food production to meet their consumption in terms of both quality and quantity or otherwise. Taking into consideration of the canopy of issues, the present study aims at analysing the consumption pattern and food security situation of the people (farmers) in different production environments. The specific objectiviesof the study are

i) to estimate the demand for various food items of farm households under different production environments.

ii) to find out the food security situation of the farm households under different production environments and

iii) to suggest suitable policy measures to narrow down the gap in food consumption position of farm households.

METHODOLOGY

The present study mainly attempts to estimate the pattern of food consumption and food security in different production environments vi., irrigated and dry situations. Such an attempt requires an area having both irrigated and dry tracts. Namakkal district has been selected for the conduct of the study because it has all the above said production environments. Among fifteen blocks, six blocks consisting of three dry blocks and three irrigated blocks having different irrigation sources namely well, canal and tank have been selected randomly based on the area irrigated under each source. From each selected block, villages were selected based on simple random technique. In all, 14 villages and 184 farm households constituted the sample framework.

The study was conducted during the months of March and April 2001 and the data collected pertained to the year 1999-2000. The information for the study were gathred from the selected farm households by personal interview with the help of pre-tested schedule. The schedule covered details information on family particulars, monthly income of the family members, assets position, land particulars, employment details including on-farm, off-farm and non-farm activities. Regarding consumption aspects, information on periodicity of consumption, nature of consumption, expenditure on food items and non-food items were gathered. Opinion survey was also carried out regarding the food accessibility and availability, food crisis and management.

To overcome the age differences of individual in a household, the data were converted into per nit consumption to arrive at more appropriate and meaningful results using Lusk Co-efficients. Quantity consumption of different food commodities were estimated differentlyl according to their nature.

A flexible and well suited Almost Ideal Demand System (AIDS) which was introduced by Deaton and Muellbauer (1980) has been widely adopted by economists in recent years to estimate demand for various food and non-food items.

The AIDS model specified in this study was

$$Wi = ai + \sum_j \gamma_{ij} \log Pj + \beta_i \log (Y/p^*) + \theta \log S_i = 1, ... n$$

Where,

Y = total household expenditure on the group of goods being analysed.

P^* = price index for the group

P_j = price of the j^{th} good

W_i = budget share of the i^{th} good

S = household size

$\text{Log } P^* = \Sigma W_k \log p_k$ which is a geometrically weighted price index used to deflate the income variable.

The AIDS model automatically satisfied the conditions of individual consumer demand theory ie., Engel aggregation ($\Sigma\alpha_i$=1, $\Sigma\beta_i$= 0, $\Sigma\gamma_{ij}$= 0) homogeneity ($\Sigma_j \gamma_{ij} = \theta = 0$) and symmetry ($\gamma_{ij} = \gamma_{ij}$).

The demand elasticities corresponding to the linear version of the AIDS are :

$e_{ii} = (\gamma_{ij} - \beta_i w_i) w_i - 1$ (own price)

$e_{ij} = (\gamma_{ij} - \beta_i w_i) w_i$ (cross price)

$e_{ij} = 1 + \frac{\beta_i}{w_i}$ (real expenditure) and

$e_{is} = (\theta_i - \beta_i) / w_i$ (household size)

The nature of the demand for food commodities can be directly inferred from the signs of the AIDS parameters Commodities with negative expenditure parameters $\beta_i < 0$ are income inelastic, and those with positive parmeters $\beta_i > 0$ are income elastic. Similarly commodities with positive own price parameters $\gamma_{ij} > 0$ are price inelastic and those with negative γ_{ij} are price elastic.

Food security index has been formulated to identify the food security situation of the people. For this, range of short term coping mechanisms were identified that is used when there is not sufficient food in the household, according to the person primarily responsible for the preparation and provision of food. In the present study, five main short term coping strategies were identified viz., borrowing money to buy food, eating less preferred foods, depletion of stores, sales of assets and skipping meals. Frequency scoring was given to each strategy based on the number of times per month they were restored by the respondents. A simple scale of 1.4 was developed for the frequency of each individual strategy and multiplied by the weighting factor based on the ordinal ranking assigned by the sample respondents. Thus, a discrete score for each strategy was obtained, which added together, made up a cumulative food security index. Higher the cumulative food security index indicated the high level of food security.

RESULTS

(i) EXPENDITURE PATTERN

The details of the average monthly consumption expenditure of the sampel households are depicted in Table 1.The total consumption expenditure accounting both food items and non-food items was estimated as Rs. 3,162.98 per month of which food items accounted for 55.21 per cent and the remaining was on non-food items. The total consumption expenditure per month was Rs.3,621.93 and Rs.2,713.85 in irrigated and dry blocks respectively. In irrigated blocks, 54.53 per cent of total consumption expenditure was spent towards food while the same was little bit higher in dry blocks (56.10 per cent). This clearly implied that the households still spend more amount of its total budget on food items only.

Table 1

Average Monthly Consumption Expenditure of Sample Households

(in rupees)

S.No.	Respondents	Food items	Non-food items	Total
1.	**Irrigated blocks**			
	(i) Well	1970.81 (54.09)	1672.58 (45.91)	3643.39 (100.00)
	(ii) Canal	2252.04 (55.86)	1779.71 (44.14)	4031.75 (100.00)
	(iii) Tank	1702.87 (53.38)	1487.08 (46.62)	3189.95 (100.00)
	Mean	1975.19 (54.53)	1646.74 (45.47)	3621,93 (100.00)
2.	**Dry blocks**	1522.411 (56.10)	1191.44 (43.90)	2713.85 (100.00)
	Total	1764.34 (55.21)	1416.64 (44.79)	3162.98 (100.00)

Figures in parentheses indicate percentage to total.

(ii) DEMAND ESTIMATES OBTAINED THROUGH AIDS

Parameter estimates of the AIDS Model

(a) Irrigated blocks

The estimated parameters based on the AIDS model for major food items for irrigated blocks are presented in Table 2. The expenditure co-efficient was found to be significant for rice, pulses, meat and milk products thus revealing the fact that the expenditure share of these items would change with an increase in real income with prices held constant. The expenditure co-efficient for rice, wheat, pulses and milk were negative indicating their income inelastic nature in the irrigated blocks. If any increase in the household size would tend to reduce the expenditure share of vegetables and meat because the household size co-efficients of vegetables and meat were found to be negative and significant. The own price co-efficients for rice, vegetables, milk and oil had positive value which indicted their price inelastic nature and other items like wheat, pulses and meat exhibited price elastic nature. Thus the sample households in the irrigated blocks, that could be categorised under high income group in the present study, were found to give important to vegetables and oils besides rice (which is a staple food) irrespective of the price changes. In the rice equation, none of the price co-efficients of food items were significant with the exception of milk and pulses. This revealed that any changes in the prices of other food items would not influence the expenditure share on rice.

b) Dry blocks

The parameter estimate of the AIDs model for major food items in dry blocks of the study region are furnished in Table 3. The expenditure co-efficients for wheat, vegetables, meat and oils were negative. Thus wheat exhibited income elastic natue in the dry blocks in contradictory to its nature in irrigated blocks. Almost all the food items, except vegetables had negative own price parameters implying their price elastic nature as far as farm households of dry blocks concerned because as compared to their counterparts in irrigated blocks they are receiving less income

Table 2
Parameter Estimates of AIDS Model-Irrigated Blocks

S.No	Food items	Constant	Rice	Wheat	Pulses	Vegetables	Milk	Meat	Oils capita expenditure	Real per	House- hold size
1.	Rice	0.4376 (3.4076)	0.0164 (2.2073)	-0.0029 (-0.1873)	0.0435 (1.9740)	-0.0172 (-0.8630)	0.0159 (2.4629)	-0.0773 (-1.8130)	0.0216 (0.9186)	-0.0695 (-2.6086)	0.0830 (3.3307)
2.	Wheat	0.0563 (1.8614)	-0.0029 (-0.7873)	-0.0083 (-1.9610)	0.0103 (0.8162)	0.0006 (2.4132)	-0.0029 (-0.4398)	-0.0006 (-4.0508)	0.0038 (0.9902)	-0.0083 (-1.9210)	-0.0056 (-0.9653)
3.	Pulses	0.2905 (3.2430)	0.0435 (1.7740)	0.0103 (0.8162)	-0.0591 (-1.9146)	-0.0249 (-2.0839)	-0.0144 (-0.8067)	0.0967 (3.2145)	-0.0521 (-1.9761)	-0.0021 (-2.9252)	-0.0095 (-0.6402)
4.	Vegetables	0.0699 (1.9135)	-0.0172 (-0.8639)	0.0006 (2.4132)	-0.0249 (-2.0839)	0.0611 (5.4773)	-0.0019 (-5.0172)	-0.0359 (-2.5752)	0.0182 (2.8153)	0.0128 (1.8040)	-0.0078 (-2.7001)
5.	Milk	0.2801 (3.4896)	0.0159 (2.4629)	-0.0029 (-0.4398)	-0.0144 (-0.8067)	-0.0019 (-5.0172)	0.0219 (2.7107)	0.0145 (0.7345)	-0.0331 (-0.1283)	-0.0415 (-2.4046)	0.0379 (2.3420)
6.	Meat	-0.2374 (-2.5262)	-0.0773 (-1.8130)	-0.0006 (-4.0508)	0.0967 (3.2145)	-0.0359 (-2.5752)	0.0145 (0.7435)	-0.0013 (-3.3036)	0.0039 (1.9740)	0.0929 (4.7585)	-0.0847 (4.7251)
7.	Oils	0.1029 (2.0102)	0.0216 (0.9186)	0.0038 (0.9902)	-0.0521 (-1.9761)	0.0182 (2.8113)	-0.3310 (-0.1283)	0.0039 (1.9740)	0.0377 (4.0003)	0.0157 (1.7114)	-0.0133 (-0.7756)

Figures in parentheses indictes 't' ratios

Table 3

Parameter Estimates of AIDS Model-Dry Blocks

S.No	Food items	Constant	Rice	Wheat	Pulses	Vegetables	Milk	Meat	Oils	Real per capita expenditure	House-hold size
1.	Rice	0.2609 (2.0633)	-0.1634 (-3.1041)	0.0315 (1.5929)	0.0892 (2.4981)	-0.0393 (-2.8657)	0.0082 (0.5411)	0.0823 (2.0204)	-0.0085 (-0.6912)	-0.0276 (-2.1814)	0.0218 (2.1700)
2.	Wheat	0.0876 (1.9645)	0.0315 (1.5929)	-0.0134 (1.9674)	0.0186 (1.1750)	0.0002 (0.0347)	0.0065 (1.0170)	-0.0375 (-2.1351)	-0.0059 (-0.8047)	0.0148 (0.4832)	-0.0258 (-0.9477)
3.	Pulses	0.6317 (6.3119)	0.0892 (2.4981)	0.0186 (1.1750)	-0.2567 (-5.6950)	`-0.0013 (-0.1142)	-0.0118 (-0.0706)	-0.1311 (3.8955)	0.0309 (1.7021)	-0.0616 (-3.0617)	0.0369 (2.2843)
4.	Vegetables	0.0639 (1.8412)	-0.0393 (-2.8657)	0.0002 (0.0347)	-0.0013 (-0.1142)	0.0289 (4.0544)	0.0031 (0.4818)	0.0157 (1.3246)	-0.0073 (-2.2614)	0.0142 (1.0740)	-0.0296 (-2.6033)
5.	Milk	0.4189 (4.2357)	0.0082 (0.54106)	0.0065 (1.017)	0.0118 (-1.0706)	0.0031 (0.4818)	-0.0087 (-0.7586)	0.0089 (5.6193)	-0.0298 (-0.9871)	-0.0825 (-3.1713)	0.0674 (2.9542)
6.	Meat	-0.4497 (-4.1940)	0.0823 (2.-0204)	-0.0375 (-2.1351)	0.1311 (3.8955)	0.0157 (1.3246)	0.0089 (5.6193)	-0.2348 (-4.8488)	0.0343 (-2.1685)	0.1154 (5.2306)	-0.0611 (-2.9699)
7.	Oils	-0.0133 (-0.9605)	-0.0085 (-0.6912)	-0.0059 (-0.8047)	0.0309 (1.7021)	-0.0073 (-2.2614)	-0.0298 (-0.9871)	-0.0343 (-2.1685)	-0.0137 (-0.9701)	0.0273 (0.6721)	-0.0123 (-1.0239)

Figures in parentheses indicates 't' ratios which led them to respond to relative change in the own prices of all the food items. the price co-efficeint of meat in the wheat equation showed negative value and significant ie., a ten per cent increase in the price of meat would reduce the share of wheat by 3.7 per cent.

PRICE, EXPENDITURE AND HOUSEHOLD SIZE ELASTICITIES

The demand elasticities derived from the AIDS parameters for the entire irrigated and dry blocks are provided in Table 4 and 5. From the parameter estimates, it is well known that wheat was considered as a luxury good by the farm households in dry blocks. When comparing between irrigated and dry blocks, the expenditure elasticities for the food items in dry blocks were higher than the irrigated blocks with the exception of pulses. It implied that the change in quantity demanded in response to income was high in dry blocks. In case of pulses, the magnitude of response was more in irrigated blocks. It was not unexpected that meat was income elastic in both the books. As regards the rice, own price elasticity was lower in irrigated blocks than that of dry blocks. This indicated that the demand for rice by the sample households were less responsive to market price of rice, probably because these households normally meet their rice consumption from their own farm production.

The own price elasticities of wheat, vegetables, milk, meat and oils were found to show higher values in the dry blocks while it was high for pulses in the irrigated blocks. It clearly explained the fact that the farm households in the dry blocks were more responsive to the food items own prices because of their low income. Among the different food items. the own price elasticity of meat in dry blocks and of pulses in irrigated blocks showed higher value indicating the sample households high response to these items own price. The own price elasticity of pulses in their

Table 4

Matrix of Food items, Price Elasticities, Expenditure Elasticities, Household Size Elasticities for the Sample Households in Irrigated Blocks

S.No.	Food items	Rice	Wheat	Pulses	Vegeta-bles	Milk	Meat	Oils	Income elasticity	Household size elasticity
1.	Rice	-0.8837	-0.0039	0.1473	-0.0319	0.0704	-0.1772	-1.6817	0.8026	0.4329
2.	Wheat	0.0025	-1.3794	0.5291	0.0624	-0.0877	0.0545	-1.4305	0.6119	0.1266
3.	Pulses	0.3660	0.0859	-1.4871	-0.2046	-0.1171	0.8034	-0.5363	0.9829	-0.0612
4.	Vegetables	-0.2549	0.0042	0.3108	-0.2948	-0.0413	-0.4561	-2.5026	1.1503	-0.2416
5.	Milk	0.2412	-0.0161	-0.0740	0.0129	-0.7856	0.1839	-1.1103	0.6727	0.6266
6.	Meat	-0.5164	-0.0122	0.4009	-0.2059	0.0126	-1.0992	-2.8565	1.4362	-0.8336
7.	Oils	0.2006	0.0432	-0.6744	0.2106	-0.4382	0.0069	-0.5449	1.1969	-0.3622

Table 5

Matrix of Food items, Price Elasticities, Expenditure Elasticities, Household Size Elasticities for the Sample Households in Dry Blocks

S.No.	Food items	Rice	Wheat	Pulses	Vegeta-bles	Milk	Meat	Oils	Income elasticity	Household size elasticity
1.	Rice	-1.0955	0.0840	0.2408	-0.0983	0.0293	0.2283	-0.0172	0.9285	0.1279
2.	Wheat	0.7566	-1.4080	0.4861	-0.0155	0.1418	-1.1929	-0.2024	1.4340	-1.1915
3.	Pulses	0.8224	0.1508	-0.8060	0.0129	-0.0352	1.0491	-1.3577	0.5517	0.7365
4.	Vegetables	-0.9077	-0.0053	-0.0650	-0.4263	0.0306	0.2584	-2.4026	1.2872	-0.8889
5.	Milk	0.3553	0.0829	-0.0039	0.0636	-0.9949	0.2348	-0.5303	0.8679	1.3305
6.	Meat	0.1771	-0.1947	0.5410	0.0472	-0.0193	-2.2177	-3.2080	1.5416	-0.8287
7.	Oils	-0.02824	-0.1013	1.8026	-0.1282	-0.4876	0.4224	-1.2310	1.4067	-0.5873

farms to meet the requirements which results in the least responsiveness to the change in price. Considering cross price elasticities, wheat and rice showed positive values in both the blocks but their magnitude of substitutability was more in dry blocks. One disquitening feature noted was that all food groups were particularly responsive to the changes in the price of oils thus indicating its importance to be given in government policies in both the blocks. Regarding household size elasticities, any increase in the household size would tend to reduce the demand of meat more proportionately in irrigated blocks while the same was wheat in case of dry blocks.

FOOD SECURITY SITUATION

Despite many household food security indicators like resources availability, production, income and consumption are available, many authors have measured food security through various coping strategies. Individual coping strategies and the cumulative food security index for the sample households in different blocks are furnished in Table 6. It could be observed that the cumulative food security index in the irrigated blocks was higher (58.61) than that of dry blocks (49.49). Thus the results implied that the farm households in irrigated blocks were more food secured that their couterparts in the dry blocks. Similarly the farm households in canal irrigated blocks are more food sufficient than others due to pronounced area under paddy in canal irrigated block than their counterparts in other irrigated blocks. This finding was in accordance with the results of the study conducted by Maxwell (1996) which showed that the cumulative food security index for very low income group had low value remarking their low level of food security.

Table 6

Cumulative Food Security Index for the Sample Respondents in Different Blocks

S. No	Blocks	Borrowing money to get food	Eating less preferred foods	Depletion of stores	Sale or mortgage of assets	Skipping meals	Cumulative index
1.	Well	3.67	7.94	11.81	15.87	19.35	58.65
2.	Canal	3.80	7.93	11.70	15.87	19.83	58.13
3.	Tank	3.40	7.80	11.50	15.47	19.89	58.06
4.	All irrigated blocks	3.63	7.89	11.67	15.74	19.23	58.61
5.	Dry blocks	3.19	6.82	9.58	11.78	18.11	49.49
	Total	**3.41**	**7.35**	**10.61**	**13.74**	**18.88**	**54.64**

FOOD CRISIS FACED

The particulars about food crisis faced by the sample households in the study region are presented in Table 7. It could be inferred that in all, 32.07 percent of sample households faced food crisis on an average for 79.95 days. The food crisis was more pronounced in dry blocks as compared to irrigated blocks. In absolute terms, 43 households in dry blocks as compared to irrigated blocks. In absolute terms, 43 households in dry blocks faced food crisis for 84.54 days as against 16 households in irrigated blocks who had experienced food crisis for 67.62 days. Among the irrigated blocks, the food crisis was prevalent in tank and well irrigated blocks as compared to canal irrigated block.

Table 7
Food Crisis Faced by Sample Housholds

(in numbers)

S. No	Particulars	Irrigated blocks				Dry blocks	Total
		Well	Canal	Tank	Sub total		
1.	No. of household faced food crisis	6 (19.30)	3 (10.00)	7 (23.33)	16 (17.58)	43 (46.24)	59 (32.07)
2.	No. of days	71.66	59.09	67.81	67.62	84.54	79.95

Figures in parentheses indicate percentage to total

CONCLUSION

The present study conducted in different production environments (irrigated and dry blocks) by Namakkal District applied the AIDS model in estimating the complete demand system. Food security index has also been formulated to analyse the food security situation of the sample households. The own price elasticities of the commodities included in the AIDS model have the expected signs ie., the change in own price indexes have inverse impact on quantity demanded in both irrigated and dry blocks. The estimates of expenditure elasticities for vegetables and meat were exceeding unity and showed that farm households increased their expenditure share on these items with increase in real income in both the blocks. Wheat was found to be a luxury good in dry blocks. This attribute leads to the importance has to be given in several food intervention programmes in these areas.

POLICY OPTION

As the price of the food commodities have a say in the consumption pattern, conserted efforts have to be taken for minimising the fluctuation in the price to a considerable extent.

REFERENCES

Chung, K., L.Haddad, J. Ramakrishnan and F. Riely, "Identifying the Food Insecure: The Application of Mixed Approaches in India", **International Food Policy Research Institute, (Research Report 35, 1997)**, p.5.

Deaton, A., and J. Muellbauer, "An Almost Ideal Demand System", **American Economic Review**, 70(3): 312-326, 1980.

Ghosh.G.N., "**Food Security in the New Millennium**", (New Delhi : The Food and Agriculture Organisation of the United Nations in New Delhi, 2001), pp 7-12.

Kannan, K.P., S.M.Dev and A.N.Sharma, "Concern on Food Security", **Economic and Political Weekly**, 35(45):3919-3922, 2000.

Maxwell, D.G., "Measuring Food Insecurity, the Frequency and Severity of Coping Strategies", **Food Policy**, 21(3) :291-303, 1996.

Pinstup-Anderson, P. and R. Pondya -Lorch, "The Role of Agriculture to Alleviate Poverty", **Agricultural and Rural Development**, 6(2):53-56, 1999.

AN ANALYSIS OF MARKETING COST AND EFFICIENCY

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Any study on marketing of agricultural commodities is incomplete without the analysis of marketing cost and efficiency of different marketing channels.

Marketing channel: Khols defined marketing channel as the path over which a commodity passes as it moves from the farmer to the hands of consumers. The marketing channel begins with farmer, the primary producer, and ends with the consumer. In between, depending on the commodity there may be different types of intermediaries such as preharvest contractor, processor, broker, commission agent, primary and / or secondary wholesaler and retailer. Wholesaler and retailer are merchant middlemen since they take tittle to the goods they handle and they buy and sell to their own gain. Brokers and commission agents are known as agent middlemen since they do not take the tittle of the goods. They provide their services to their clients and negotiate purchase or sale. Processors buy commodities from farmers directly or through intermediaries and convert them in to value added products and sell them to consumers through intermediaries.

Marketing cost: the cost involved in moving a product from the point of production to the point of consumption is referred as marketing cost. More refers marketing cost to the actual expenses incurred in the marketing process, which includes not only the cost of performing various marketing functions but also taxes and other assessments as well. It includes expenditure incurred on marketing activities such as transporting, loading and unloading, cleaning, grading, packing, processing, storage, market fee,

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brokerage, commission, sales tax and allowance for wastage. The cost of marketing per unit of agricultural commodities, especially, for fruits and vegetables is relatively high because of pereshability and bulkiness.

Marketing margin: It is the profit earned by different intermediaries involved in the marketing channel.

Price spread: It is the difference between the price paid by the ultimate consumer and the net price received by the farmer for a given quantity of product. Price spread includes the cost incurred by the farmer and the various intermediaries and the profit margin earned by the intermediaries. There is direct relationship between price spread and the length of marketing channel while the farmers' net share in consumer price is inversely related.

METHODOLOGY

For the present study, brinjal, one of the important vegetable crops grown in Madurai district was selected. Two marketing channels were identified for brinjal, They are

1. **Farmer Market**

   Farmers
   ↓
   Consumers

2. **Central Market**

   Farmers
   ↓
   Commission Agents
   ↓
   Wholesalers cum retailers
   ↓
   Retailers
   ↓
   Consumers

The sample consists of 90 randomly selected farmers, 60 consumers, 25 retailers, 10 commission agents and five wholesaler cum retailers. The commission agents and wholesaler cum retailers are functioning in central market. The respondents were selected at random and primary data were collected by presonal interview using a pre tested interview schedule.

Data related to area under brinjal, frequency of harvest, yield, expenditure on grading, packing, transporting, loading and unloading, commission and other changes paid, price received were collected from the selected brinjal growers. From the intemediaries data were collected on investment on vegetable trade, maarketing cost, marketing margin, method of buying and selling and prices. From the consumers, data on frequency of buying, quantity purchased and prices paid were gathered.

Secondary data on arrivals, prices were collected form records maintained in three farmer markets functioning in Madurai City.

ANALYSIS

Average and percentage analyses were used to study the marketing cost, margin and price spread and marketing efficiency.

1. Price spread = Price paid by consumers - Net price received by farmer.
2. Producer's share in consumer's rupee

$$= \frac{\text{Net price received by farmers}}{\text{Consumer's price}} \times 100$$

3. Consumer's price = Net price received by farmers + Marketing cost + Marketing margin
4. Average Net Price received by farmer / unit = (Gross price received / unit) - (Average per unit cost incurred on marketing)
5. Total Marketing Cost = Cost incurred by farmers + Cost incurred by intermediaries in the marketing channel.
6. Marketing Margin of the middleman = Sale price per unit - (Purchase price per unit + Cost incurred on marketing per unit)

MARKETING EFFICIENCY

Marketing efficiency was studied by using Shepherd's index.

Shepherd used the ratio of the total value of goods marketed to the marketing cost and margin as a measure of marketing efficiency. The higher the ratio the higher the efficiency and vice versa.

$$\text{Marketing} = \frac{\text{Value of goods sold or price paid by the consumers}}{\text{Total marketing cost plus margin}}$$

MARKETING COST FUNCTION

To study the factors influencing the marketing cost incurred by the farmers a log linear regression equation of the following form was used since it was found to be the best fit. The regression model fitted is.

$$\ln MC = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + e_t$$

Where,

MC = Marketing cost incurred by farmer (Rs/qtl)

X_1 = Quantity of brinjal marketed in quintal

X_2 = Distance transported in km.

X_3 = Number of Labour days engaged in post harvest operations.

a = Constant term

e_t = Disturbance term

b_1, b_2, and b_3 are Regression Coefficients.

RESULTS AND DISCUSSION

The sample farmers were post stratified in to three categories viz. marginal (operating up to 1 ha), small (1.01 to 2 ha) and large (above 2 ha).

Table 1
Size Group Wise Distribution of Brinjal Growers According to Place of Sale

Size group	Number of farmers selling				Total Number of farmers	
	In Farmer market		In Central Market			
	Number	%	Number	%	Number	%
Marginal (Up to 1 ha)	18	90	2	10	20	100
Small (1.01 to 2ha)	26	52	24	48	50	100
Large (Above 2 ha)	0	0	20	100	20	100
Total	**44**	**49**	**46**	**51**	**90**	**100**

It could be seen from Table that out of 90 sample brinjal growers 20 were marginal, 50 were small and 20 were large. Of the 90 growers, 44 sold their output in farmer market and 46 sold both in farmer market and central market. When different size group of farmers were considered, 90 percent of marginal and 52 percent of small sold brinjal only in farmer market. While 10 percent of marginal 48 percent of small and all the 20 large farmers sold their output both in farmer market and central market. The reason for selecting central market for disposal is that large quantities can not be sold directly to consumers in farmer market and hence farmers with large output sold in the central market through commission agents.

GROUP WISE PRODUCTION AND SALE PATTERN OF BRINJAL

The information of production and sale pattern of brinjal by different groups of farmers is presented in Table 2.

Table 2
Production and Sale Pattern of Brinjal -GroupWist
(in Quintal)

Sl. No.	Size Group	Market	Peak Picking Period (PPP)	Lean Picking Period (LPP)	Total
1.	Marginal	Farmer Market	610.70 (70.18)	246.30 (91.97)	857.00 (75.31)
		Central Market	259.50 (29.81)	21.50 (8.03)	281.00 (24.69)
		Production	870.20 (100.00)	276.80 (100.00)	1138.00 (100.00)
2.	Small	Farmer Market	1259.87 (47.18)	629.63 (66.85)	1889.50 (52.31)
		Central Market	1410.27 (52.87)	312.20 (33.15)	1722.48 (47.69)
		Production	2670.14 (100.00)	941.83 (100.00)	3611.98 (100.00)
3.	Large	Farmer Market	682.30 (25.21)	286.68 (35.22)	968.98 (27.53)
		Central Market	2023.70 (74.79)	527.32 (64.78)	2551.02 (72.47)
		Production	2706.00 (100.00)	814.00 (100.00)	3520.00 (100.00)

Figures in parentheses are percentages to total production

As revearled by Table 2 the proportionate quantity sold in farmer marker to toal output decreased with an increase in farm size. It was highest with 75.31 per cent in marginal, 52.31 per cent in small and only 27.53 per cent in large group. When peak picking period (PPP) and lean picking period (LPP) were considered separately a larger percentage of output during LPP sold in farmer market. The quantities of output for LPP sold in the farmer market was as high as in 91.97 per cent in marginal followed by 66.85 per cent in small and 35.22 per cent in large group. During PPP the proportionate output sold in farme market was lesser as compared to LPP. Marginal farmers sold 70.18 per cent of PPP output in farmer market while the corresponding percentages in small and large group were 47.18 and 25.21 respectively.

PRICE SPREAD IN CHANNEL I AND CHANNEL II FOR BRINJAL

The result of the price-spread analysis is presented in Table 3

Table 3

Price Spread for Brinjal in Channel I and Channel II (rs/qtl.)

Sl.	Particulars	Channel I		Channel II	
No.		Rs	%	Rs	%
1.	Net price received by the farmer	831.95	94.54	664.14	50.24
2.	Cost of grading, packing, transport, loading, unloading and miscellaneous expenses incurred by farmers	48.05	5.46	81.13	6.14
3.	Commission paid by the farmer	-	-	82.81	6.26
4.	Farmer's sale price or wholesaler cum retailer's purchase price	-	-	828.08	-
5.	Cost incurred by commission agent *	-.20.88	-		
6.	Margin earned by commission agent*	-	-	61.93	-
7.	Cost incurred by the wholesaler cum retailer	-	-	39.74	3.01

8.	Margin earned by wholesaler cum retailer	-	-	95.51	7.22
9.	Wholesaler cum retailer's sale price/retailer's purchse price	-	-	963.33	-
10.	Cost incurred by retailer	-	-	101.49	7.68
11.	Margin earned by retailer	-	-	257.18	19.45
12.	Retailers sale price/ consumers purchase price	880.00	100.00	1322.00	100.00

* The cost incurred by commission agent and his profit margin have not been included in working out the price spread to avoid double counting since these items are covered by the commission paid by the farmers.

After harvest, the brinjal is graded and packed in gunnies by family labour and hired labour if necessary. Farmers selling in farmer market transport brinjal through town buses, run by state Transport Corporation, connecting villages with farmer market. Expenditure incurred on labour and packing materials constituted the cost of grading and packing. Transport cost includes only the value of tickets for farmers selling in farmer market since vegetables are transported at free of cost. Miscellaneous cost included food, refreshment etc., The average marketing cost incurred in channel I was Rs.48.05 per quintal for brinjal and the share of marketing cost in consumers rupee was 5.46 per cent. The net price received by the farmers was 94.54 per cent in channel I.

When farmers sell in central market (channel II), over and above the cost incurred on grading, packing and transport they also have to pay a commission of 10 per cent on the value of sales to the commission agent who arranges the sales. The commission agent, wholesaler cum retailer and retailers operating in the marketing channel in between farmers and consumers also incur cost for performing various marketing services and they earn a profit margin. In the marketing channel II, cost incurred by farmers including commission per quintal of brinjal was Rs. 163.94. Of the total marketing cost incurred by farmers, commission charges constituted 6.26 per cent of the consumer's price.

The cost incurred by commission agents was about Rs.20.88 per quintal of brinjal while his margin was Rs.61.93. The commission agent meet the cost of providing services and earn the profit from the commission paid by farmers.

The wholesalers cum retailers participate in auction, buy brinjal and sell it to retailers and bulk consumers. The total marketing cost incurred by wholesaler cum retailer was Rs.39.74 for brinjal and their margin was Rs.95.51.

The average marketing cost incurred by retailers per quintal was Rs.101.49 for brinjal and the profit margin earned by them was Rs.257.18. The percentage of marketing margin earned by retailers in consumer's rupee was 19.45 per cent. Among the three intermediates the marketing cost incurred and the profit margin earned were highest for retailers.

MARKETING EFFICIENCY

The marketing efficiency has been worked out and presented in Table 4.

Table 4

Marketing Efficiency in Channel I and Channel II (Rs/qtl)

No.	Particulars	Channel I	Channel II
1.	Marketing cost incurred by farmer	48,05	163.94
2.	Marketing cost incurred by Wholesaler cum Retailer	0.00	39.74
3.	Marketing cost incurred by Retailer	0.00	101.49
4.	Wholesalers cum Retailers margin	0.00	95.51
5.	Retailer's margin	0.00	257.18
6.	Total marketing cost and Marketing margin	48.05	657.86
7.	Retailer's sale price/Consumer's price	880.00	1322.00
8.	Net price received by producer	831.95	664.14
9.	Shepherd's Index of Marketing efficiency (7/6)	18.31	2.01

The total marketing cost and marketing margin involved in channel I was Rs.48.05 per quintal of brinjal, where as in channel II it ws Rs,657.86. Since the marketing cost and marketing margin in channel II in relation to consumer's price were higher the Shepherd Index of marketing efficiency was very low with 2.01 for the channel II. For channel I, because of saving in marketing cost due to the absence of intermediaries and relatively low cosumer's prices the marketing efficiency was higher in this channel with 18.31.

MARKETING COST FUNCTION

To evaluate the factors influencing the marketing cost of farmers at central market, a double log type of marketing cost function was fitted with producer's marketing cost per quintal (Y) as dependent variable and quantity marketed in quintals (X_1), Distance of transport in kilometers (X_2), and Labour engaged in post harvest operations (X_3) as independent variables. The results of the regression analysis are presented in Table 5.

Table 5

Estimates of Regression Model of Marketing Cost for Brinjal

No.	Variable	Notation	Geometric Mean	Co-efficient	Marginal Cost
1.	Marketing Cost incurred by the farmres (Rs/qtl)	Y	131.83	-	-
2.	Quantity marketed in quintals	X_1	1.98	0.379** (0.122)	0.75
3.	Distance from Village to Central Market (Km)	X_2	20.28	0.194** (0.074)	3.93
4.	Labour engaged in post harvest operations	X_3	1.05	0.162^{NS} (0.099)	0.17

Intercept : 1.751

Co-efficient of multiple regression (R^2) : 0.483

Figures in parenthesis are standard errors

** Significant at one per cent level; NS = Non-Significant

Table 5 revealed that 48 per cent of variation in marketing cost of brinjal was explained by the independent variables included in the model. Regression co-efficient for quantity marketed (X_1) and the distance (X_2) wer 0.379 and 0.194 respectively and significant at one percent level of probability. The marginal values imply that for every quintal increase in quantity marketed for mean level the marketing cost would increase by Rs. 0.75 and for every km increase in distance from mean level, marketing cost would increse by Rs.3.93 per quintal of brinjal.

CONCLUSION

The finding of the study reveled that quantity of brinjal sold and distance between farm and market were the major factors influencing the marketing cost of brinjal. It was found that small and marginal farmers have sold a larger proportion of output in farmer market as compared to large farmers. Marketing efficiency of farmer market was higher than central market. The farmer market helps in increasing farmer's share in consumer's rupee and provides fresh vegetables to consumers at relatively low prices.

REFERENCES

Geoffrey S. Shepherf and Gene A. Futrell, **Marketing Farm Products - Economic Analysis** (Ames: The Iowa State University Press, 1969), pp. 246-247.

John A. Moore et. al., **Indian Food Grain Marketing** (Mew Delhi, Prentice Hall of India, 1975), p.60.

Richard L. Khols and Joseph N. Uhl, **Marketing of Agricultural Products**, (New York: Macmillan Publishing Co., Inc., 1980), p.8.

APPLICATION OF RANKING TECHNIQUES IN AGRICULTURE

*Dr. N. Manonmoney**

Agricultural is one of the most important sectors in Tamil Nadu. Within the state - Madurai district is one where there has been significant agricultural development. There are many factors such as irrigational facilities, soil type, development of transport, availability of inputs like seeds, fertilizers and finance bring about notable changes in the area under cultivation. But adoption of better cropping pattern is one among the factors.

In this article an attempt is made to study the cropping pattern in Madurai district by using three ranking techniques. They are:

1) **Spearman's ranking** is used for testing the relation between the cropping pattern in different types of soil.

2) **Kendall Tau Coefficient** has been used to study the influence of the size of farm (holdings) on the cropping pattern.

3) **Garrett Ranking Technique** is adopted to analyse the agro-biological and economic factors responsible for the existing cropping pattern in the district.

This article consists of four sections. Section I explains the procedure of each ranking method. Section II, III & IV deals with applications of Spearman, Kendall and Garrett ranking methods in cropping pattern respectively.

SECTION I
PROCEDURE OF RANKING METHODS

1) The Spearman rank correlation coefficient: It is the nonparametric equivalent of the parametric correlation coefficient. As is true for the value of parametric correlation coefficient, the value of the rank correlation coefficient can range form $r_k = -1$ to $r_k = 1$. The sign of the co-efficient indicates the nature of relationship while the absolute value of the coefficient expresses the extent of relationship. A value of $r_k = -1$ indicates a perfect negative (inverse) relationship, a value of $r_k = 0$ indicates a lack of relationship and a value of or $r_k = 1$ indicates a perfect positive (direct) relationship between two variables.

It is possible to avoid making any assumption about the population being studied by ranking the observation according to size and basing the calculation on the ranks rather than upon the original observation. It does not matter which way the items are ranked, item number one may be the largest or it may be the smallest. Using ranks rather than actual observation gives the coefficient of rank correlation. This method of finding out coveriability or lack of it between two variables were developed by the British psychologist Chariles Edward Spearman in 1904. This measure is especially useful when quantitative measures for certain factors cannot be fixed but the individual in the group can be arranged in order, there by obtaining for each individual a number indicating his or her rank in the group.

After the set of paired rank is listed, the next step is to calculate the difference 'd' between each pair of ranks. The Spearman rank correlation is then computed by the

$$r_k = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$$

Where ,

D = x-y for each pair of ranks

r_k = coefficient of rank correlation

n = number of paired observations

2) Kendall's Tau Coefficient

It can be defined as

$$T_a = \frac{S}{\frac{1}{2}N(N-1)} = \frac{C-D}{\frac{1}{2}N(N-1)}$$

N = Number of items

C = Positive scores in second ranking

D = Negative scores in the second ranking provided the first ranking is in increasing order (ascending order)

In the second ranking, the positive scores are calculated by making use of +1 every time a given pair is order, the same way (referred to as a concordant pair) for both first and second ranking and -1 whenever they ordered oppositely (referred to as 'discoldant' pair). The value of 'S' is obtained by summing these +1's and -1's for all possible pairs. Therefore 'S' is equal to the number of concordant pairs 'C' minus the number of discordant pairs 'D'.

Kendall's Tau varies between -1.0 and +1.0 and is based upon a different operation. If there is perfect disagreement between the two ranking system, the value of S would be 1/2 N(N-1) and T would be -1.0. Also if the two variables are completely unrelated, the positive and negative contributions to S will exactly cancel and T will be zero.

3. Gareett Ranking Technique

It is often desirable to transmute orders of merit into units of amount of "scores". This may be done by means of tables if we are justified in assuming normally for the trait. The transmutation of ranks into scores either on (a) a scale of 10 points and (b) a scale of 100 points.

The ranking given by the respondents is converted into percent position by using the formula.

$$\text{Percent Position} = \frac{100\,(R-5)}{N}$$

R = Rank given for a factor by an individual

N = Number of individual ranked.

The percent position of each rank thus obtained is converted into scores by referring to the Table given by Garrett. (annexureI). Then the scores of the individual respondent for each factor, added together and divided by the total number of respondents for whom the scores are added.

SECTION II
APPLICATION OF SPEARMAN RANKING METHOD

Spearman Ranking is applied to study the relationship between crops cultivated and the type of soil. In this case, three classification of soil are taken into consideration. The cropping pattern is explained with six selected crops namely rice, cholam, cumbu, ragi, cotton and groundnut. Area under crops in different types of soil are collected and converted into percentage and ranks are assigned to them depending upon the number of hectares of crops in each type of soil. Table I explains the results of Spearman's rank correlation. It shows that if there is a combination of red calcarious and red non-calcarious in an area, the cropping pattern does not vary much as the r_k (correlation coefficient) is 0.89. In the combination of red non-calcarious and black soil, the cropping pattern differs to some extent, as r_k is 0.40 and in the combination of red calcarious and black soil, the cropping patten differs very much and the r_k is 0.18. Thus it has been concluded that there is significant agreement between the red-calcarious and red non calcarious soil in the cropping pattern and disagreement between red calcarious and black soil regarding cropping pattern.

SECTION III
APPLICATION OF KENDALL'S TAU RANK COEFFICIENT METHOD

To study the influence of size of farms on cropping pattern, data regarding area under different crops, size group-wise are collected from agricultural census. The size of farm is classified into seven namely less than 1 ha, 1-2 ha, 2-3 ha, 3-4ha, 4-5 ha, 5-10 ha and more than 10 hectares.

Table 1

Spearman's Rank Correlation Coefficient with reference to crops under different classification of soil in Madurai District

Sl. No.	Crops	Red Calcarious Soil (I Classification)	Red non -Calarious (II Classification)	Black soil (III Classification)
1.	Rice	I (43.68)	I (59.52)	II (28.05)
2.	Cholam	III (33.00)	IV (1.70)	IV (9.75)
3.	Cumbu	IV (3.58)	III (15.02)	V (5.93)
4.	Ragi	V (1.66)	VI (0.75)	VI (0.59)
5.	Cotton	VI (0.09)	V (1.26)	I (38.35)
6.	Groundnut	II (17.99)	II (21.75)	III 17.33
		100	100	100

Figures in Parentheses indicate percentages.

Spearman's Correlation coefficient of Soil Classification as follows.

1) Red Calcarious x Red non-calcarious = 0.89

2) Red non - calcarious x Black soil = 0.37

3) Red calcarious x black soil = 0.15

The area under different crops (in hectares) size group wise are converted into percentage, and are presented in Table II. This table II reveals that there is inverse relation between area under rice and the size of farms, whereas for other crops like cholam, cumbu, ragi, cotton and groundnut, more area of crops are in land size group 1-2 hectares. After this size of land (1-2 ha) the area under crop is declining as there is increase in the size of farms. In general, it is observed that a larger percentage of cropped area is under both in food and non-food crop in the smaller farm size groups (less than 1 hectare and 1-2 hectares.)

Kendall's Tau coefficient is employed to study in influence of six of farm on cropping pattern. This coefficient is used for size crops namely rice, cholam, cumbu, ragi, cotton and groundnut. The Tau coefficient used for this analysis is as follows.

$$T_a = \frac{S}{\frac{1}{2}N(N-1)}$$

The Tau rank coefficient is presented in Table III. The results show that the values of 'S' is same for the three, millets namely cholam, cambu, ragi and also same for the two non-food crops of cotton and groundnut. Thus the Tau rank coefficient is presented under three heads namely paddy, millets and non-food crops.

In rice, the Tau rank correlation co-efficient is 0.76, for millets Cholam, cumbu and ragi it is 0.43 and for non-food crops (groundnut and cotton) it is 0.57. These coefficients prove that, change in the size of farm brings about change in the area under crops is more in rice and low in millets. Thus it has been concluded that the size of farm has influenced the cropping pattern in Madurai District.

Table II

Percentage Area under Major Crops - size groupwise in Madurai District

Sl. No.	Size of farms	Rice	Cholam	Cumbu	Ragi	Cotton	Ground nut
1.	<1ha	30.20	18.09	16.04	18.65	18.47	16.94
2.	1 -2 ha	23.34	21.75	22.06	22.45	22.68	22.73
3.	2 - 3 ha	13.99	14.30	15.19	14.74	15.00	15.28
4.	3 - 4 ha	8.32	9.65	10.18	10.01	10.60	10.66
5.	4 - 5 ha	5.85	7.22	7.49	7.09	7.75	7.32
6.	5 - 10 ha	11.82	17.51	17.68	16.86	17.60	16.87
7.	> 10 ha	6.48	11.48	11.36	10.20	7.90	10.20

Table III

Results of Tau Rank Correlation Coefficient

Sl. No.	Crops	Positive Scores C	Negative ScoresD	S (C - D)	Tau_a
1.	Rice	18	2	16	0.76
2.	Millets (Cholam,Cumbu,ragi)	15	6	9	0.43
3.	Non-food crops (Cotton & groundnut)	17	5	12	0.57

SECTION IV

APPLICATION OF GARRETT RANKING METHOD

For analysing the factors responsible for the cropping pattern in the district, Garrett ranking technique is used both in S_1 farms (<2 ha) and S_2 farms (>2 ha). The reasons for the adoption of the existing cropping pattern are classified under two broad heads namely, (a) agro-biological factors and (b) economic factors. **Agro biological factors** include (i) introductionh of High yielding varieties. (ii) increase in irrigation facilities. (iii) suitability of the soil and (iv) availability of fertilizers and manuers. The **Economic factors** are

(i) Easy availability of credit

(ii) Availability of market facilities

(iii) Availability of labour

(iv) Availability of transport

(v) Fair price provided by regulated markets and

(vi) Availability of time for personal attention.

The respondents are 160.80 in S_1 farms and 80 in S_2 farms. The main crop cultivated are sugarcane, banana, groundnut, pulses and ragi. The sample farmers are asked to rank these reasons. The percent position of each rank obtained is converted into scores by referring the Garrett table. The scores of the individual respondents for each reason added together and divided by the total number of farmers. How far the agro-biological and economic reasons are responsible for the existing cropping pattern for two size of farms in the district has been analysed and the results are given in Table IV.

From Table IV it is found that, among the four agro biological factors, suitability of soil ranks first and the availability of irrigated facilities rank second in S_1 farms. whereas in the case of S_2 farms soil ranks second and irrigation facilities ranks first. Therefore it is concluded that soil and irrigation patten are the important agro biological factors for designing of the cropping pattern in the district.

In the same manner, the influence of economic factors, for the adoption of cropping pattern has also been ranked. Among the six factors, fair price by the regulated market is the main reason for the adoption of particular cropping pattern in both S_1 and S_2 farms. Time for personal attention to agricultural activities and the availability of credit facilities are the other two important economic factors influencing the cropping pattern of the district.

Table IV

Results of the Garrett Ranking is S1 and S2 farms of the District

Sl. No.	Reasons	S1 farms		S2 farms	
		Garret's Score	Rank	Garret's Score	Rank
	A) Agro-Biological reasons				
1.	Introduction of High-yielding varieties	89.86	III	84.96	III
2.	Increasing in Irrigational Facilities	91.15	II1	89.75	I
3.	Suitability of the soil	92.08	I	87.50	II
4.	Availability of Fertilizer & Manuer	81.23	IV	80.12	IV
	B) Economic Reasons				
1.	Easy Availability of Credit	87.09	III	85.91	II
2.	Availability of market facilities	65.00	V	69.00	V
3.	Availability of market labour	75.28	IV	77.79	IV
4.	Availability of market transport	61.77	VI	61.94	VI
5.	Fair price provided by regulated markets	93.11	I	89.41	I
6.	Availability of time for personal attention	90.47	II	84.80	III

ANNUEXURE I
GAREETT RANKING

The transmutation of orders of merit into units of amount or "scores"

Example : If N =2 5, and R = 3 percentage position is 100(3-5) or 10 and from the table, the equivalent rank is 75, on ascale of 100 points.

Percent	Score	Percent	Score	Percent	Score
0.10	99	22.32	65	83.31	31
0.20	98	23.88	64	84.56	30
0.32	97	25.48	63	85.75	29
0.45	96	27.15	62	86.89	28
0.61	95	28.86	61	87.96	27
0.78	94	30.61	60	88.97	26

Percent	Score	Percent	Score	Percent	Score
0.97	93	32.42	59	89.94	25
1.18	92	34.25	58	90.83	24
1.42	91	36.15	57	91.67	23
1.68	90	38.06	56	92.45	22
1.96	89	40.01	55	93.19	21
2.28	88	41.97	54	93.19	21
2.63	87	43.97	53	94.49	19
3.01	86	45.97	52	95.08	18
3.43	85	47.98	51	95.68	17
3.89	84	50.00	50	96.11	16
4.38	83	52.02	49	96.57	15
4.92	82	54.03	48	96.99	14
5.51	81	56.03	47	97.27	13
6.14	80	58.03	46	97.72	12
6.81	79	59.99	45	98.04	11
7.55	78	61.94	44	98.32	10
9.17	77	63.85	43	98.58	9
8.33	76	65.75	42	98.82	8
10.06	75	67.48	41	99.03	7
11.03	74	69.39	40	99.22	6
12.04	73	71.14	39	99.39	5
13.11	72	72.85	38	99.55	4
14.25	70	76.12	36	99.68	3
15.44	71	77.68	35	99.80	2
16.69	69	77.68	35	99.91	1
18.01	68	79.17	34	100.00	0
19.39	67	80.61	33		
20.93	66	81.99	32		

In which R is rank of the individual in series* and N is the number of individuals ranked, determine the percentage position of each individual.

*A rank is an interval on a scale; .5 is subtracted from each R because its midpoint best represents an interval. E.G.R = 5 is the 5th interval, namely 4-5, 4.5 (or 5-.5) is the midpoint.

MARKET INTEGRATION-AN APPLICATION OF ARIMA MODEL TO DOMESTIC TEA AUCTION MARKETS

*N. Mahesh, T.R. Keshava Reddy and R. Sundaresan**

Supply and demand are the two main variables, which dictates the development process of any industry or enterprise. In a market economy, the increase in agricultural production and transfer of surpulses from one sector to other are to be brought about by the price signals. The prices of most agricultural commodities are inherently susceptible to violent fluctuations, the economic consequences of which are dire. The great depression of the thirties was attributed to the cyclical fluctuations of primary product prices (Lewis, 1963). Prices according to Mellor (1968) perform the function of allocation of resourcs, distribution of income and capital formation.

In many cases, even though the production systems are physically efficient, yet inefficiency in pricing is seen because of market imperfections. In other words, the mobilization and allocation of productive resources takes place through the marketing system. Efficient pricing of agricultural commodities therefore assumes a crucial role in initiating and maintaining the development process. A system of efficient pricing is sinequo-non to maximize agricultural production. It also leads to the attainment maximum social welfare from the given output. The objectives can be achieved only if the marketing system ensures prics, which are stable and remunerative to producers. The price must be reasonable to consumers as well as to meet the demand for the increased production.

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In India, tea is marketed in three ways 1. Sale of tea on wholesale basis at well-organized auction centers. 2. Through forward contract and 3. Ex-garden sale.

Out of these, the 165-year-old auction system is the industry's main trading mechanism. There are seven auction centers in the country located at Calcutta, Cochin, Coonoor, Amristsar, Guwahati, Siliguri and Coimbatore. The auction system still continues to be the best trading mechanism to strike a better deal and it also provides a readymade feed back system. In this paper, therefore, an attempt has been made to shown that tea auction markets are closely related i.e., price information in one market is fully reflected in the prices of another market.

METHODOLOGY

The commonly adopted method of analysis of market integration consists of computing the correlation of the time series data on prices of the two concerned markets. To analyse the extent of relationship between different domestic auciton markets, tea prices of different grades (leaf, dust) relatec to four domestic auction markets viz Calcutta, Guwahati, Coimbatore and Cochin were collected for the period from 1979-80 to 1998-99 from the Tea Statistics, Tea Board of India, Calcutta.

The time series data were first detrended by taking the first difference to eliminate the time effect on the prices. The ARIMA model was fitted and is based on a class of models called Auto Regressive Integrated Moving Average (ARIMA) process. Auto regressive (AR) and moving average (MA) and mixed auto regressive moving average models have been developed by Box and Jenkins (1969).

The time series at equally spaced intervals t, say at monthly intervals, denoted by P(t), P(t-1), P(t-2) .... P(t-n) is first subjected to first differncing. The result obtained a(t), a(t-1), a(t-2), a(t-n) is a white noise consisting of uncorrelated random normal deviation with zero mean and variance $\sum a^2$.

Let P (t) = P(t) - μ .... (2)

Whne P(t) is the deviation from the mean μ and if the deviations are lineraly dependent on a(t) and on one or more of the previous a's then we have a moving average (MA) process. A first order MA model is

$P(t) = a(t) - \theta_1 a(t-1)$ ....(3)

In general a Qth order MA process is

$P(t) = a(t) --- \theta_1 a(t-1) .... \theta_q a(t-Q)$ ....(4)

Alternatively, if P(t) is linearly dependent on previous deviations P(t-1), P(t-2) .... and a(t), we have an Auto regressive model.

$P(t) = a(t) + \phi_1 P(t-1)$ ....(5)

is a first order Auto Regressive model. A p^{th} order

AR model is generated as,

$P(t) = a(t) + \phi_1 P(t-1) + \phi_2 P(t-2) + ... + \phi_p(t-p)$ .... (6)

In the above models, θ and ϕ are parameters to be estimated.

Some economic times series show a distinct seasonal pattern. Price of agricultural commodities, for instance, tends to decrease during periods of surplus production and increase during scarcity; similarly, production also follows a seasonal pattern. There is a tendency for pattern to repeat year after year. In addition, there is a tendency towards a secualr trend. In periodic data, two aspects are important, viz., the relationship between

To estimate the ϕs and θs, it is first necessary to work out the moving average process to estimate θ and then prefer analytical least squares to estimate the auto regressive parameters, ϕ s

If the fitted MA process is of the form

$P(t) = a(t) - \theta a\ (t-1)$ ....(12)

specified values of θ can be used to generate a set of a(t) from the observed P(t)s. The starting values of a(0) is assumed to be zero and hence,

$a(1) = P(1)$ ....(13)

$a(2) = P(2) - a(1)$ .... (14)

The sum of squares are obtained as

$S(Q) = \sum a^2(t)$

This could be obtained corresponding to a particular choice of θ

The sum of squares surface can then be plotted for a grid value of θ and the final selection of the value that minimize $S(\theta)$. The preliminary values of the tentatively entertained model are obtained by using the sample ACF as proxy for(k) and solved for ϕ and θ. Then, by an iterative process we obtained the maximum likelihood estimate of ϕ and θ.

The identified model is fitted to the data and the parameters are estimated. Diagnostic checks are then employed to the model to check whether the estimated model is adequate or otherwise. Diagnostic checking in a way pertains to checking the goodness of fit. Over fitting involves fitting a more elaborate model than is indicated by the identification procedure. If the model to be fitted is identified as a MA (011) and instead we fit a MA (012), it is called as overfitting. One major problem with this method of diagnostic checking is that what kind of discrepancy to accept should be known.

After checking the randomness of the resultant series, the domestic monthly prices were cross correlated between the four domestic auction markets for two different grades, separately, using the following equation.

$$\bar{r}_{x1}(K)_{x2} = \frac{\sum_{t=1}^{n}(X_{1t}-\bar{X}_1)(X_{2t-k}-\bar{X}_2)}{\sqrt{\sum_{t=1}^{n}\{(X_{1t}-\bar{X}_1)^2(X_{2t-k}-\bar{X}_2)^2\}}} \qquad \text{..........(16)}$$

Where,

$$\bar{X}_1 = \sum_{i=1}^{n} X_{1t}/n \text{ and}$$

$$\bar{X}_2 = \sum_{i=1}^{n} X_{2t}/n$$

n being the number of observations and k is the length of lag

X_1 = Detrended price series of market 1 i.e., monthly prices of different grades

X_2 = Detrended price series of market 2 i.e., monthly prices of different grades

$\bar{r}_{x1x2}$ = Cross correlation between two series of prices of market 1 and market 2

The test statistic of the following form was used in testing the null hypothesis of independence of the two markets.

$$Qm = n \sum_{k=-m}^{m} \bar{r}^2 k \quad ....(17)$$

Where,

Qm = Box-pierce Q statistic

n = number of observations

k = number of particular lag

m = number chosen to compute lags and

$\bar{r}^2 k$ = the square of co-efficient of corss correlation of lag k.

The null hypothesis of independence is rejected at a given level is significance, if

$$Qm = n \sum_{k=-m}^{m} \bar{r}^2 k > \chi^2 m(\alpha)$$

Where,

$\chi^2 m(\alpha)$ = Chi-square table value at α level of significance and m degrees of freedom.

RESULTS AND DISCUSSION

In order to study the interaction between different domestic auction markets, the prices for two grades (leaf and dust) of two processing methods (C.T.C. and Orthodox) and to examine the pricing efficiency, the cross correlations were computed and the results are presented in what follows:

i) Intregration of Guwahati auction markt prices with Calcutta auction market prices

The monthly auction prices of Guwahati and Calcutta were cross-correlated for the period of 20 years and the correlation coefficients at different lags and leads are presented in **Table -1.**

In the case of C.T.C. leaf, the correlation co-efficient (r) of these two auction markets worked out to 0.580 at zero lag. This significant correlation between these two domestic auction markets reveal that they move together in same direciton to a mdoerate degree. For leads 1 and 5, the co-efficients were found to be statistically significant whereas for lags 7, the correlation co-efficient was statistically significant. It implies that Guwahati price series lead the Calcutta price series by one and five months, whereas Calcutta price series leadthe Guwahati price series by seven months.

In the case of C.T.C. dust, the correlation co-efficient (r) of these two markets worked out to 0.537 at zero lag which was moderately significant, implying that prices in these two markets move together in the same direction. However, all these values were statistically non-significant and it implies that there is no lead-lag relationship between these two price series.

In the case of Orthodox leaf, the correlation co-efficient (r) of these two auction markets worked out to 0.451 at zero lag, which was moderately significant, implying that prices in these two markets move together in the same direction. For leads6, the co-efficient was statistically significant implying that Guwathi price series lead the Calcutta price series by six months.

In the case of Orthodox dust, the correlation co-efficient (r) of these two auction markets worked out to 0.421 at zero lag, which was moderately significant, implying that the prices in these two markets move together in the same direction. For lags 1,2 and 5 the co-efficients are statistically significant and implies that the Calcutta prices lead the Guwathi price series by one, two and five months.

The hypothesis of independence between Guwahati and Calcutta auction market prices of tea was tested using the Box-Pierce Q statistic. The compound test statistic was compared with table chi-square value. For both leaf and dust of C.T.C. tea, the null hpothesis was accepted. It indicated that both markets are dependent for both leaf and dust of C.T.C. tea. In other words, the price series of Guwahati and Calcutta auction markets are dependent on each other for both leaf and dust of C.T.C. tea.

In case of both leaf and dust of Orthodox tea, the null hypothesis was accepted. Thus it indicates that spatial markets are integrated. In other words, the price series of Guwahati and Calcutta auction markets are interdependent for both leaf and dust of Orthodox tea.

ii) Integration of Cochin auction market prices with Coimbatore auciton market prices.

The leaf monthly auction prices of Cochin and Coimbatore were cross correlated for the period of 20 years and the correlation co-efficients at different lags and leads are presented in **Table -2**.

In case of C.T.C. leaf, the correlation co-efficient (r) of these two markets worked out to 0.574 at zero lag, which was moderately significant implying that prices in these two markets move together in the same direction. For leads 1 and 5 and for lags 7, the co-efficients were statistically significant implying that Cochin price series lead to Coimbatore price series by one and five months and also Coimbatore price series lead the Cochin price series by seven months.

In the case of C.T.C. dust, the correlation co-efficient (r) of these two auction markets worked out to 0.526 at zero lag, which ws moderately significant implying that prices in these two markets move together in the same direction. For leads 4 and for lag 1, the co-efficients were statistically significant implying that the Cochin price series leads the Coimbatore price series by four months and also Coimbatore price series lead the Cochin price series by one months.

In the case of Orthodox leaf, the correlation co-efficient (r) of these two auction markets worked out to 0.462 at zero lag. This significant correlation between these two markets reveal that they move together in same direction to a moderate degree. For lags 1 and leads 1, the co-efficients were statistically significant and it indicates that Cochin price series lead the Coimbatore price series by one month and also Coimbatore price series lead the Cochin price series by one month.

In the case of Orthodox dust, the correlation co-efficient (r) of these two auction markets worked out to 0.0431 at zero lag, which was moderately significant implying that prices in these tow markets move together in the same direction. For leads 2 and for lags 1, the co-efficients were statistically significant implies that Cochin price series lead Coimbatore price series by two months and also Coimbatore price series lead the Cochin price series by one month.

The hypothesis of independence between Cochin and Coimbatore auction market prices of tea was tested using the Box-Pierce Q statistic. The computed test statistic was compared with table chi-square value. For both leaf and dust of C.T.C. tea, the null hypothesis was acceptaed. It indicated that both markets are dependent for both leaf and dust of C.T.C. tea. In other words the price series of Cochin and Coimbatore auction markets are dependent on each other for both leaf and dust of C.T.C. tea.

In case of both leaf and dust of Orthodox tea also, the null hypothesis was accepted. Thus, it indicates that spatial markets are integrated. In other words, the price series of Cochin and

Coimbatore auction markets are interdependent for both leaf and dust of Orthodox tea. The main reason is the Indian tea marketing system is domestically well organised in terms of effective price signals, better communication network and fster transport systems and alos a rapid flow of market intelligence among the domestic auciton markets (Sundaresan and Preeti Menon, 1994).

CONCLUSION

The foregoing analysis indicated that the price series of different domestic tea auction markets are closely associated with each other. This implies that non-competitive pricing behaviour does not exit in these spatially separated auction markets. From this study, it is concluded that the price changes are fully and imediately passed on among domestic tea auction markets. This calls for simultaneous development of all the domestic markets for sustaining the interdependence.

REFERENCES:

1. Box and Jenkins, 1976, Time Seies Analysis, Forecasting and Control, Holden-Day Inc.
2. Brorsen, B.W., Chavas, J.P. and Grand, W.R., 1984, Dynamic reltionship of rice import prices in Europe. European Review and Agric. Econ., 11(1) : 29-42.
3. Chengappa, P.G. and Muralidharan, M.A. 1980, Pricing efficiency of Indian coffee market. Processing Technology and Marketing, Trivandrum.
4. Lewis, W and Arthus, 1963, Economic Survey 1919-1939, George Allen and Unwin, London.
5. Meller and W. John., 1968 The function of Agricultural Prices in Economic Development, Indian.J.Agri.Econ., 23(1):23-37.
6. Sundaresan, R. and Preeti Menon, 1994, An analysis of production, export and price variaton in tea. Bihar J. Agril,Mktg., 2(4): 359-364.

Table -1

Correlation coefficients of Guwahati auction market prices with Calcutta auction market prices (1979-80 to 1998-99)

Months	C.T.C.				Orthodox			
	Leaf		Dust		Leaf		Dust	
	Lead	Lag	Lead	Lag	Lead	Lag	Lead	Lag
0	0.580**	0.580**	0.537**	0.537**	0.451**	0.451**	0.421**	0.421**
1	0.171**	0.033	0.009	0.012	0.289	-0.129	0.077	0.191**
2	-0.004	0.011	-0.005	0.026	0.004	0.057	0.058	0.150**
3	-0.022	-0.005	-0.028	-0.056	-0.004	-0.067	-0.031	-0.084
4	-0.005	0.063	-0.021	-0.035	-0.006	0.010	-0.025	0.105
5	0.028**	0.015	0.011	0.037	0.113	-0.087	0.008	0.156**
6	-0.045	0.018	0.015	0.058	0.142**	-0.041	0.039	0.036
7	0.013	0.048**	0.010	0.019	0.053	0.046	-0.034	0.089
x^2	50.82		72.11		71.79		72.36	

Note: ** indicates significance at 1 percent level

x^2 is the calculated value

Table -1

Correlation coefficients of Cochin auction market prices with Coimbatore auction market prices (1979-80 to 1998-99)

Months	C.T.C.				Orthodox			
	Leaf		Dust		Leaf		Dust	
	Lead	Lag	Lead	Lag	Lead	Lag	Lead	Lag
0	0.574**	0.574**	0.526**	0.526**	0.462**	0.462**	0.431**	0.431**
1	0.161**	0.034	0.007	0.015**	0.267**	0.125**	0.072	0.114**
2	-0.005	0.005	-0.004	0.024	0.005	-0.048	0.054**	-0.150
3	-0.011	-0.002	-0.029	-0.048	-0.007	-0.115	-0.021	-0.082
4	-0.004	-0.006	0.051**	-0.024	-0.015	0.005	-0.035	0.106
5	0.024**	0.014	0.005	0.037	0.013	0.041	0.007	-0.152
6	0.042	0.017	0.021	0.045	-0.142	-0.045	-0.012	0.027
7	0.012	0.045**	0.014	0.012	0.043	0.067	0.028	0.088
x^2	87.96		69.13		83.17		67.57	

Note: ** indicates significance at 1 percent level

x^2 is the calculated value

METHODS AND TECHNIQUES FOR VALUAING ENVIRONMENTAL IMPACTS OF AGRO FORESTRY PROJECTS

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INTRODUCTION

Markets for environmental goods and services do not exist and in some cases markets are not well developed. It may not be possible to value the environmental impacts of an agro forestry projects by using market techniques. A viable alternative in thes situation may be use of Contingent Valuation Method (CVM). CVM was first used in developed economies for valuation of public goods like parks, endagered species and multi-purpose dams. The essential feature of public goods is that one person's consumption does not affect the amount available to next person. Once provided, the marginal cost of additional person consuming a public good is zero. The environmental impacts of agro forestry at the farm level have not been systematically assessed. Contigent Valuation may be used for valuing environmental impact of agro forestry projects (Swintels and Scherr, 1991; Scherr and Muller, 1991; Current, Lutz and Scherr, 1995; Subramanian et al., 1995; Manoharan and Muraleedharan and Anitha, 1998). With this background, an attempt has been made in the present study to estimate environmental impacts associated with agro forestry systems in Tamil Nadu, Which constitutes four per cent of India's land and seven per cent of overall population.

METHODOLOGY

When farmers make decision about what and how much to produce, they normally take into account the price of what they

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will produce and the cost of items for which they will have to pay: labour, raw materials, energy and so on. These are called as the private costs of the farm firm. But there is another type of cost that, which representing a true cost to society does not show up in the farm firm's profit and loss statement. For example when farmers go for Casuarina cultivation, it involves cost of bird scaring to other farms. It is the external cost. They are called 'external' because although they are real costs to some members of society, firms do not normally take them into account when they go about making their decision about output rates. These costs are external to the firm but internal to society as a whole. Thus social cost includes private cost and exterjnal costs (Hydge, 1988).

Social Cost = Private cost + External cost

Likewise, if a farmer cultivates agro forestry and sells his produce to the prople in the city, of course, the farmer's main concern is the income he can derive from the operation, the agro forestry trees produce several other benefits to the society, including nitrogen fixation in case of Casuarina, a habitat for birds, honey production and scenic values for passers-by. These benefits, while internal from the standpoint of society, are external from the standpoint of the farmer. They do not appear any where in his profit and loss position. They are external benefits o his farming decisions. In this case the agro forestry value of the land to the farmer understates the social willingness to pay to have the land in agro forestry. Thus the social benefits include private benefits and external benefit (Cook and Grut, 1989; Dixon et al., 1994).

Social benefit = Privat benefit + Extenal benefit

In the usual cost benefit analysis, private cost and private benefit stream are considered in order to work out the returns to investment on agro forestry enterprises. In the last one decade, significant progress has been made in developing techniques of economic valuation of non-market environmental goods and servives. This has enabled an economic appraisal of alternatives, which could be applied to forests as well. A detailed review of methods and used in valueation of natural resources is available from Markandya (1992), Kuik et al. (1992), Smith (1993), Murty and Menkhaus (1994) and Munasinghe (1994). The concept of Total Economic Value (TEV) has been evaluated in environmental economics literature to recognize the full range of benefits provided by the forests. Usually TEV of natural forests is dominant by various intangible benefits such as recreation, watershed benefits, ecological services, evolutionary process and biodiversity. The totl economic value conceptually is the sum of use values (UV) and non-use values (NUV) and it has been illustrated with the help of flow chart.

FLOW CHART

TOTAL ECONOMIC VALUE

Use values			Non-use values	
Direct use values	Indirect use values	Option value	Bequest value	Existence value
↓	↓	↓	↓	↓
Output that can be consumed directly	Functional benefits	Future direct and indirect use values	Value of learning use and non-use values for off-spring or others	Value form knowledge of continued existence

Direct use of values A. Consumptive and productive

Timber

Firewood

Medicine

Grazing

	B.	Non-consumptive Eco tourism Education and Research Human habitat
Indirect use value	A.	Watershed benefit Agriculture productivity Soil conservation Recharging of ground water Regulation of stream flows
	B.	Ecosystem services Nitrogen fixing Waste assimilation Carbon store Microclimatic function
	C.	Evolutionary processed Global life support Biodiversity

Source : Barbier, (1991), Munasinghe and Lutz (1993)

In case of agro-forestry non-use values such as bequest value and existence value does not exist and option value also does not in case of agro forestry economic valuation. Tangible and intangible benefits and costs associated with agro forestry systems included in this study are:

Intangible costs:	Cost of birds scaring
Intangible benefits:	Soil and Water Conservation Agriculture productivity Nitrogen fixing Waste assimilation Carbon store
Tangible costs:	Cost of cultivation

Tangible benefits: Firewood
Timber
Non-timber forest products.

Intangible benefits and intagibel costs are essetially non-marketed goods and services and their valuation in monetary terms is difficult and in certain case it is virtually not possible. Several methods are suggested in the liteature to quantity intagible benefits and intangible costs of forests (Dixon and Sherman, 1990, Pearch and Moran, 1994). These methods can be broadly classified into two: direct methods and indirect methods while the direct methods try to find out people's preferences by directly questioning them, the indirect methods try to know the preference for various alternatives.

Contigent valuation method (CVM) was used in this study to place monetary value on intangible benefits. CVM is used where market for environmental goods or services do not exist, are nto well-developed, or where there are no alternative markets and it may not be possible to value to environmental effects of a particular project by using the market or surrogate-market techniques (Dixon et al., 1994). CVM is a direct approach - it asks people what they are willing to pay (WTP) for a benefit, or what they are willing to accept (WTA) by way of compensation to tolerate a cost or both. There are many common techniques to carryout CVM. Here open-ended question method was used, where the respondents were asked to state their willingness to pay for the given non-marketed good. That was an open question and the respondent had the full freedom to state the value.

This study involved survey of agro forestry adopters, extension officials with agro-forestry projects. For the present study Dharmapuri district of Tamil Nadu State, India had been selected considering its lead in agro forestry. In total 200 farmers were interviewed in different agro forestry system taken for this study. The agro forestry systems adopted by the farmers of the study region are agrisilviculture and Silviculture.

AGRI-SILVICULTURE

Mango and Tamarind were grown in the farmers' field along with agricultural crops like millets and Groundnut as intercrops (Sekar and Rai, 1993).

SILVICULTURE

Subabul and Casuarina were grown as pure tree crops (Sekar and Rai, 1993).

In each category 50 farmers have been surveyed and thus the total sample of 200 farmers are interviewed. The data are collected during the year 2000. Financial measures used for analyzing the economics of agro forestry were Benefit Cost Ratio (BCR) and net Present Value (NPV).

BENEFIT COST RATIO (BCR)

The cost and benefit streams were discoutned to arrive preset worth of costs and benefit stream. This ratio was obtained when the present worth of benefit was derived by the present work of costs. The BCR should be greater than one for worthiness of the system. Mathematically, the Benefit Cost Ratio (BCR) for the private return and social return has been calculated by using the following formula:

Benefit Cost Ratio (Private)

$$BCR_p = \frac{\sum_{t=1}^{n} B_t / (1+r)^t}{\sum_{t=1}^{n} C_t / (1+r)^t}$$

Benefit Cost Ratio (Social)

$$BCR_s = \frac{\sum_{t=1}^{n} SB_t / (1+r)^t}{\sum_{t=1}^{n} SC_t / (1+r)^t}$$

Where, B_t = Benefit obtained from the enterprise during period 't'

C_t = Cost incurred for the enterprise during the period 't'

r = The discount rate

t = The number of years of the project

SB_t = Social benefit realized from the enterprise during period 't'

SC_t = Social cost incurred for growing tree crops during period 't'

Net Present Value (NPV)

The present worth of net benefits of agro forestry systems were obtained by deducting present woth of stream of costs from present worth of benefits. The NPV should be positive for a tree crop to be worth. Mathematically,

Net Present Value (Private)

$$NPV_P = \sum_{t=1}^{n} B_t / (1+r) - \sum_{t=1}^{n} C_t / (1+r)^t$$

Net Present Value (Social)

$$NPV_S = \sum_{t=1}^{n} SB_t / (1+r) -- \sum_{t=1}^{n} SC_t / (1+r)^t$$

For analysing private return, private benefit stream and private cost stream have been used. For analysing social return, social benefit stream and social cost stream have been used.

RESULT AND DISCUSSION

The basic characteristics features of the sample farms are presented in Table 1. The average area under agro forestry per farm formed 34.74 per cent and 41.03 per cent in agri-silviculture. The average area under agro forestry per farm formed 57.3 per cent and 58.41 per cent in silviculture. This table also indicated that as the size of the farm increased the area under agro forestry also increased. It could be seen that the farmer shifted from agri-siviculture to silviculture as farm size increased. Life cycle and the productivity of tree crops grown to the study area are presented in the Table 2.

TABLE 1
GENERAL PARTICULARS OF THE FARM

S. No.	Model	Crops	Area under agro-forestry (ha)	Farm size (ha)	Percentage of agro-forestry area to total optional area
1.	Agri-silviculture	Mango + Millet + Groundnut	1.07	3.08	34.74
2.	Agri-silviculture	Tamarind + Millet + Groundnut	1.35	3.29	41.03
3.	Silviculture	Casuarina	2.43	4.16	58.41
4.	Silviculture	Subabul	2.47	4.31	57.3

TABLE 2
LIFE CYCLES AND YIELD FROM TREA CROPS

Trea Crop	Life cycle (years)		Yield (Tonnes/ha)
Subabul	10	Fourth year	10.25
		Seventh year	22.00
		Tenth year	25.50
Casuarina	6		56.30
Mango	20	5 to 10 years	2-6 tonnes
		10 to 15 years	8-10 tonnes
		15 to 20 years	15-20 tonnes
Tamarind	20	5 to 10 years	2-5 tonnes
		10 to 15 years	7-8 tonnes
		15 to 20 years	10-13 tonnes

Subabul and Casuarina are the commonly grown agro forestry tree crops. Casuarina is mostly used as scaffolding materials and to some extent as fuel wood. In Tamil Nadu farmers started growing Casuarina right from the beginning of 20th century to be used as firewood. But the major thrust in the area expansion came during the world war - II. The surge in the building activity combined with growing demand for firewood gave an impetus to the area expansion of Casuarina (Swaminathan, 1999).

The owners of Subabul and Casuarina do not harvest the wood. They sell the plantation as such either to charcoal producers or to fuel wood traders. Charcoal producer and traders estimate the yield and value the trees as they stand in the field and fix the price through negotiation. The traders, in general make arrangement for harvesting of wood and absorb the harvesting costs. While harvesting, the wood above the ground only is cut in order to allow coppicing. When farmers feel that the coppicing ability declines, stumps are removed during harvesting. This happens either during the fourth of fifth harvest. The yield in the first harvest was always low and it tended to increase in subsequent harvest because of profuse branching after the first harvest. The yield was higher in the final harvest because of removal of stump with roots. Being a dry region, in this district farmers prefer to grow mango and tamarind in this dry lands as they need less attention and give sizeable annual income from fifth year onwards. For first five years, crops like millet (Ragi) and groundnut were cultivated under mango and tamarind. Income from these inter crops covered the establishment cost and variable cost for first five years. Economics of intercrops has been incorporated in the social benefit and cost analysis.

TABLE 3
PRIVATE BENEFIT AND PRIVATE COST

(In Rupees)

S. No.	Tree Crops	Discounted benefit (10 per cent)	Discounted cost (10 per cent)	BCR	NPV
1.	Subabul	42244	24505	1.72	17740
2.	Casuarina	74189	19635	3.78	54554
3.	Mango	247943	101589	2.44	146354
4.	Tamarind	155417	76939	2.02	78478

TABLE 4
SOCIAL BENEFIT AND SOCIAL COST

(In Rupees)

S. No.	Tree Crops	Discounted benefit (10 per cent)	Discounted cost (10 per cent)	BCR	NPV
1.	Subabul	53194	29795	1.78	23399
2.	Casuarina	85972	21955	3.91	62017
3.	Mango	265651	107972	2.46	157679
4.	Tamarind	169287	82797	2.04	85490

BCR and NPV result for analyzing private benefit and private cost are presented in Table 3. It has been evidenced from Table 3 Casuarina ranked first in private BCR analysis comparing with other tree crops. It might be dut to higher productivity (56.30 tonnes/ha) of Casuarina in short duration (6 years). Private NPV analysis showed that Mango topped the list due to sustahined production of fruits over a long period. Results of social benefit and social cost analysis are presented in Table 4. External benefits are higher in Mango and Tamarind and hence these crops were topping in the social benefit and cost analysis.

TABLE 5
EXTERNAL BENEFIT AND EXTERNAL COST

(In Rupees)

No.	Composition	Subabul	Casuarina	Mango	Tamarind
I	**Intangible cost**	5290	4320	6383	5858
	Cost of birds scaring	5290	4320	6383	5858

II	**Intangible benefits**	10950	11783	17708	13870
1.	Soil & Water Conservation	3214	4457	5706	7054
2.	Agricultural Productivity	1057	--	6072	4722
3.	Nitrogen fixation	2857	1507	1882	--
4.	Waste assimilation	2343	3782	2754	997
5.	Carbon store	1479	2037	1294	1097

From the Table 5, it could be seen that intangible cost included cost of birds scaring only. It was higher in case of Tamarind and Mango since these two crops provide shelter to birds, have longer gestation period and being fruit crops they attract more birds. Composition of Intangible benefits is presented in Table 5. Intangible benefits are realized due to soil and water conservation, agricultural productivity of intercrops, nitrogen fixation, waste assimilation and carbon store.

1CONCLUSION AND POLICY IMPLICATIONS

The economic valuation of agro forestry systems was dominated by intangible benefits (social benefits). In India the revenue from forests to the Government has declined heavily as a result of the introduction of various conservation measures during the last decade. Currently, the accounts in forestry sector show a net deficit. During 1985-90, the net revenue from the forestry in forestry sector was US$ 178723.40 million per year, which has turned to a net deficit of US$ 34042.55 million per year during 1990-94 (ICFRE:1997). This may be a fall out of increasing conservation activities. However, it may be noted that this estimate is mostly based on tangible benefits (timber and non-timber forest products), which is in most cases less than that of intangible benefits. The contribution of forests has to be looked into in a wider perspective by considering both tangible and intangible benefits when analyzing its benefits and costs.

Assigning monetary vlaue to intangible benefits of agro forestry makes more people to go for this system, which would facilitate the authorities to properly value the natural resources. Similarly the estimation of benefits generated by the agro forestry system and share received by local people may help the goverment to impost tax, which will help to enhance the conservation activities. As the contribution of various intangible benefit of agro forestry is often under estimated or ignored, the economic valuation of making. Major difficulties to achieve this task (i.e.,) the lack of appropriate methodologies so it is essential to develop economic valuation methodologies for the possible intangible benefits. it also justified the Government role in natural resources conservation activities. When social and environmental aspects are incorporated into the economics of agro forestry, the economic valuation of agro forestry is more profitable to the farming society and country.

REFERENCES

Barbier, E.B. 1991, The economic value of Ecosystems : 2 - Tropical forestsz. London Environmental Economic Centre. Gate Keeper Series No. 91-01.

Dean Current, Ernst Lutz and Sara Scherr (Eds.) 1995). Costs, Benefits and Farmer Adoption of Agroforestry Project Experience in Central America and the Caribeean A CATIE - IFPRI - World Bank Project, World Bank Environment Paper Number 14.

Dixon A. John, Louise Fallon Scua, Richard A Carpenter and Paul B. Sherman. 1994. "Economic Analysis of Environmental Impacts". Earthscar Publications Ltd., London.

Dixon, J.A. and Sherman, P.B. 1990. Economics of protected areas : A new look at Benefits and Costs. Earth Scan Publications Limited, London.

Government of Tamil Nadu 1998. "Season and Crop report of Tamil Nadu for 1997-98, Commissioner of Statistics, Madras.

Hyde William, F. 1998. "Demand - Side Management". In : C. Binkley, G. Brewer and V.A. Sample (Eds.). Redirecting the

RPA. New Haven : Yale University School of Forestry and Environmental Studies Bulletin 95.

ICFRE. 1997. Forestry Statistics in India 1988-94, Indian Council of Forestry Research and Education, Dehradum.

Krutilla John, V. 1967. "Conservation reconsidered" American Economic Review, 47 : 777-786.

Kuik, O.J., F.H. Oosterhuis and H.M.A. Jansen. 1992. Assessment of Benefits of Environmental Measures, Grahan and Trotman, London, for the commission of the European communities.

Manoharan, T.R. 1996. Economics of protected areas : A case study of Periyar Tiger Reserve Ph.D. Thesis. Forest Research Institute, Dehra Du.

Manoharan, T.R., Muraleedharan, P.K. and Anitha, V.1998. Economic valuation of non-market benefits. In : Muraleedharan, P.K., Subramanian, K.K. and Pillai, P.P. (Eds.), Basic Readings in Forest Economics, Kerala Forest Research Institute and the Ford Foundation, Peechi.

Markandya Anil, 1992. "The value of the Environment : A state of the art survey", in Anil Markandya and Julio Richardson (Eds.). 1992. Environmental Economics, Earthscan Publications Ltd., London.

Munasinghe, Mohan. 1994. "Economic and Policy Issues in Natural Habitats and Protected Areas", In Munasinghe, Mohan and Jeffrey McNeely (ed) 1994; protected Area Economics and Policy: Linking Conservation and sustainable development, World Bank and World Conservation Unions, Washington, D.C., U.S.A. pp.15-49.

Murty, M.N. and Susan M. Menkhaus. 1994. Economic aspects of wildlife protection in the developing countries: A case study of Keoladeo National Park, Bharatpur, India, Working paper series E/163/94, Institute of Economic Growth, Delhi.

Nadkarni, M.V. 1996. Forests, people and economics, Indian Journal of Agricultural Economics, 51 (122) : 1-24.

Nick Hanley and Clive L. Spash. 1993. "Cost-Benefit Analysis and the Environment", Edward Elgar Publishing Company, U.S.A.

Pearce, D. and Moran, D. 1994. The economic value of biodiversity. Earth Scan Publications Limited, London.

Ramasamy, C., Uma, K. and Sekhar, C. 2000. Prosopis for wastelands / drylands of Southern Tamil Nadu, Journal of Tropical Forest Products, 6(1) : 12-20.

Sedjo, Roger A., and Kenneth S. Lyon 1990. The long-term adequacy of World Timber Supply, Washington DC. Resources for the future.

Sekar, C. and Vinay Raj, R.S. 1993. "Comparative Economics of Trees and Agricultural Crops in Tamil Nadu". My forest, March 29 (1) : 53-58.

Smith V. Kerry, 1974. Technical Change, Relative Price and Environmental Resource Evaluation, Baltimore MD : Johns Hopkins University Press.

Smith V. Kerry ed. 1979. "Scarcity and Growth Reconsidered Baltimore, MD : Johns Hopkins University Press.

Subramanian, S.R., Ramasamy, C., Chinnadurai, C., Shanmugam, T.R. and Ashok, K.R. 1995. Study on Natural Resources Economics" Project report Department of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore.

Swaminathan, L.P. and Balaji, S. 1997. "A Socio Economic Analysis of Charcoal Production and Marketing in Tamil Nadu. Project report of Society for Social Forestry Research and Development in Tamil Nadu, Chennai.

Swaminathan, L.P. and Balaji, S. and Vidhyavathi, A. 1999. "Casuarina Production and Marketing in Tamil Nadu - A Socio - Economic Analysis" Indian Council of Forestry Research and Education and Tamil Nadu Agricultural University collaborative project report, Coimbatore.

William, F. Hyde and David H. Newman, with a contribution by Roger A. Sedjo, 1991. Forest Economics and Policy Analysis. An Overview, World Bank Discussion paper 134, Washington D.C.

THE USE OF REGRESSION ON DUMMY DEPENDENT VARIABLE TECHNIQUE IN THE NATURAL RESOURCE MANAGEMENT

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INTRODUCTION

In this article, the use of regression technique with dummy dependent variable is explained to identify the factors responsible for irrigation water transfer from agricultural to non-agricultural uses.

Globalisation of the national economy from agricultural sector to the industrial sector has resulted in resource transfer from rural to urban areas. In this context, one of the most important natural resources; water has been transferred from agricultural to urban use and it leads to decline in cultivable land area, cropping pattern change shortage of labour to agricultural activities and finally degradation of that particular region. Especially in the case of minor irrigation like well water to the non-agricultural use is remarkable, particularly private investment in groundwater development has contributed more as individuals own majority of the wells. In India, out of nine million wells, public wells accounts for only less than one per cent. There are several factors responsible for the rapid development of groudwater in the after green revolution period. The introduction of modern agricultural technologies in farming and rapid industrialization of economy are caused an over exploitation of groundwater potential by way of bore wells and other type of wells. The present level of utilization of groundwater potential is about 70 per cent in Tamil Nadu. Effect of groundwater diversion from agricultural to non-agricultural use

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that resulted in loss of irrigated agriculture, when seemed form the national perspectives such effects are substantial. Hence, in future the availability of irrigateion water irrigated agriculture and non-agricultural use poses a threat and if the water utilization in future will be in danger.

The main objective of the present work is to explain how regression technique with dummy dependent variable can be used in analyzing the factors responsible for the transfer of irrigation water from agricuture to non-agricultural uses.

PROBLEM TO BE INVESTIGATED

Tiruppur and Palladam taluks were selected based on the intensity of water transfers compared to other taluks and then Tiruppur, Palladam and Pongalur blocks were selected randomly. Ten villages in Tiruppur, Palladam and Pongalur blocks were selected in different directions and distances from Tiruppur municipality. Then 180 farmers were selected randomly from the selected villages and the selected farmers were post-stratified into three groups based on the distance of their fields from the town viz., inner (3-5 km radius), middle (6-10 km radius) and outer most rings (above 10 km radius). The sample was also post-stratified into small (< 2 hectares), medium (2-4 hectares) and large (> 4 hectares) farms to study the farm characteristics. The probit regression analyses has been used to analyze the sustainable management of water among agriculture and commercial sectors in Coimbatore district.

Economic theory holds that a farmer will sell his groundwater to urban used if it maximizes his discounted utility. Considering that the utility of a groundwater holder who does not sell and continues to employ his groundwater in agriculture, groundwater used in farming produces a stream of profits from the sale of crops in both the current and future periods. The value in today's rupees from this profit stream is determined by the discount rate and the farmer's planning scenario. Other factors such as the farm size and off-farm employment may also influence a households' utility level, from alternatives such as crop cultivation and / or sale of groundwater.

Annual farming profits are determined by crop choices and input intensity, which are inturn influenced by more factors, such as land characteristics and personal attributes of the farmers. The most important farm specific characteristics are water availability, labour problem and farm size, which may also affect farming profits due to economics (or diseconomics) of scale. As for the discount rate, a high discount rate is consistent with a debt problem or difficulty in obtaining credit. An individual's characteristic also affects the present value of groudwater sales.

Farming requires lot of production inputs other than water and the decision to sell ground water, which is a decision to reduce production or to entirely leave farming due to less remunerative needs that these other production inputs be reallocated.

The present study considered the following factors, which might have contributed for groundwater holders' decision to sell water to the urban uses: (i) low annual farm profit per unit of water applied; (ii) uncertainities in groundwater supply; (iii) increased industrialization and urbanization; (iv) high value of labour in off farm sectors of the economy; (v) concentration and localization of groundwater buyers; and (vi) access to road and transportation.

Soil quality, off farm employment, labour problem, groundwater availability, ownership of tankers/dyeing units and other characteristics such as well ownership are described as discrete variables and continuous variables such as farm family size, distance to the town/city, farm size and on-farm income all affects the level of groundwater sales.

Soil quality is one of the principal determinants of farm profit. Here soil type was used as a weighted averaage of each owner's acres in land capability classification given by Soil Atlas, Coimbatore District, Soil Survey and Land Use Organization, Department of Agriculture, Tamil Nadu, Coimbatore.

Distance from the city/town has important implications for water quality and availability of groundwater and farms on the periphery of the city/town are having groundwater with low in quantity and quality aspects. Hence the distance in kilometers to the city will indicate the level/intensity of quality deterioration of groundwater. This measure also explains the difference in productivity and finally farm profits. Water availability, distance to the main irrigation canal or perennial irrigation source and to the city/dyeing and processing industries, high labour wage rate and acres owned will affect the level of annual farm profits. Water availability is also another principal determinant of farm profitability. The general relationship is explained as follows:

MODEL SPECIFICATION

The decision to sell groundwater to industrial / urban may be characteristised as a dichotomous choice between two mutually exclusive alternatives. Assuming that each well owner has well defined utility function over the participation choice, an owner will compare the utility from participation to that of non-participation. Defining the utility 'U_1' if an owner decides to sell his water rights and utility 'U_0' otherwise. The utility of either choice is defined from the economic and non-economic factors plus a random error.

$$U_{io} = X_1 \gamma_0 + e_{i0}$$

$$U_{i1} = X_i \gamma_1 + e_{i1}$$

Mathematically,

$$I = \gamma_0 + \gamma_1 X_1 + \text{............} + \gamma_n X_n \text{ ....(1)}$$

and $Y = g(I)$

Where

$Y = 1$ if $I > I^*$

$Y = 0$ if $I < I^*$

'I' is the index reflecting the combined effect of 'X' factors that prevent of promote participation in water selling this index level 'I' is not observed. What is observed is whether the farmers participation in groundwater selling (Y=1), when 'I' exceeds the threshold level I* otherwise the farmers do not participate in groundwater selling over the doing agriculture, (Y=0) when 'I' falls short of I*. Now probability of getting a positive response (Y=1) is given by

$Y = F(I/\sigma) = F(Z); Z - I\sigma$

$$\frac{\partial F(Z)}{\partial Xi} = f(Z)^* \frac{\gamma_i}{\sigma}$$

Where,

I = is as defined in (1)

σ = is the standard error of estimate and F(Z) is the area under cumulative normal distribution function.

The choice probability must lie between zero and one. However, the index 'I' is in the range ($-\alpha$ to $+\alpha$). Size F(Z) gives only the probability of participation, the elasticity gives the percentage change in the choice probability in response to a percentage change in the explanatory variable.

$$\eta = \frac{fF(Z)}{fX_i} * \frac{X_i}{F(Z)}$$

Where,

f(Z) = value of the 'Y' oridinate of the cumulative normal density function at 'Z'

γ_1 = Probit (regression) coefficient of the i^{th} variable for which the elasticity is to be worked out.

The probit equation was fitted to find out the factors affecting the groundwater transfer from agriculture to urban uses.

WSALES = f (FSIZE, DIST, ONFINC, OFFFEMP, LABOR, GWAVAIL, OWNERSHIP, SQLTY)

Where,

WSALES = Groundwater sales (Selling = 1 and Non-selling = 0)

FSIZE = Farm size (ha.)

DIST = Distance from farm to city/town (kms)

ONFINC = On-farm income (Rs./ha.)

OFFFEMP = Dummy for off-farm employment

LABOR = Represented by ratio between agricultural wage and industrial wage

GWAVAIL = Groundwater availability measured as a ratio between days of well water availability and crop duration in days

OWNERSHIP = Dummy for well ownership (if, own well = 1; jointed well = 0)

SQLTY = Dummy for soil quality (if, good=1; bad = 0)

This model measures not only the change in the probability of selling water but also the change in intensity of water selling and also to understand the motivation behind farmer perceptions towards water sales.

RESULTS AND DISCUSSION

Factors influencing the irrigation water transfer from agriculture to industrial uses

Groundwater market mechanism is becoming an important tool for reallocating water from agricultural to the industrial uses. Most economists presume that such urban water trading will be efficient, since groundwater holder reveals their valuations of water by selling to the industrial/urban uses. it induces the farmers to use water more efficiently by modern water saving techniques like drip irrigation for crop cultivation. Those with comparatively lower income from agriculture used to sell water to industrial/urban uses and others who realised higher efficiency in the water use remained in agriculture. However, the short-term valuations of water in agriculture based on the income realised are conditional on the personal and socio-economic characteristics of the concerned farmers. As a result, short-term valuations of water in agriculture may be different from long-term valuations that are determined mainly by the physical characteristics of the particular region and land, which will be discussed later.

The farm level survey data were used to estimae the Probit model that explains farmers' decision to sell water as a function of personal and farm characteristics. The exogenous variables used to explain the sales decision are farm size, distance to city, on-farm income, off-farm employment, labour scarcity, water availability, well ownership and soil quality.

The marginal effects of a change in one of the independent variables on the probability of participation are calculated at the mean of each variable and are presented in Table 1. The corresponding elasticities (the percentage change in the probability of selling given a 1% change in the value of the variable) are given for the continuous variables, as is the difference in the probabilities as a discrete variables changes from zero to one.

The overall fit of the statistical model is good. Tables 1 and 2 present the model estimates. Influence of the relevant characteristics on water selling and their significance are explained by the estimated coefficients of the model. However, the elasticity estimates has shown the inelastic responses to the changes in farm size, on-farm income, labour scarcity, water availability, well ownership, distance to city, off-farm employment and soil quality characteristic. Farm sizes significantly and positively influenced the water sales and for each hectare of additional holding by a seller, the probability of water selling would increase by 0.246 per cent on an average for the entire sample. This suggests that a 10 per cent increase in the farm size characteristics by expected to result in about 2.46 per cent increase in the participation in water selling by the sample farmers.

TABLE 1

Results of elasticity decomposition for changes in the water sales characteristics perceived by sellers

Variables	Estimated Coefficients	Standard Errors	T-ratio	Marginals	Elasticities
Constant	0.1389	0.5970	0.2327	0.0433	
Farm size	0.1248***	0.0311	4.0123	0.3887	0.2456
Distance to City	0.0812***	0.0338	2.404	0.3463	0.3233
On-farm income	-0.0005***	0.00007	-6.0235	0.0189	-0.6019
Off-farm employment	0.0878**	0.2890	2.3037	0.0189	0.0160
Labour Scarcity	0.2178NS	0.2980	0.7309	0.0498	0.4159
Water availability	-0.5651*	0.2928	-1.9301	-0.1175	-0.0940
Well ownership	0.1442***	0.2902	2.4968	0.0312	0.0259
Soil quality	-0.6795*	0.3421	-1.9864	-0.1460	-0.1208
Log-likelihood function					-60.80
Restricted log liklihood					-110.79
Likelihood ratio test (χ)					99.96

Note : ***-1%, **-5%, *-10% level significance and NS - non significant.

The elasticity of the distance to city variable has shown that one kilomete increase in the distance of the farm from city would result in 0.323 per cent increase in the probability of participation in water selling. It might be expected that land closer to city could be sold for urbanization and industrial development and groundwater source available within the short distance would be of poor in quality (TDS > 1200 mg l^{-1}), which would not suitable for dyeing processes. Hence, water has been transferred from the farms, located faraway and with good quality groundwater.

Owners whose major occupation was farming have been less likely to participate in the water selling. A 10 percent increase in the on-farm income is expected to result in about 6.02 per cent decrease in the probability of participation in water transfer. When farming is the major occupation as well as when profitability from on-farm activities is higher, which in turn made the farmers less reliance on income from water sales.

Off-farm employment opportunity significantly influenced the farmer participation in water selling. The probability of participation in water sales could increase by 0.016 percent as off-farm employment increases. A 10 percent improvement in the case of groundwater availability characteristics is expected to result in 0.94 decreases in the participation in water sales by the farmers. The water availability will increase the farming activities such as vegetables cultivation as the farms close to city center's would get remunerative price than selling water.

Ownership of well has the largest influences on participation in water sales. A one per cent increase in ownership of well has the impact on the probability of participation by 0.0259 per cent.

Owner farm with good soil is less likely to sell their water than those with land of poor quality. The elasticity of probability of participation in water sales could fall by 0.1208, as soil quality is good. This result is intuitive since owners of low quality farmland might have lower yields and hence lower revenues, thus making agriculture less profitable.

Difference among water sellers and non-sellers with respect to labour scarcity is not significant. They might still however, have indirect influences on water sales. Interview with sellers revealed that these factors did motivate few farmers to sell their water to the industrial uses.

REFERENCE

Alley, W.M. and J.A. Schefter, "External Effect of Irrigators Pumping Decisions in the High Plains Aquifer", **Water Resources Research**, 23(7) : 1123-1130, 1987.

Baumol, W.J., "External Economics and Second Order Optimality Conditions", **American Economic Review**, 54(2): 358-372, 1964.

Bhatia, B., "Lush Fields and Parched Throats : Political Economy of Groundwater in Gujarat", **Economic and Political Weekly**, 27(51&52) : A142-A170, 1992.

Billings, R.B. and D.E. Agthe, "Price Elasticities for Water : A Case of Increasing Block Rates", **Land Economics**, 56(1) : 73-84, 1980.

Bredehoeft, J.D. and R.A. Young, "The Temporal Allocation of Groundwater - A Simulation Approach", **Water Resources Research**, 6(1) : 3-21, 1970.

Buchanan, J.B. and W.C. Stubblebine, "Externality", **Econometrica**, 29(4) : 371-384, 1962.

Carruthers, I., "Introduction : Public Sector Opportunity and Limitations in Ground water Development", **Agricultural Administration**, 16(1) : 169-180, 1984.

APPLICATION OF TRANS-LOG COST FUNCTION FOR INVESTIGATING THE SUBSTITUTION POSSIBILITIES

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INTRODUCTION

The per capita availability of water in India was 1353 m^3 in 1981 and it may dwindle to 910 m^3 in 2001. Rapid population growth coupled with poor water management had led to this unenviable situation. The demand for water currently estimated at 75 m.ha.m.is expected to rise to 105 m.ha.m in another 25 years. That is almost all the utilizable potential will have to be harnessed to meet the demands for agriculture, industry, energy generation and domestic consumption. Since the water demand of the non-agricultural sectors will finally have to be met by reduction in agricultural demand, increasing water use efficiency in agriculture is a matter of priority. Even among the user sectors, the consumption of water in India is highly skewed. In many parts of the State, the groundwater resource is said to be overexploited leading to certain undesirable consequences such as salt water intrusion in coastal areas, depletion of underground aquifers leading to secular lowering of groundwater table, thus jeopardizing the present and future water supplies for agriculture, increasing migration and unemployment etc., especially in those areas where surface water supplies are insignificant.

Also, groundwater pollution and quality need to be recognized as point of environmental significance. On one level, pollution and water quality affect the usability of groundwater resources for domestic, industrial, or agricultural applications. If groundwater becomes degraded, human demands will focus on

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other resources such as surface streams, with potentially huge secondary impacts. On another level, groundwater quality and pollution have direct implicaitons for the environment. In this context, it is imperative to take up a study on analyze the subsitution possibility for water with other production inputs in the bleaching and dyeing industries. The present study was taken up in Tiruppur city of Coimbatore district where large quantity of water has been used by the bleaching and dyeing industries over years resulting in pollution hazards and reduction in irrigated area in and around the Tiruppur city.

OBJECTIVE

The present study aims to:

* Investigate the substitution possibilities between water and other production inputs for the aggregate bleaching and dyeing industries, and
* Suggest policy options for effective allocation of scarce groundwater to agriculture and urban/industrial uses.

HYPOTHESIS

Based on the above objectives, the following hypothesis has been formulated for empirical verification:

* There is very good scope for substituting the water in industry with other production inputs.

METHODOLOGY

STUDY OF BLEACHING AND DYEING INDUTRIES

Most of the bleaching and dyeing units were linked to the overall knitwear industry through job-work basis. The survey conducted indicated that while about three fourths of the bleaching and dyeing units were taking up only contract works, which receive cloths from other manufacturers in the knitwear industry, the remaining one fourth units were independent producers. Generally, this type of producers was a large firm and they involve in all the activities of the knitwear industry. These firms have been vertically integrated in the knitwear manufacturing.

A survey of non-random sample of 40 bleaching and dyeing firms were taken up. the Tiruppur Bleachers' and Dyers' associations were contacted to ensure that the sample captured firms of different sizes, processes, and effluent treatment decisions. Primary data collection has involved both interviews and a firm-level survey to collect both quantitative and qualitiative data. Information on processes involved in bleaching and dyeing, investment patterns and reaction to environmental regulations were collected through personal interview of individual units.

APPLICATION OF TRANS-LOG COST FUNCTION

The economics of water use in different sectors of the economy is a metter of continuing important for water resource planners and policy makers. Generally when projecting future demands for water, people will assume of constant coefficients. Despite the truth that virtually every one agrees that projection of the future industrial water requirements needs analyses as an individual industry-wise assessment of available, emerging and potential water use technologies and other potentials for substituting other factor inputs for water in the production process.

Keeping this in mind, focusing the importance of examining water substitution in production process will be an interesting aspect of inquiry. But there is other way to know the extent of substitution in industrial water demand through econometric analysis of aggregate industry data. In this study, an attempt was made to estimate the elasticity's of substitution between water and other production inputs for the aggregate dyeing and bleaching industries.

SUBSTITUTION FOR WATER IN PRODUCTION

The main aim is to examine the extent to which conventional inputs such as capital and labour would be substituted for the water input in production. Two types of substitution away form water withdrawals are possible.

i) Industry might utilize existing technology to design and install production processes use less water per unit of output.

   * The extent to which this is possible would depend on current stock of technical knowledge.

ii) Recycling might reduce withdrawals.

   * Recycling may be viewed as the substitution of capital, labour, energy and other materials used in recovering and treating wastewater for the withdrawal of new water.

Engineering-economic studies would differentiate between these two substitutions. The econometric approach, however, would explain the combined effects of the different sources of substitution without identifying the separate contribution of each. this perspective seems mostly appropriate if it is more concerned with estimating the total effects of such changes in water prices or in interest rates/investment.

The substitution possibilities also require the consideration of time horizon. In the short run, curtailments in the water supply likely would effect on production because current processes have specified water use characteristics. In the very long run, the application of advanced dyeing machine or more labour or other materials is possible to insure the msot efficient uses of existing supplies of water given a cosntant capital stock. This implies that limited possibility for substitution in the short run and a greater potential for substitution would exist in the long run. In the very long run sufficient to invest entirely new techniques/rapid dyeing technique, substitution possibilities presumably would be the highest of all. The empirical analysis was done based on cross section data that relate to the range of production technologies currently under use.

MODEL SPECIFICATION

To model the dying and processing industries assumed that it is characterized by a positive, strictly quasi-concave, monotonic and twice differentiable production funciton.

$$Q = Q(K, L, W, X1, X2 ....Xn)$$

Where, Q is output; K, L, W refers to inputs of capital, labour and water respectively and the Xi, i = 1, ... n are all other inputs. This funciton gives the maximum output of the manufacturing sector for any specified levels of the various inputs used in the sector, and the assumptions serve to give it economically relevant characteristics such as smooth and concave production iso-quants. In this analysis is only limited to dyeing and processing industries becasue of data availability.

The economic theory of duality implies that the characteristics of (i) may be represented by a cost function of the form.

$$C = C(Q, P_k, P_l, P_w, P_{X1}, P_{X2} ....P_{Xn}) .... \text{(ii)}$$

Where C is total cost and the P refer to prices of the subscripted inputs. Duality also implies that

$$\partial c/\partial p_i = Z_i, i = K, L, W, 1, 2, ...n \quad .... \text{(ii)}$$

Where Z_i is the cost minimizing quantity demanded of the i^{th} input. In the following analysis we make use of the cost function rather than the production function. This method has become widely employed in many studies of this type because it is easier to assume that prices are exogenous to firm's decision-making rather than quantities on inputs.

In order to reduce the problem to manageable proportions it is assumed the displays constant returns to scale. Also, assumed that the dyeing and processing production process is separable in K, L and W. This implies that the relations among inputs of capital, labour and water are unaffected by the levels of use of any other input, and thus permits to examine these relations in isolation from these other inputs. This assumption is forced due to data availability. With the background of these two assumptions, the Trans-log (transcental logarithmic) cost function is written as

$$\text{In } C = \text{In } \alpha_0 + \sum_i \alpha_i \text{ In } P_i + 1/2 \sum_i \sum_j \gamma_{ij} \text{ In } P_j \text{ ....(iv)}$$

where i.j = K,L,W

Linear homogeneity in prices implies

$$\sum_i \alpha_i = 1 \qquad \text{......(v)}$$

$$\sum_i \gamma_{ij} = \sum_j \gamma_{ij} = 0$$

Also, by twice differentiability of the production function, then

$$\gamma_{ij} = \gamma_{ji} \qquad \text{.......(vi)}$$

Differentiating (iv) logarithmically and using (iii) give

$$\frac{\partial \text{ In } C}{\partial \text{ In } P_i} = \frac{\partial C}{\partial P_i} = \frac{P_i}{C} = \alpha_i + 1/2 \sum \gamma_{ij} \text{ In } p_j \text{ ....(vii)}$$

Where i, j = K, L, W

Expressions (vii) gives three input funcitons:

$$M_W = P_W \text{ (W/C)} = \alpha_W + \gamma_{KW} P_K + \gamma_{LW} \text{ ln } P_L + \gamma_{WW} \text{ ln } P_w$$
$$M_L = P_L \text{ (L/C)} = \alpha_L + \gamma_{KL} P_K + \gamma_{LL} \text{ ln } P_L + \gamma_{LW} \text{ ln } P_w \text{ ......(viii)}$$
$$M_K = P_K \text{ (K/C)} = \alpha_K + \gamma_{KK} P_K + \gamma_{KL} \text{ ln } P_L + \gamma_{WW} \text{ ln } P_w$$

Where M_W, M_L and M_K , are the cost shares of capital, labour and water resspectively.

To estimate system of equation (viii) an error term was added to each input share equation that essentially registers errors in cost minimizing behavious. Since $\Sigma M_i = 0$, however, the variance co variance matrix to these errors will be singular. This requires that drop one equation from the system to be estimated; in this study the third equation (M_K) was dropped, obtaining its coefficients via conditions (v) and (vi) after estimating the first two equations. Even the errors on the first two equations are likely to be correlated because, for example oversue of that input would often be assocaited with under use of another input. It has thus become common when using this approach to utilize simultatneous estimating techniques like the Zellner approach to generalize least squares, which yields more efficient estimates in this condition. It is necessry to ensure that the estimates are not sensitive to the particular euation chosen to be drop from the estimation procedure. This implies that miximum likelihood estimation procedure has tobe used for estimating the system of equations. Interating through the Zellner procedure provides maximum likelihood estimates and it is an efficient method of estimating the coefficients of the share equations.

The non-normalized price elasticities to represent substitution possibilities. Thus, price elasticity (η_{ij}) is the percentage change in the quantity of the i[th] input resulting from a one per cent change in the price of the j[th] input; out put being constant. It has been shown that these can be derived as follows:

$$\eta_{ii} = (\gamma_{ii} + M_i^2 - M_i) / M_i \qquad i = K, L, W$$

$$\eta_{ij} = (\gamma_{ij} + M_i M_j) / M_i \qquad i, j = K, L, W \quad \text{...........(ix)}$$

The price elasticities are non-normalized and non-symmetrical. The empirical observations consisted of industry data for 40 dyeing and bleaching industries for 1999 and water withdrawals for these sectors in quantity terms (liters). To proceed with the analysis, it is necessary to get data on labour and capital inputs price and price of water. The quantity of labour is taken as the number of employees in each industry and the contribution to the total cost is taken as the corresponding payroll. Data on total quantity of capital for dyeing and bleaching industries were collected and price of capital form commercial banks, SIDBI (Small Industries Development Bank of India) and interest offered in informal capital markets also collected from firms. Another information needed for the analysis is the price of water.

To find the cost of water to each indutry, these prices were multiplied by the quantity of withdrawals mentioned earlier. The water prices represent, of course, a very high degree of unrealistic, since study has been conducted where water scarcity is very high. It is also true that many firms, particularly those that use large quantity of water, will produce and transport their own. This does not mean that cost of water is lower to those firms; since they have to invest heavily on making their own supply of water in terms of purchase of land, digging well, investment on machinery's etc. Generally, water prices are average figures, based on the ratio of total costs and quantity. As such they may not accurately reflective of marginal water cost. This problem is widely encountered in studies of natural resources economics.

RESULTS AND DISCUSSION

The bleaching and dyeing of cloth and thread are key intermediate processes in garment production. Consequently, the bleaching and dyeing industry growth has paralleled that of the overall knitwear industry. The city has grown from less 100 firms in the early 1980s to 866 firms in 1996. About 180-250 firms are engaged only in bleaching the cloth, and are commonly referred as "bleachers". the remaining firms are engaged in dyeing or both bleaching and dyeing. They are commonly grouped together and referred to as "dyers".

Most of the bleaching and dyeing units are linked to the overall knitwear through the job-work basis. Three fourth (75 per cent) of bleaching and dyeing units are taking only contract works, who receive cloths from other manufacturers in the knitwear industy, while one fourth (25 per cent) are independent producers and generally this type of producers are big firms, which are vertically integrated in the knitwear production.

Substituting for Irrigation water in Bleaching and Dyeing Units with Other Production Inputs using Trans-log cost function

Since most of the inputs are water derived, in the sense that water is the key input in the bleaching and dyeing industries and labour and other inputs are necessarily derived from the demand for water in these industries. However, it is important to examine how the water use could be minimised to the extend possible as well as to reduce the pollution hazards. This means that substitution possibilities shoudl be explored in the bleaching and dyeing industries. The trans-log cost function was used to analyse the substitution possibilities.

Table 1

Estimated Coefficients of Trans-log cost functions containg water, labour and capital inputs in dyeing industries

S. No.	Variables	Regression coefficients	t-value	Level Significance (%)
1.	Constant	-5.8842 (1.2330)	-4.772	1
2.	W	0.05890 (0.014205)	4.1466	1
3.	L	1.09168 (0.42234)	2.585	1
4.	K	1.77295 (0.34752)	5.102	1
5.	WW	0.03256 (0.002477)	13.147	1

6.	WL	-0.02951 (0.003236)	-9.121	1
7.	WK	-0.0008998 (0.001999)	-0.450	NS
8.	LL	-0.01476 (0.03591)	-0.411	NS
9.	LK	-0.06877 (0.06181)	-1.113	NS
10.	KK	-0.11477 (0.04966)	-2.311	5

Figures in parentheses indicates the standared errors

The results are presented in Tables 1 and 2. Most of the estimated coefficients are highly significant and share of water in the total cost is significantly high. Inputs cost share are given by the intercept terms. The share of water is 3.54 per cent. Table 2 give the own and cross-price elasticities of input demand estimated. These elasticities were calculated at the mean input cost shares. All of the estimated elasticities are significantly different from zero. The value for the own price elasticity of demand for water is-0.0448. This value may be small and in fact that these are output-constant price elasticities of input demand and they probably understate the true elasticiteis where the effect of input price changes on output price is taken into account. This is likely to be an under estimation for inputs having a large proportion of total cost, such as labour. But the water input accounts for a small proportion of total cost in the function. Water has maximum share of only 12 to 18 per cent. It is unlikely that changes in the price of water input would have much impact on output price; hence for water the constant-output price elasticity of input demand may not be a serious underestimate of the true elasticity.

Table 2

Estimated constant - output price elasticities of input demand for dyeing industries

S.No.	Particulars	Elasticities
1.	Water	-0.044826
2.	Labour	-0.400401
3.	Capital	-0.994933
4.	Water-Capital	0.315902
5.	Water-Labour	-0.210336
6.	Capital-Labour	2.640741
7.	Capital-Water	0.026464
8.	Labour-Water	-1.023658
9.	Labour-Capital	0.230984

The cross price elasticities between water and other two inputs such as capital and labour were calculated. The water-capital, capital-water, labour-capital and capital-labour elasticities are all significantly positive, inplying that capital is good soubstitute for water and labour in production. But the labour-water and water-labour elasticities are significantly negative. Negative cross elasticities indicated complementarity rather than substitutability as the price of labour decreases. The usage of capital increases, while that of both wate and labour decrease. The result of present study would indicate the possibility of substitution between water and capital.

Water and labour inputs are viewed as bundle of inputs in many industrial process and within this combination, water and labour are substitutable. If price of another input, e.g., capital increases, both labour and water are also increased. The results had shown that labour-water complementarity reflected the dominance of this labour-cum-water phenomenon in the case of traditional (winch type) dyeing industries.

The policy implications of these findings are very important. The finding implies that production processes were to become more capital intensive in response to lower relative prices of capital in the long run. They would be characterized by a decrease in water coefficients. Thus, the subsidies used in the Indian industrial development to motivate or stimulate capital investment, such as tax incentives, have worked out to increase disproportionately the dependency of the bleaching and dyeing sectors on water withdrawals. Similarly, increase in interest rates, other things being equal, will lead to increase in water coefficients. In the study water price data used are highly disaggregated and based on the assumption that two type of production functions exist for all bleaching and dyeing industries viz., one is traditional with type and second one is modern compact dyeing machine.

CONCLUSIONS

The bleaching and dyeing of cloth and thread are key intermediate processes in garment production. Consequently, the bleaching and dyeing industry growth has paralleled that of the overall knitwear industry. In the case of bleaching and dyeing industries, total investments in very small units were relatively smaller than in larger units, compared to processing capacity.

The own and cross-price elasticities of input demand were estimated. These elasticities were calculated at the mean input cost shares. The value for the own price elasticity of demand for water was -0.0359. The cross-price elasticities between water and the other two inputs such as capital-labour were calculated. The water-capital, capital water, labour-capital and capital-labour elasticities were all significantly positive, implying that capital is good substitute for water and labour in production. But the labour-water and water-labour elasticities were significantly negative. Water and labour inputs are viewed as bundle of inputs in many industrial processes and within this combination, water and labour are substitutable. If price of another input, e.g., capital increases, both labour and water are also increased. The results has shown that labour-water complementarity reflects the dominance of this labour-cum-water phenomenon in the case of traditional (winch type) dyeing industries.

POLICY RECOMMENDATIONS

* It could be concluded from this study that there was high rate of groundwater transfer from agriculture to industrial uses would lead to over exploitation of groundwter resource in the study area. Since already study area has been failing under dark category. So, there is need for comprehensive approaach to harness the available surface water sources and rainwater harvesting should be spread out, as to groundwater recharge could be increased.
* The bleaching and dyeing industries need to be encouraged to invest more capital substituting for water, to install "soft flow" dyeing machines to reduce water use and concentration of chemicals in the effluent wastewater.

REFERENCES

A.D. Mohile, T.S. Bathija and V.K. Jyothi, "A Futuristic Perspective Plan for Water Resource Development vis-a-vis the Agricultural Requirements", Journal of Indian Water Resources Society, 2(1) : 1-7, 1996.

A.M. Zellner, "An Efficient Method of Estimating Seemingly Unrelated Regression and Tests for Aggregation Bias" Journal of America Statistics Association, 57 : 585-612, 1962.

B.D. Dhawan, Studies in Minor Irrigation, (New Delhi : Commonwealth Publishers, 1990, pp.20-57).

James M. Henderson and Richard E. Quandt, Microeconomic Theory - A Mathematical Approach (Singapore : McGraw-Hill, 1988, pp.16-20).

Ministry of Water Resources (MOWR), "World Bank India Water Resources Management Sector Work, Report of the Sub-Group on Groundwater" Government of India, New Delhi, 15-40, 1991.

R. Balasubramanian, "An Enquiry into the Nature, Causes and Consequences of growth of Well Irrigation in a Vanguard Agrarian Economy", (Unpublished Ph.d. thesis submitted to the Department of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore, 1998) pp.137-218.

R.K. Sivanappan, Land and Water Resources and Rural Development In India : Situation and Prospects. Tema V Report 16, Department of Water and Environmental Studies, University of Linkoping, Sweden, pp.3-9, 1991.

R.Repetto, The "Second India" Revisited : Population, Poverty and Environmental Stress Over Two Decades, Washington, D.C. : World Resource Institute, 1994.

R.S. Saksena, "Present Status of Groundwater Management in India and Perspectives for the Future", Paper Presented in the Workshop on Efficiency and Equity in Groundwater Use and Management, Institute of Rural Management, Anand, India, 1989.

The World Bank Report on Groundwater Regulation and Management, Water Resource Management, India, South Asia Rural Development series, (New Delhi : Allied Publishers, 1999) pp.9-30.

TECHNIQUE TO STUDY THE CROPPING PATTERN

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INTRODUCTION

Agriculture is the backbone of Indian Economy. Agricultural sector offers employment opportunities to a major proportion of the world's population. In the field of agriculture one could notice few alarming changes. They are, first, the declining man - loud ratio due to increasing population, secondly declining culturiable land due to rapid industrialisation, urbauisation and increasing waste laud and thurdly change in the clopping pattern.. Food crops are being replaced by perenuial crops like coconeit. Under thus sibiation the scientists owe a major responsibility to the society. They have to identify the existing situation and suggest measures to preserue the agriculture to provide food to the teeming millions. A note on the population of India reveals that between 1971 and 2001 within a period of 30 years population has nearly doubled that is it has increased from 548.2 millions (1971) to 1027.0 (2001) millions. But declinuing culturated laud, increasing fallow lauods and a change in cropping pattern may lead to insecurity of food. Under the circumstance there is a need to undertake studres on various agricultural phenomenon which finally aeims at planning of agricultural development.

Scientists are in need of simple and fruitful techniques. Any research has planning and development as its main scope. Another important component is Spatial analysis. Earlier Geographers were mainly concerned with spatial analysis as their major approach. But of late the introduction of Remote sensing technology has brought spatial analysis under the purview of all disciplines. Spatial

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analysis may be termed as the analysis of the selected variable with reference to its spatial distribution.

In the field of agriculture one is compelled to make a spatial analysis of any phenomenon that is selected for observation. Agriculture phenomenon namely cropping pattern could be successfully undertaken only through spatial analysis.

CROPPING PATTERN

The study on cropping pattern is essential to understand the existing spatial pattern of distribution of crops. This will help one to suggest the potential crops for that area so as to attain OPTIMUM LANDUSE. An effecture technique is needed to understand the cropping pattern. In thus paper an account of the methodology to study cropping pattern is presented the methodology involves the collection of data on acreage under selected crops in any areal unit. Areal unit refers to the spatial unit of observation. It may be a village or a panchayat union or a taluk or a district. Depending upon the area of observation it may be classified into microlevel, mesolevel and macrolevel. For the purpose of ease it may be assumed that district level data for Tamil Nadu State is collected. The cropped area of individual crops may be calculated as percentage to the total cultivated area of each of the district. (Table1). The values calculated thus may be classified on the basis of logically selected scale into low, moderate, high and very high. The cropped area may be mapped on a Tamilnadu map with district boundary using proportionate symbols. The map will show the spatial pattern of distribution of the selected single group. This will be helpful in understanding the physical, social, economic and technological factors that have determined the spatial pattern of distribution of the particular crop. We are interes led in understanding the cropping pattern of a particular area rather than to confine the analysis to a paragraph single crop. Cropping pattern may be defined as the association of different crops over a space at a particular point of time. One could select the major crops in an area and collect district wise data for a particular point of time. The cropped area may be calculated for the selected crops as percentage to the total cultivated area of the respective district and mapped. These maps will help us to understand the spatial pattern of distribution of individual crops. Since our objective is to understand the cropping pattern of the area we are in need of a technique that will present a picture of the cropping pattern of that area. This could be achieved with the help of a semistatistical technique namely Ranking technique.

RANKING OF CROPS

Crop ranking refers to the ordering of the cropped area in a descending order. The top rauking crops may be identified as the major crops of that area. This is done by using the calculated cropped area of the selected crops.

ILLUSTRATION

The following illustration explains the calculation of Paddy cropped area in ten districts of Tamilnadu.

Cropped area = Area imder a crop / Gross sown area x 100

Table - 1
Paddy Cropped area

District	Gross Sown Area (Hectares)	Paddy Area (Hectares)	Paddy Cropped Area (in Percent)
1	198543	144902	72.98
2	295192	113839	38.56
3	380552	158643	41.69
4	255283	49868	19.53

5	358003	17875	4.99
6	201384	80907	40.18
7	168256	99114	58.81
8	267850	188910	70.53
9	165211	82325	49.38
10	303848	28341	9.33

Table 2

Crop ranking for a district

Crop	Cropped area	Rank
Paddy	49.83	1
Cholam	5.20	5
Cumbu	1.09	8
Pulses	6.51	2
Sugarcane	4.74	7
Groundnut	5.14	6
Gingelly	1.05	9
Coconut	5.88	4
Cotton	6.15	3

Crop ranking table

Rank	Crop	Percentage
1	Paddy	49.83
2	Pulses	6.51
3	Cotton	6.15
4	Coconut	5.88
5	Cholam	5.20
6	Groundnut	5.14
7	Sugarcane	4.74
8	Cumbu	1.09
9	Gingelly	1.05

written. The crop-ranking table will show the significance of that crop and its cropped area. Now crop rank maps could be prepared. Generally arbitrary method is used in mapping. Either three ranks of five ranks are selected for mapping. The crops are assigned some symbols and these symbols will be used to represent the particular crop in the particular district. The First ranking crop map will show that distribution of first ranking crops in the districts of Tamilnadu. Similarly the second, third, fourth and fifth ranking crops may be shown in maps. The disadvantage of this method is that one could not arrive at a concrete conclusion of the major crops in an area. Hence there is a need to use a statistical technique to arrive at a conclusion on the cropping pattern of an area. John C.Weaver fulfilled this in the year 1954. He introduced a statistical technique to identify the significant crops of an area by calculating the CROP COMBINATION for that area. Crop combination analysis is useful in identifying the

CROP COMBINATION ANALYSIS

Modern techniques for classifying land use and delimiting relatively small-scale agricultural regions have stemmed from the work carried out by Weaver, J. (1954) on the crop and livestock patterns of the American Middle West. Weaver, J. is of the opinion that crop combinational analysis provides an adequate understanding of an individual crop geography. He further says that crop combination in itself is an integrative reality that demands definitions and distributional analysis and lastly crop combination regions are essential for the construction of still more complex structure of valid agricultural regions. The study of cropping pattern forms the basis for delimiting crop combination regions.

WEAVER'S MINIMUM DEVIATION METHOD

Weaver, J. (1954) calculated the deviation of real percentages for all the possible combinations in the unit against a theoretical standard.

The theoretical values assumed by Weaver are as follows:

Mono crop	100%
Two crops	50.0%
Three crops	33.3%
Four crops	25.0%
Five crops	20.0%
Six crops	16.66%
Seven crops	14.3%
Eight crops	12.5%
Nine crops	11.1%
Ten crops	10.0%

Weaver used a formula to delimit the crop combination regions,

$$\delta = \Sigma d^2/n$$

δ = Value of the crop combination

d = The difference between the actual percentage in a given unit and appropriate percentages in the theoretical standard

n = The number of crops in a given combination.

The smallest variance of the various combinations is considered to be the actual crop combination of the area under study.

Weaver's method though seemingly simple involves much calculation and most of the time only a generalized result is obtained. Weaver's method of crop combination analysis is illustrated in Table 3 using the selected example for crop ranking.

Table - 3

Weaver's minimum deviation method

Theoretical value - Actual value	= d	d^2	Σd^2	$\Sigma d^2/m$
MOMOCROP				
100 - 49.83	= 50.17	2517.03	2517.03	2517.03
TWO CROPS				
50-49.83	= 0.17	0.0289		
50-6.51	= 43.49	1891.38	1891.41	945.70
THREE CROPS				
33.3 - 49.83	= 16.5	272.25		
33.3 - 6.51	= 26.82	719.31		
33.3 - 6.15	= 27.18	738.75	1730.31	576.77
FOUR CROPS				
25 - 49.83	= 24.83	616.5		
25 - 6.51	= 18.49	341.88		
25 - 6.15	= 18.85	355.32		
25 - 5.88	= 19.12	365.57	1679.3	419.83
FIVE CROPS				
20 - 49.83	= 29.83	889.83		
20 - 6.51	= 13.49	181.98		
20 - 6.15	= 13.85	191.82		

20 - 5.88	=	14.12	199.37		
20 - 5.20	=	14.80	219.04	1682.04	336.41

SIX CROPS

16.67 - 49.83	=	33.16	1099.59		
16.67 - 6.51	=	10.16	103.23		
16.67 - 6.15	=	10.52	110.67		
16.67 - 5.88	=	10.79	116.42		
16.67 - 5.20	=	11.47	131.56		
16.67 - 5.14	=	11.53	132.94	1694.41	282.40

SEVEN CROPS

14.29 - 49.83	=	35.54	1263.09	
14.29 - 6.51	=	7.78	60.53	
14.29 - 6.15	=	8.14	66.26	
14.29 - 5.88	=	8.41	70.73	
14.29 - 5.20	=	9.09	82.63	
14.29 - 5.14	=	9.15	83.72	
14.29 - 4.74	=	9.55	91.20	1718.16
245.45				

EIGHT CROPS

12.5 - 49.83	=	37.33	1393.53
12.5 - 6.51	=	5.99	35.88
12.5 - 6.15	=	6.35	40.32
12.5 - 5.88	=	6.62	43.82
12.5 - 5.20	=	7.30	53.29
12.5 - 5.14	=	7.36	54.17

12.5 - 4.74	=	7.76	60.22		
12.5 - 1.09	=	11.41	130.19	1811.42	226.43

NINE CROPS

11.11 - 49.83	=	38.72	1499.24		
11.11 - 6.51	=	4.6	21.16		
11.11 - 6.15	=	4.96	24.60		
11.11 - 5.88	=	5.23	27.35		
11.11 - 5.20	=	5.91	34.93		
11.11 - 5.14	=	5.97	34.93		
11.11 - 4.74	=	6.37	40.58		
11.11 - 1.091	=	10.02	100.40		
11.11 - 1.05	=	10.06	101.20	1885.1	209.46

The variance is minimum for nine-crop combination. Hence all the crops are significant in the cropping pattern of this area.

DEMERIT

1. It involves laborious calculation
2. It gives generalized result

RAFIULLAH'S MAXIMUM POSITIVE DEVIATION METHOD

Rafiullah (1965) introduced a new deviation formula and his method may be applied to delimit the crop combination units. In Rafiullah's method, the differences of the actual values are calculated from the middle value of the theoretical value and the maximum deviation value gives the crop combination. His formula is as follows:

$\delta = \Sigma D^2p - \Sigma D^2n/N^2$

δ = Variance

D^2p = Positive difference from the middle value of the theoretical value

D^2n = Negative difference from the middle value of the theoretical value

N = Number of crops

THEORETICAL VALUE

MIDDLE VALUE

Mono crop	100 %	50. %
Two crops	50.0 %	25 %
Three crops	33.3 %	16.6 %
Four crops	25.0 %	12.25 %
Five crops	20.0 %	10.00 %
Six crops	16.66 %	8.33 %
Seven crops	14.3 %	7.15 %
Eight crops	12.5 %	6.25 %
Nine crops	11.1 %	5.55 %
Ten crops	10.0 %	5.0 %

Refiullah's technique is illustrated in Table 4.

Table - 4
Rafiullahs maximum positive deviation method

Actual value - Theoretical. value =

	d	d^2	Σd^2p	Σd^2n	$\Sigma d^2p - \Sigma d^2n/N^2$
MONOCROP					
49.83 - 50 =	-0.17	-0.029	-0.029	0.0291	= -0.029
TWO CROPS					
49.83 - 25 =	+24.83	+616.53	+616.53		
6.51 - 25 =	-18.49	-341.88	-341.88	274.65/4	= +68.66
THREE CROPS					
49.83 - 16.67	+33.16	+1099.59	+1099059		
6.51 - 16.67	-10.16	-103.23			
6.15 - 16.67	-10.52	-110.67	-213.90		885.69/9 = +98.41
FOUR CROPS					
49.83 - 12.5		+37.33	+1393.53	+1393.53	
6.52 - 12.5		-5.99	-35.88		
6.15 - 12.5		-6.35	-40.32		
5.88 - 12.5		-43.82	-43.82	-120.02	1273.51/16=79.59

Since the variance for three crop combination is having a maximum positive deviation it may be concluded tht the three crops namely paddy, pulses and cotton dominate the cropping pattern of this area.

In Rafiullah's method, the differences of the actual values are calculated from the middle value of the theoretical value and the maximum positive deviation value gives the crop combination.

Although Rafiullah's method involves laborious calculations is quite suitable for delineating sharply the primary crop combinations of auarea.

These crop combination techniques are widely and successfully used in geographical research to identify the major crops that are culturated in an area.

REFERENCES

Rafiullah, S.M. (1965): A New Approach To Functional Classification of Towns, The Geographer, Vol. XII.

Shanthakumari, A. (1986) : Maduari Region An Analysis of changing Pattern of Crop Landuse And Modernization Of Agriculture Among Rural Farmers. Ph. D. Thesis, Unpublished, Madurai Kamaraj University, Madurai.

Weaver, J.C. (1954) : Changing Pattern of CropLand Us in the Middle West, Economic Geography, Vol 30, No 1.

DEVELOPMENTS IN FRONTIER PRODUCTION FUNCTION METHODOLOGY TO ESTIMATE TECHNICAL EFFICIENCY IN AGRICULTURE

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INTRODUCTION

In the eighties most researchers in India shifted their interest from estimating C-D and CES specifications of production function to estimating flexible functional forms particularly translog, highlighting the limitations of the former and the advantages of the latter. The objectives were to estimate degree of homogeneity, Allen partial elasticities of substitution between pairs of inputs and output elasticities of inputs.

Since the early nineties the interest is to estimate levels of efficiency or precisely inefficiency of farms using frontier approach. Widely used specification for the frontier is C-D.

Flexible functional forms allow for a more sophisticated technology and estimation of systems of equations may give asymptotically more efficient estimates of technology and efficiency. However, estimation is more difficult and statistical efficiency is lost.

Theoritical Underpinnings for Frontier approach

Let a firm employ n inputs $x = (x_1, x_2 ..... x_n)'$ available at fixed prices $w = (w_1, w_2 .... w_n) > 0$ and produce a single output y which is sold at fixed price $p > 0$. By definition, function $y = f(x)$ characterizes the maximum output obtainable from various input vectors. Cost function $c(y, w) = \min \{w'x/f(x) \geq 0\}$ by definition

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gives the minimum expenditure required to produce output y at input prices w and represents equivalent representation of production technology under certain regularity conditions. By Shephard's lemma $x(y, w) = \nabla_w C(y, w)$. A vector of minimizing input demands can be derived provided $\nabla_w C(y, w)$ exists.

A third equivalent representation of efficient production under certain regularity conditions is provided by the profit function $\pi(p, w) = \max y.x \{py\text{-}w / f(x) \geq y, x \geq 0, y \geq 0\}$. By definition it characterises the maximum profit possible at output price p and input prices w. By Hotelling's lemma $y(p. w) = \pi_p(p, w)$ and $x(p, w) = -\nabla_w \pi(p,w)$. A vector of profit maximizing output supply and input demands can be obtained provided $\pi_p(p,w)$ and $\nabla_w \pi (p,w)$ exist. Cost function $C(y, w)$ and the profit funciton $\pi(p, w)$ are typically referred to as frontiers in econometric literature as they characterize optimizing behaviour of an efficient producer.

1.1 TECHNICAL EFFICIENCY

Let the firm's observed input vector is x^o and output produced is y^0. The firm is said to be technically efficient if $y^0 = f(x^0)$ and technically inefficient if $y^0 < f(x^0)$. A measure of technical efficiency (TE) is given by $TE = y^0 / f(x^0)$. Range for TE is [0, 1]

Technical inefficiency is due to excessive input usage which increases cost of production and therefore $w'x^0 \geq C(y^0, w)$. When cost is not minimized, profit is not maximized and hence $(py^0 - w'x^0) \leq \pi(p,w)$

1.2

The firm is said to be allocatively efficient if it combines the inputs in such a way that the ratio of marginal products of any two inputs is equal to the price ratio of the inputs. ie, $f_i(x^0)/f_j(x^0) = w_i/w_j$.

Allocative inefficiency results from employing inputs not in the right proportions which implies $w'x^0 \geq C(y^0, w)$ and $(py^0 - w'x^0) \leq \pi(p,w)$

1.3

Observed expenditure $w'x^0$ is equal to the minimum cost of production of y^0. ie, $w'x^0 = C(y^0, w)$ if and only if the firm is technically as well as allocatively efficient.

1.4

However, even if the frim is both allocatively and technically efficient, observed profit $(py^0 - w'x^0)$ need not be equal to the maximum profit $\pi(p, w)$ unless the firm is scale efficient also. Allocative and technical efficiencies are necessary for profit maximization but are not sufficient. For sufficiency, scale efficiency is required. In other words, for profit maximization the firm should be allocatively, technically and scale efficient.

2. LITERATURE ON FRONTIER APPROACH:

Farrel (1957) in his pioneering study elaborated the concept of technical efficiency. He observed that inputs combinations used by farms were on or above the isoquant for unit output. He measured technical efficiency using cross section data and a deterministic frontier approach. Aigner and Chu (1968) and Timmer (1971) and Kopp (1981) extended the frontier approach.

2.1.

Using C-D type specification on the frontier Timmer computed an output-based measure of efficiency. The specifcation on the frontier was $\ln y = \alpha + {}^{n}\Sigma_{j=1} \beta_j \ln x_j + \mu$.

The largest error term of the fitted model was added to the intercept (to correct for the scale effect) untill all residuals are non-positive and one is zero and the frontier production function was estimated. Timmer measure of technical efficiency of the 'i' farm is yi/y* where y* is the maximum possible output obtained for given levels of inputs using frontier production function and y_i is the actual output.

2.2.

Kopp (1981) suggested another approach. The minimum (efficient) level of inputs required for producing an output y is compared with actual levels of inputs used to produce the same output level to measure technical efficiency.

Let the production function be $\ln y = \alpha + {}^{n}\Sigma_{j=1}\, \beta_j \ln x_j + U$ and $x^*_1, x^*_2, \ldots x^*_n$ denote the optimum use of inputs and let $Ri = \frac{X_i}{X_2}$ and $i \neq 2$

$${}^{n}\Sigma_{j=1}\, \beta_j \ln x_2^* = \ln y - \alpha^* - \beta_1 \ln R_1 - \beta_3 \ln R_3 - \ldots \beta_n \ln R_n$$

$$\ln x_2 = 1/\Sigma\beta_j\, [\ln y - \alpha^* - \beta_1 \ln R_1 - \beta_3 \ln R_3 - \ldots \beta_n \ln R_n]$$

Similarly $\ln x_1^*, \ln x_3^*, \ldots \ln x_n^*$ are computed.

$x_1^*, x_2^*, \ldots x_n^*$ indicate frontier values of the inputs. Technical efficiency (TE) of the i^{th} farm is given by

$$TE_i = x_2^*/x_2 = x_1^*/x_1 = x_3^*/x_3 = \ldots x_n^*/x_n \qquad \ldots\ldots\ldots\ldots (4)$$

In Timmer and Kopp approaches each farm does not have a frontier of its own. All the sample farms share a common frontier. In reality the influence of random factors need not be the same for all farms. Further, selection of the variables and data errors would also influence the results greatly. Hence Aigner, Lovell and Schmidt (1977) and Meensen and Broeck (1977) independently developed stochastic frontier approach, which improved the estimation of technical efficiency by incorporating both statistical noise representing uncontrolled exogenous factors and a one sided disturbance term to capture inefficiency. They discussed about average technical efficiency of a group of firms. Jondrow et.al (1982) and Kalirajan and Flinn 1983 independendly derived the formula to work out individual technical efficiency from the average technical efficiency. If panel data is not used then to obtain estimates of individual farm efficiencies, specific distributional assumption about the one-sided component of the disturbance term must be made.

Aigner, Lovell and Schmidt (1977) proposed half normal and exponential distributions, Stevenson (1980) proposed truncated normal and Greene proposed Gamma distribution. For tests of appropriateness of these various distributions lagrangian multiplier techniques proposed by Lee (1983) and Schmidt and Lin (1984) can be used.

If panel data are used one can avoid specific distributional assumptions. However a model for how efficiency varies over time must be imposed.

2.3

The stochastic production function proposed is

$$y_i = f(X_i : \beta)\, e^{\varepsilon_i - t_i}$$

where ε_i represents the usual random noise and t_i technical efficiency of the 'i' th farm. t's are assumed to be independent and identically follow half normal distribution. Later their approach is extended in different ways. Measurement of technical efficiency using cost functions, panel data and truncated normal, exponential and gamma distributions for the residual term is discussed in Forsund, Lovell and Schmidt (1980), Bauer (1990), Battese (1992) and Coelli (1995).

Technical efficiency term t_i need not remain constant. It may vary over time. Battese and Coelli model allows for testing whether TE varies over time or not.

2.4

Their model is $y_{it} = f(X_{it}:\beta)\ e^{v_{it} - U_{it}}$ where $U_{it} = e^{-\eta(t-T)}\ U_i$, $i = 1, 2, ... N.$ $t \in I(i)$ -----------(1)

It is assumed that U_i is a non-negative truncation of $N(\mu,\sigma_u^{\ 2})$. U_{it} and V_{it} are assumed to be distributed independently. η is unknown scalar parameter to be estimated. I(i) represents the set of Ti time periods among the T periods involved for which observation of the i^{th} farm are obtained.

Technical efficiency of the i^{th} farm at the t^{th} time period can be calculated using

$TE_{it} = \exp(-U_{it})$ -----------(2)

$E[\exp(-U_{it})/E_i] = \exp[-\eta_{it}\mu_1^{\ *} + 1/2\ \eta^2_{it}\sigma_i^{2*}]\ \{(1-\phi[\eta_{it}\sigma_i^{\ *} - (\mu_i^{\ *}/\sigma_i^{\ *})])/1-\phi(\mu_i^{\ *}/\sigma_i^{\ *})\}$ -----------(3)

where Ei represents the $(t_i\ X_i)$ vectors of E_{it}'s associated with the time periods for the i^{th} farm and so is η_i correspondingly.

$E_{it} = V_{it} - U_{it}$ -----------(4)

$\mu_i^{\ *} = \mu\sigma_v^{\ 2} - \eta_i'\ E_i\sigma^2/\sigma_v^{\ 2} + \eta_i'\ \eta_i\sigma^2$

$\sigma_i^{2*} = (\sigma_v^{\ 2}\sigma^2)\ /\ (\sigma_v^{\ 2} + \eta_i'\ \eta_i\sigma^2)$

The variance ratio γ can be estimated by $\gamma = \sigma^2/\sigma_k^{\ 2}$ where $\sigma_k^{\ 2} = \sigma_v^{\ 2} + \sigma^2$.

Equation (4) can be used to derive the individual technical efficiencies.

The mean technical efficiency of farms at the t^{th} time period can be derived using

$TE_t = E [\exp(-\eta_t U_i)]$

where $\eta_t = \exp[-\eta(t-T)]$ obtained by integration with the density function of U_t is

$TEi = ((1-\Phi[\eta_t\sigma-(\mu/\sigma)]) / [1-\Phi(\mu/\sigma)]) \exp[-\eta_t\mu + (1/2)\eta^2\sigma^2]$

2.5. MEASUREMENT OF TECHNICAL EFFICIENCY USING COST FUNCTION

Let $\ln C_i = \ln C(y_i, w_i) + u_i + v_i$

where C_i is observed cost, y_i is a vector of outputs, w_i is an input price vector, V_i is a positive and a one-sided disturbance measuring inefficiency follows half normal distribution with mean 0 and variance σ_v^2, U_i is the usual statistical noise following normal distribution with mean 0 and variance σ_u^2.

The likelihood function for u and v can be written as

$\ln L = N/2 (\ln(2/\pi) - N\ln\sigma + \Sigma_{i=1}^{N} \ln[1-\varphi(-\varepsilon_i \lambda/\sigma)] - (1/2\sigma^2) \Sigma_{i=1}^{N} \varepsilon_i^2$

where N is the number of observations, $\varepsilon_i = u_i + v_i$, $\sigma^2 = \sigma_u^2 + \sigma_v^2$, $\lambda = \sigma_u / \sigma_v$ and $\phi(.)$ is the standard normal distribution.

Corrected ordinary least squares or Maximum likelihood method can be used to estimate the model. Observation specific estimates of inefficiency, U can be obtained by using the distribution of the inefficiency term conditional on the estimate of the entire composed error term.

$E[U/\varepsilon] = (\sigma_u^2 + \sigma_v^2) / \sigma^2 [[(\varphi(\varepsilon\lambda/\sigma)) / (1-(\varphi(\varepsilon\varphi/\sigma)))] - (\varepsilon\lambda/\sigma)]$ is an estimate of U but not a consistent estimate. Different modifications of the model is discussed in Bauer (1990).

3. APPLICATION OF STOCHASTIC FRONTIER PRODUCTION FUNCTION APPROACH

There are many studies in India that have used frontier production function approach to measure technical efficiency in agriculture. One of such studies is cited here Mythili and Shanmugam studied technical efficiency of rice growers in Tamil Nadu using frontier production function approach. They used the farm level panel data complied under the scheme of "Cost of Cultivation of principal crops", sponsored by The Directorate of Economics and Statistics, Ministry of Agriculture, Government of India for three years from 1990-1993. The sample is an unbalanced panel with 234 observations and second season is chosen for all the three years. The production function employed is Cobb-Douglas type. Main output (Paddy) is measured in quintals. Inputs included in the production function are human labour (L) measured in man-hours; land (A) measured in hectares, fertilizers (F) NPK used in Kg and expenditure incurred on bullock labour, machine labour and pesticides (C) are expressed in rupees.

The model used is

$$\ln Q_{it} = \beta_{0t} + \beta_{1t}\ln L_{it} + \beta_{2t}\ln F_{it} + \beta_{3t}\ln A_{it} + \beta_{4t}\ln C_{it} + v_{it} - \eta_{it}u_{i}$$

The model is estimated using Maximum likelihood method. For the purpose FRONTIER Computer package (version 4.1) developed by Coelli (1994) is used. Estimates of σ^2 and γ terms if positive and statistically significant it implies that observed outputs differ significantly from frontier outputs. If γ is zero it implies that the firm is technically eficient. The asymptotic t-values on the estimated values of η if statistically significant at 5 percent level, it implies that technical efficiency of the sample unit improves over time. If η is not statistically significant it implies that technical inefficiency of the farm does not improve over time. If the estimated value of μ is zero it indicates that the farm effects associated with last period will have a half normal distribution.

The null hypothesis that $\eta = \mu = 0$ is tested by using the generalized likelihood ratio test statistic which has an asymptotic χ^2 distribution with degrees of freedom equal to 2 (the number of restrictions tested).

The estimated value of γ is 0.82, implying that about 82 per cent of the difference between potential and actual outputs are mainly due to technically inefficiency of the farms. The mean technical efficiency of all the farms taken together is 82 per cent, which implies that mean potential can be 18 per cent more.

They should have tested the null hypothesis $\gamma = \eta = \mu = 0$

Estimated values of the Parameters of Stochastic Frontier Producton Function For Paddy Farmers in Tamil Nadu

Variable	η and μ unrestricted	η and μ restricted
lnL	0.1798	0.1958
	(4.036)	(4.427)
lnF	1.1181	0.1126
	(5.321)	(4.984)
lnA	0.7101	0.7047
	(15.519)	(15.232)
lnC	-0.0119	-0.0129
	(0.386) (0.567)	(0.608)
Constant	2.0955	2.0406
	(6.504)	(6.206)
σ^2	0.2456	0.0851
	(2.140)	(6.0491)

γ	0.9389 (31.828)	0.826 (23.071)
μ	-0.9604 (1.461)	--
η	0.0095 (0.228)	--
χ^2 value	90.228	87.6861
Number of iterations	22	11
Log - likelihood	90.1438	88.8726

Figures in parentheses indicate asymptotic t values.

Source : Mythili, G. and K.R.Shanmugam (2000) "Technical Efficiency of Rice Growers in Tamil Nadu : A study Based on Panel Data", Indian Journal of Agricultural Economics, Vol 55, No.1, Jan. - March.

REFERENCE :

1. Aigner, D.J., C.A.K. Lovell and P. Schmidt (1977), "Formulation and Estimation of Stochastic Frontier Production Function Models", Journal of Econometries. Vol 6, No.1, pp 21-37.
2. Battese, G.E. (1992), "Frontier Production Functions Technical Efficiency - A survey of Empirical Applications in Agricultural Economics", Agricultural Economics, Vo,.7, Nos 3 and 4 pp 185-208.
3. Battese, G.E; T.J. Coelli an T.C. Colby (1989), "Estimation of Frontier Production function and the Efficiencies of Indian Farms using panel Data from ICRISAT Villges", Journal of Quantitative Economics, Vol 5, No.2, pp 327-348.

4. Battese, G.E; T.J. Coelli (1992) "Frontier Production Functions, Technical Efficiency and Panel Data with Application to Paddy Farmers in India "Journal of Productivity Analysis Vol 3, pp 153-169.

5. Baver D.W. (1990), "Recent Developments in the Econometric Estimation of Frontiers", Journal of Econometrics, Vol 46, pp 39-56.

6. Coelli, T.J. (1995) "Recent Developments in frontier Modelling and Efficiency Measurement", Australian Journal of Agricultural Economics Vol 39, No.3, Dec pp 219-245.

7. Coelli, Tim J. (1994), A guide to FRONTIER Version 4.1 : A Computer Program from Stochastic Frontier Production and cost function Estimations, University of New England.

8. Forsund, F.R., K.C.A. Lovell and P.Schmidt (1980) "A Survey of frontier Production Functions and their Relationship to Efficiency Measurement", Journal of Econometrics Vol 13, pp 5-25.

9. Kopp, R.J. (1981) "The Measurement of Production Efficiency - A Reconsideration" Australian Journal of Economics, Vol 97, pp 477-503.

10. Mythili.G. and K.R. Shanmugam (2000) "Technical Efficiency of Rice Growers in TamilNadu: A Study Based on Panel Data", Indian Journal of Agricultural Economics, Vol 55, No.1 Jan - March pp 15-25

11. Timmer, C.P. (1971) "Using a Probabilistic frontier Production Function to Measure Technical Efficiency", Journal of Political Economy, Vol 79, No.4, July-Aug. pp 776-794.

ABOUT

THE SCHOOL OF ECONOMICS

The Department of Economics, which had its origin way back in 1959 as the extension centre of the University of Madras blossomed into a full fledged Department of Economics at the time of the formation of Madurai University in the Year 1966.

The Department of Economics which made significant progress ever since its inauguration was selected by the UGC which provided Departmental Research Support Programme (DRS) in 1991 for its further growth and subsequently the Department of Economics was converted into a School of Economics with Seven Departments namely Mathematical Economics, Econometrics, Industrial Economics, Agricultural Economics, Environmental Economics, Rural Development Economics and Human Resources Development Economics in the year 1991.

The major breakthrough of the then Department lies in its pioneering work of introducing a Post-Graduate Course namely, M.Sc., Mathematical Economics. In other words, the Department of Economics of Madurai Kamaraj University was the trend setter for this course in the whole of South India. Currently, the School is offering M.A. and M.Phil courses in Economics. The students who had their studies in the School of Economics are now working in various Universities, Colleges, Research Institutes and Financial Institutions in India and abroad. Some of them are working in foreign Universities as faculty members. The products of the School also work in Planning Commission, Reserve Bank, Department of Statistics of the State and Central Governments. The School has hosted the Tenth Indian Econometric Conference in 1970, the All India Labour Economics Conference in 1988, the Conference of the Association of Economists of Tamil Nadu twice and various workshops and seminars at state and national levels.

The School of Economics has eleven faculty members and it has produced around 500 M.Phil., and more than 60 Ph.D. The faculty members have undertaken several major and minor projects on themes of local and national relevance funded by UGC, ICSSR and other agencies.

The School was earlier headed by eminent scholars like Dr.D.Bright Singh, Dr. John D.K. Sundar Singh etc., Dr. D. Bright Singh was a member of the Tamil Nadu planning Commission. Eminent Economists like R.G.D. Allen, P.R. Brahmananda, Raja J. Chelliah, Marc Nerlove, Vaithyanathan have visited the School.