CHAPTER 1

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INTRODUCTION

Technological changes are one of the most significant forces which have altered the structure of the agricultural production process. In the developing countries, the physical and value productivity of farm resources are changing continuously due to the adoption of modern innovations. With the introduction of new techniques of production, production functions have shifted upwards. Increased efficiency of resources has contributed to the social and economic development of the developing economies.

Technological transformations have helped to reduce the marginal cost of output. This change can occur either by the employment of the existing input but in different composition or by introducing new factors of production either by replacing the old ones or simply through additional inputs. Technological change in either case is associated with shift in the production functions representing the technical relations between input and output. Thus "technological change can be broadly defined as a change in the parameters of a production function resulting directly from the use of new knowledge." 1

Technological change in agriculture can be classified broadly as labour-augmenting changes and land-augmenting changes. The former refer to those which increase the marginal physical productivity of labour by the introduction of machines in farm operations and the latter consist of introduction of new or improved inputs which increase the marginal yield of cultivated areas. The adoption of these changes is not uniform at the farm level. It is a complex process which is governed by many socio-economic factors related with the adopters. Thus it refers to a change in practices with the adoption of improved farming technique and innovation over traditional farming. The essential ingredients of such techniques include use of improved variety of seeds, fertilisers, assured irrigation water, pesticides and improved implements. Mechanisation of agriculture is another technological revolution in the field of agriculture.

India has made considerable progress in the development of agriculture since the beginning of the era of five year plans. Between 1950-51 and 1992-93, the gross cropped area increased by 40.5 percent and gross irrigated area went up by 193 percent. Significant development took place from the fifth plan onwards in the agricultural sector because of the new strategy called "Green Revolution". In countries like India, the first feature of agricultural supply planning was postulated as a realistic estimate of land as a binding
constraint. Alternative methods which introduce land as a binding constraint in an agricultural plan were advocated. Since the new technology on account of the photo-insensitive high yielding variety seeds permitted shorter duration crops, this factor permitted further increases in cropping intensity.

It is probably correct to argue that Indian agriculture is now moving on a growth path over 3 percent compound growth rate per annum in foodgrains.\(^2\) Area growth is now less than one third percent of the planned level. Therefore almost the entire growth of output is explained by expansion of yield which had resulted by the adoption of new strategies in farming activities. The area covered under HYVs of foodgrain seeds has increased from 1.9 million hectares in 1966-67 to 75 million hectares in 1995-96. Also the consumption of ingredient factors like fertilisers, pesticides, insecticides, machineries etc. has increased over this period. Thus total foodgrain production has rose from 50.8 million tonnes in 1950-51 to 185 million tonnes in 1995-96, showing an increase of 270 percent during the period.

In Kerala Economy, primary sector had registered either very low growth rates or negative growth rates during the last three decades. As a result of the structural changes that had taken place in the economy, relative share of this

sector began to decline. With a period of thirty years from 1960-61 to 1990-91 relative share of primary sector in net domestic product of the state declined from 55 percent to 29 percent. Agricultural crop production which is the most important single activity accounts for nearly 94.31 percent of the SDP generated within the primary sector.

Agricultural sector of the state economy had passed through three stages in terms of growth rates. During the first phase (1960-61 to 1975-76) agricultural production, area and productivity indices increased at the annual compound growth rates of 2.9 percent, 2.3 percent and 0.6 percent respectively. The second phase (1975-76 to 1985-86) is usually termed as the period of 'agricultural stagnation' because the annual compound growth rates in agricultural production, area and productivity were found to be -2.4 percent, -1.5 percent and -0.9 percent respectively. During the third phase (1985-86 to 1995-96) total cultivated area and agricultural productivity have shown positive growth rates.

With respect to the foodcrops, Rice has a significant role in the state agricultural economy since it accounts for more than 98 percent of the total foodgrain production. But the per capita daily availability of domestic rice in Kerala has been declined from 162 gms in 1961 to 97.15 gms in 1991. During the past two decades, the gap between internal production and requirement of rice in the state
has been widening. At present more than 75 percent of the State's rice requirements are met through imports by private traders and through central allotments.

Several agricultural development programmes have been designed by the state Government during the last three decades. Most of them were for the development of paddy sector with a view to increasing the area under paddy and to augment its productivity by the adoption of modern strategies in farming practices. Intensive Agricultural development programme (IADP) of 1960-61, Intensive Paddy Development Programme of 1971-72, Group Farming Programme of 1989-90, Irrigated Programme for Rice Development of 1994-95 were meant for the development of paddy cultivation in the state. In spite of the execution of these programmes, paddy sector of the state has been showing declining trends in area and production since seventies.

1.1 Importance of the Study

The new strategy adopted in mid-sixties has played an important role in the growth of foodgrain production in the Indian economy. But in the state economy, foodgrain production showed a marked negative growth rate due to the drastic decline in the area under rice since 1975-76. But the productivity of rice has been considerably increased during 1965-66 to 1990-91 (i.e. from 1243 Kg/Ha to 1942 Kg/Ha).
So it can be argued that the increase in productivity was the result of adoption of HYVs and other modern inputs.

The area under cash crops and plantations, particularly under coconut and rubber has been registering rapid growth against the sharp decline in rice area. So within the land constraint, agricultural growth must come primarily from more productive utilisation of the existing land area. This is possible only by the indigenous use of modern inputs and adoption of new farm practices. Thus the questions which naturally arise at this point are "whether the farmers have used a right composition of the complementary inputs with HYV seeds to utilise effectively the potentials of the new technology?" and "if not, what are the factors that have been restricting farmers from doing so?". No such deep attempts have been made regarding these questions in state agriculture. So, to fill this gap in the agricultural research, an attempt is made to get an overall picture of the level of adoption of modern strategies in state agriculture. The intensity of adoption of modern farm practices and the problems faced by the farmers in the adoption of new methods have been analysed by taking a sample from Trichur District. The analysis is concentrated on the most important food crop 'paddy' and cash crop 'coconut'.

1.2 Objectives of the Study

The specific objectives of the present study are:

1. To discuss the extent and magnitude of HYV technology
that has been adopted in agriculture.

2. To measure the intensity of adoption of various improved farm practices and their combinations based on sample.

3. To analyse the impact of socio-economic factors on the level of technological adoption.

4. To examine the impact of modern technology on Resource-Use Efficiency.

1.3 Data & Methodology

1.3.1 Data

The present study is based on both primary and secondary data. Primary data is collected from Trichur District for the normal year extending from June 1997 to May 1998 using a specially prepared questionnaire which is given in Appendix (4). Detailed procedure of sample selection has been given in Section 4.2 and related organogram is presented in Appendix (2). Also geographical map of Trichur District is given in Appendix (1).

Secondary data has been used to get an overall view of the magnitude and extent of HYV technology in agriculture. Main sources of secondary data are various issues of 'Statistics for Planning', 'Economic Review' (both published by Government of Kerala), Fertiliser Statistics (Ministry
of Agriculture, New Delhi), Economic Survey (Government of India) etc. More secondary information has been collected from other publications like journals, Data Base and Statistical Compendium.

1.3.2 Concepts and Definitions

It is necessary to discuss briefly the concepts and definitions of the terms used in the study.

(i) HYV Technology:

We define 'HYV Technology' as one which uses high yielding varieties of seeds along with other inputs like fertilisers, irrigation, insecticides and machineries.

(ii) Adoption

Adoption means acceptance of a single improved practice or a package of such practices.

(iii) Gross Output

'Gross Output' includes the output from the crops including their by-products.

(iv) Bio-Chemical Inputs:

Bio-chemical inputs consist of seeds, fertilisers & Manures, irrigation and insecticides. The value of these inputs has been computed at the respective prices that prevailed in the study area during the period of survey.
1.3.3 Methodology

Various methods to measure the level of technological adoption are available in the literature. Use of these different measures depends largely on the problem of enquiry and availability of data. In the case of time series data, the level of adoption can be assessed by using logistic growth function. But to make a cross-section analysis on the level of adoption, simple and complex methods can be used. In most of the studies, adoption index has been treated as the simple percentage of HYV crop area to total crop area.

In this study, simple analytical tools like percentage, ratio, index and compound growth rate have been used to discuss the magnitude and extent of HYV technology in agriculture.

Adoption Index

The intensity of adoption of various improved farm practices is measured by calculating the Adoption Index (AI) of


area and acceptance using the formulae,

$\text{AI area} = \frac{\text{Area under a particular practice} \times 100}{\text{Total farm area}}$

$\text{AI acceptance} = \frac{\text{Number of farms under a particular practice} \times 100}{\text{Total number of farms}}$

Linear Probability Model (LPM)

Impact of socio-economic factors on the level of adoption has been analysed using Linear Probability model. As HYV seeds are widely accepted in paddy cultivation, the present study concentrates on the socio-economic factors which determine the adoption of HYV seeds of paddy by the farmers. Since the whole paddy area possessed by a farmer is cultivated either by high yielding variety or by local variety, we assign the values 1 or 0 for the adoption level of HYV. Thus the level of adoption is treated as a qualitative variable in the LP model.

Models which express the dichotomous $Y_i$ as a linear function of the explanatory variables $X_i$, are called linear probability models (LPM). The conditional expectation of the model can be interpreted as the conditional probability of $Y_i$. The stochastic form of LPM used in the study is:

$Y_i = b_0 + b_1 X_{i1} + b_2 X_{i2} + b_3 X_{i3} + b_4 X_{i4} + b_5 X_{i5} + U_i$.

Where
\[ Y_i = \begin{cases} 1 & \text{if the farmer adopts HYV} \\ 0 & \text{if the farmer doesn't adopt HYV.} \end{cases} \]

\[ X_{1i} = \text{Educational status of ith farmer which is quantified by giving scores ranging from 1 to 5. (Illiterate - 1, Primary - 2, High School - 3, Under Graduate - 4, Graduate and above 5.)} \]

\[ X_{2i} = \text{age of ith farmer which is also quantified by giving scores ranging from 1 to 5. (Below 30 years = 1, 30-40 years = 2, 40-50 years = 3, 50-60 years = 4, above 60 years = 5).} \]

\[ X_{3i} = \text{Size of ith farm in acres.} \]

\[ X_{4i} = \text{Percapita income of ith farm family.} \]

\[ X_{5i} = \text{Net Income from paddy per acre.} \]

\[ U_i = \text{Random disturbance term.} \]

\[ b_0 = \text{Intercept term.} \]

Although ordinary Least Square (OLS) does not require the disturbances \((U_i)\) to be normally distributed, we assume them to be so distributed for the purpose of statistical inference. But the assumption of normality for \(U_i\) is no longer tenable for the LPMs because like \(Y_i\), \(U_i\) takes on only two values.

But the nonfulfillment of the normality assumption may not be so critical as it appears because we know that the OLS point estimates still remain unbiased. Furthermore,
as sample size increases indefinitely, it can be shown that the OLS estimators tend to be normally distributed generally. Therefore, in large samples the statistical inference of the LPM will follow the usual OLS procedure under the normality assumption.

Another problem related to the LPM is 'heteroscedastic variance of the disturbance'. Since the variance of $U_i$ depends on the expected value of $Y$ conditional upon the $X$ value, one way of resolving the heteroscedasticity problem is to transform the data by dividing both sides of the model by the square root of $W_i$ where $W_i = \hat{Y}_i (1 - \hat{Y}_i)$.

Using the estimated $W_i$, we can transform the model as:

$$\frac{Y_i}{\sqrt{W_i}} = \frac{b_0}{\sqrt{W_i}} + b_1 \frac{X_{1i}}{\sqrt{W_i}} + b_2 \frac{X_{2i}}{\sqrt{W_i}} + b_3 \frac{X_{3i}}{\sqrt{W_i}} + b_4 \frac{X_{4i}}{\sqrt{W_i}} + b_5 \frac{X_{5i}}{\sqrt{W_i}} + \frac{U_i}{\sqrt{W_i}}$$

The disturbance term will now be homoscedastic. Ordinary Least Square can be run on the function thus transformed.

**Cobb-Douglas Production Function**

Among the various types of production functions that could be fitted to agricultural production data, the Cobb-Douglas function has the advantage that it also serves to provide information regarding economies of scale in farming operation. Therefore, this type of function which is linear in logarithms has been fitted to the data under consideration
in this study. The general form which this function takes is, \( Y = A x_1^{b_1} x_2^{b_2} \cdots x_n^{b_n} \), the value of the constant \((A)\) and the coefficients \((b_i)\) in respect of independent variables have been estimated by using the method of least squares. The regression coefficients \((b_i)\) in respect of independent variables in the function represent elasticities and these help to estimate the marginal productivity of each resource on the farm.

The form of the function used in the study is:

\[
Y = A x_1^{b_1} x_2^{b_2} x_3^{b_3} x_4^{b_4}
\]

Where

- \(Y\) = Gross value of output in Rupees.
- \(x_1\) = Human Labour in Mandays.
- \(x_2\) = Land area in Acres.
- \(x_3\) = Value of biochemical inputs in Rupees.
- \(x_4\) = Rental value of machineries.

From the regression analysis, the marginal value product of each input has been estimated. It is a measure of the efficiency of inputs used in production. The Marginal Value Product of each input factor, land, labour, biochemical inputs and machineries have been calculated by the following expression:
\[ MVP_{x_i} = \text{Estimated value of } Y \text{ by keeping } X_i \text{ at their Geometric Mean} \\
\times \text{Geometric Mean of } X_i \]

Where \( b_i \) = Elasticity of output with respect to \( X_i \).

The Marginal Value Product (MVP) derived in this manner can be compared with the Marginal Cost (MC) of the respective inputs to determine the profitability of additional investment.

1.4 Limitations of the Study

The present study depends upon both primary and secondary data and it faces different types of data problems. Recent data on certain factors were not available from secondary sources. The reliable secondary data may sometimes be insufficient to establish the problem under consideration.

Primary data also suffers from its usual drawbacks. In our sample, since Mathilakam Block has little paddy cultivation, we could trace only 85 percentage of cultivators under this crop. As the generalisation is made on the basis of the collected sample data for the year 1997-98, the results may sometimes deviate from the real facts.

1.5 Plan of the Study

The present study is an attempt to analyse the impact of modern technology adoption in agriculture. This study is divided into Seven Chapters.
The thesis opens with an introductory Chapter which mainly includes importance of the study, objectives, data and methodology. Second Chapter reviews the related literature.

Chapter Three discusses the technological transformation in agriculture since mid-sixties, based on secondary data on technological components. Chapter four deals with socio-economic profile of the study area and sample households. Sample design and profile of farmers have been discussed in this Chapter.

In the Fifth Chapter we analyse the adoption level of technological inputs based on primary data. Influence of socio-economic factors on the adoption level has also been analysed.

Next Chapter examines the impact of modern technology on Resource Use Efficiency. The following Chapter concludes with the Summary of findings and recommendations.