RETURN AND EFFICIENCY OF INTERCROPPED PINEAPPLE CULTIVATION IN KERALA

Thesis submitted to
Cochin University of Science and Technology
for the award of the Degree of
Doctor of Philosophy
under the
Faculty of Social Sciences

By

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Certificate

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Declaration

I, Jomy M.Thomas, hereby declare that the thesis titled "Return and Efficiency of Intercropped Pineapple Cultivation in Kerala", submitted to Cochin University of Science and Technology under the Faculty of Social Sciences is the record of the original research done by me under the supervision and guidance of Prof.(Dr.) Mary Joseph T., Professor (Rtd), School of Management Studies, Cochin University of Science and Technology. I further declare that no part of the thesis has been submitted elsewhere for the award of any degree, diploma or any other title or recognition.

Kochi-22 **Jomy M. Thomas**
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Jomy M. Thomas

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List of Abbreviations

AE	Allocative Efficiemcy.
AEZ	Agri Export Zones
AOA	Agreement on Agriculture
APEDA	Agricultural and Processed Food Products Export Development Authority
CAGR	Compound Annual Growth Rate
CMIE	Centre for Monitoring Indian Economy
CSO	Central Statistical Organisation
DAC	Department of Agriculture & Cooperation
DEA	Data Envelopment Analysis
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
GSDP	Gross State Domestic Product
HBHS	Hand Book on Horticulture Statistics
ICMR	Indian Council of Medical Research
KAU	Kerala Agricultural University
KHDP	Kerala Horticulture Development Programme
MLE	Maximum Likelihood Estimation
MMT	Million Metric Tons.
NHB	National Horticulture Board
NHM	National Horticulture Mission
OLS	Ordinary Least Squares
PFA	Pineapple Farmers Association
PRS	Pineapple Research Station
SFA	Stochastic Frontier Analysis
TE	Technical Efficiency
WTO	World Trade Organisation

Chapter 1

INTRODUCTION

Contents

1.1 Introduction

Traditionally, it is considered that horticultural products provide food security as well as a means of livelihood of millions of small farm holders in developing countries. As the world population is estimated to be about 8 billion by 2025, horticultural products expect an increase in demand all over the world. This increase in demand results mainly due to income elasticity; it particularly arises from the high and middle income group among the developed and developing countries. The major factor that makes a rise in demand is the change in life style among the people who live in these countries due to rise in income level and a search for a balanced healthy diet by including more fruits and vegetables in the daily diet and the international travel and communication. (Global Horticultural Market Outlook 2015 and Dattatreyulu 1997). This increase in demand for horticultural products especially of fruits and vegetables is beneficial not only to the farmers but also to the associated sectors like transportation, distribution, storage, processing and packaging. Besides this there arises a large number of employment opportunities benefiting a large number of people directly and indirectly, contributing towards the economic growth and development among the nations, especially, in developing ones.[1]

Apart from the fresh horticultural products, the global fruits and vegetable processing industries have also shown a steady growth in the past few years. The transformation of the people in the developing countries to more urban trends and the rise in income have created an increased demand for higher quality and more diversity in their daily diet. This leads to an increase in demand for more processed fruits and vegetables in these nations. It is expected that the fruit and vegetable processing industry and trade grow at a rate of 2.4 per cent per annum while the revenue grows at 1.9 per cent per annum. Again, in developed economies and in many developing economies, the consumption of processed fruit and vegetable products has long been high on a per capita basis.(IBIS World Industry Report 2014).

These aforesaid situations have made an opportunity to government and private institutions in the developing countries, especially the tropical developing countries, to make investments and initiate various measures to promote horticultural production and exporting especially, the fruits and vegetables to reap the associated benefits to their nations.[2]The world trade of fresh and processed fruits shows an increasing trend and tropical fruits such as banana, orange and pineapple have a major role in international trade.

[1] Ibid
[2] Ibid

Developing countries definitely have a comparative advantage in tropical fruit production and can perform well in exporting of these fruits.[3]

China is the top fruit producing country (21 per cent) globally followed by India (13 per cent) and Brazil (6 per cent) respectively ,whereas in per cent share of area of cultivation, China, India, and Brazil are 21 per cent, 12 per cent and 4 per cent respectively in 2012-13.(see details in *appendix* II)

1.2 The Indian Scenario

India is one of the world's largest agrarian economy even though the share of agriculture GDP decreased from 30 per cent in 1990-91 to 14.5 percent in 2010-11.Agriculture is considered still as a critical sector in Indian economy because, it is essential for food and nutritional security to the people, it can provide livelihood and income to the rural people, it meet the input/raw material requirement of the agro based industries in the domestic segment and provide employment to around 58 per cent of the total workforce (Annual Report 2013-2014, DAC, Ministry of Agriculture and Cooperation, Government of India.)

The agricultural sector in India underwent a significant structural change between the periods 1990-91 and 2010-11.This change occurred by identification of the government after the green revolution in the sixties, horticulture in the mid eighties, as a promising and emerging sector for agricultural diversification, to enhance profitability of farmers through efficient land use, optimum utilization of natural resources and creating employment for rural masses (Choudhary 2013). India is in a position to produce almost any type of horticultural crops as we have certain unique favourable geographical and climatic conditions. The varied climatic

[3] Dattatreyulu 1997 op.cit

conditions allow the production of a wide variety of fruits, vegetables, flowers, spices, medicinal and aromatic plants (Padmini 2002).

The Working Group on Horticulture Plantation, Crops and Organic Farming for the XI Five Year Plan (2007-12) redefined horticulture as "Science of growing and management of fruits, vegetables including tubers, ornamental, medicinal and aromatic crops, spices, plantation crops, their processing, value addition and marketing" (Singh and Mathur 2008).Meantime the plan investments in horticultural development increased significantly from VIIIth five year plan onwards and a massive increase has been made in the share for the horticultural crops in the five year plan from the tenth plan and eleventh plan as compared with the previous plans .

Table 1.1: Per cent share of Horticulture Vth Plan to XIIth Plan period (1974-2017).

Plan	Period	Total outlay in Agriculture& Allied activities (Rs in crores)	Share of Horticulture (Rs in crores)	Per cent share
V	1974-1978	4865	7.61	0.16
VI	1980-1985	5965	9.13	0.15
VII	1985-1990	10525	24.19	0.23
VIII	1992-1997	22467	789	3.51
IX	1997-2002	37546	1453	3.9
X	2002-2007	58933	5025	8.5
XI	2007-2012	136381	15800	11.6
XII	2012-2017	363273	16840	4.6

Source: Compiled from planning commission data& HBHS-2014

The rationale for focusing on diversification towards horticultural crops for triggering agricultural development is on account of its contribution to poverty reduction through higher employment generation, higher potential for value addition and for generating foreign exchange and provision for food and nutrition security through supply of micro – nutrients and roughages. [4]

Due to the interventions of the government, the share of horticulture in the agricultural output increased from 16 per cent in 1990-1991 to 20 per cent in 2009-10 which was almost equal to the share of food grains in agricultural output. Other major changes witnessed in horticultural sector are; the earlier seasonal availability of fruits and vegetables has now extended to all the years round, horticulture has moved from the rural confine to commercial production and the increased horticultural production makes India as one of the major horticultural exporter in the world market.[5]

Fruits and vegetables are the major sub sector in horticultural sector in India. The major changes that occurred in the fruits and vegetable sector from 1980-81 to 2005-06 were: the share of fruits and vegetables cultivated area increased from 2.8 to 4.9 per cent and their share in crop output increased from 15.95 per cent to 25.61per cent, fruits and vegetables sub sector showed a growth of 64per cent from 1995 -96 to 2004-05, which was more than thrice their share during earlier period, the area of fruit crops increased by about 17 per cent and production by 24 per cent in the XIth plan period, and the area of fruit crops showed an annual growth of 5.16 per cent and production by 7.54 per cent during 2012-13 with reference to 2004-05(Chand *et al*.2008, Birthal *et al*.2008, [6])

Demand side prospects of fruit crops can be captured from trend in domestic consumption and trade. The share of fruits and vegetables in urban food expenditure increased 12 per cent in 1983 to 14.9 per cent in 1993-94 and

[4] Ibid
[5] Annual report 2013-2014& Choudhary 2013 op.cit
[6] Ibid

further to 15.8 per cent in 2004-05. There was also a considerable rise in their share in rural food expenditure from 9.3per cent in 1983 to 12.4 per cent in 1993-04 and 14.5 per cent in 2004-05 .Intervention of NHM activity led to an increased per capita availability of fruit from 58 gm/person/day in 2007-08 to 182gm/person/day in 2012-13.Similarly the per cent share of calorie intake from fruits and vegetables in the rural area was 6.87 per cent in 2004-05 which increased to 7 per cent in 2009-10 while the same increased from 7.22 per cent to 8 per cent in the same period in urban area (HBHS 2014)[7]

Almost all states, except Haryana, witnessed an increase in area share of fruits and vegetables in total cropped area during 1990-91 to 2005-06. Fruit crops play a significant role in a developing country like India. They not only provide protective food in the diet of the increasing population, but also help to enhance foreign exchange earnings of the country (Padmini 2002, [8]).

The increased horticultural production helps India to gain the position of a major exporter in the world, but we can't find a place in horticultural market of developed countries. Our horticultural exports are mainly concentrated to the developing countries and the major destinations are the neighboring markets targeting migrant low end working community.UAE imports 60 per cent of India's export of papaya, pineapple, sapota, lemon and pumpkins. Other major exporting countries of India in fresh fruit and vegetables are Malaysia, Singapore and Saudi Arabia. This localization of horticulture, leads to a poor per cent share of 1.07 and 1.3 per cent in case of fruit and vegetable export from India during 2010[9]

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[7] Ibid, Annual report 2013-2014 op.cit
[8] Chand *etal*.2008 op.cit
[9] IBIS World Industry Report 2014&Global Horticultural Market Outlook 2015 op.cit

1.3 The Kerala Scenario

The share of agriculture and allied services to the GSDP of Kerala declined over the years. The share fell from about 30 per cent in 1990-91 to 10.6 per cent in 2010-11. The growth rate of agriculture and allied sector is almost at a stagnant rate of 0.4 per cent in the recent decade. However agriculture alone accounted for about 8.2 per cent GSDP of Kerala in 2010-11, and approximately one fourth of the workforce in Kerala still depends directly up on agriculture and allied services (Kerala-Vision 2030, Govt.of Kerala,).

In this juncture agriculture in Kerala needs a new paradigm which redefines and recognizes the role of horticulture in economic growth and development considering the livelihood and food security issues as well as the environmental constraints. Economic reforms and policies adopted and initiated since 1990's at national level, increased the pace of diversification in favour of horticultural crops in Kerala too. The government provides numerous fiscal incentives to producers, processers and exporters in recognizing the fact that agricultural growth can be improved only through triggering the production and exporting of horticultural crops especially the fruit crops. Besides this, the potential of horticulture, to provide livelihood for marginal and small farmers, the predominant section of farmers in Kerala, employment generation capacity and foreign exchange earnings are realized by the government.[10] Keeping this objective, the government has earmarked more funds to horticultural sector and introduced many supporting programmes to enhance the cultivation and production of horticultural crops and thereby to increase the income of farmers.

[10] Ibid

In Kerala, the Kerala Horticultural Development Program (KHDP) 1993, a joint project of Government of Kerala and the European Union started in 1993, is the pioneer programme initiated in the state which envisages the overall development of horticultural crops. The KHDP aims at increased cultivation and production of vegetables and fruits in Kerala and thereby increasing the level of income earned by small scale horticultural farmers in the state. (Dept.of Agriculture, Government of Kerala). Pingali and Premarajan (1999) found out that the KHDP achieved 86% increase in area of cultivation of fruits and vegetables and 57% increase in income of the farmers. The main reasons accounted for increase in income are the change in farming practices and increase in area and yield. Other major initiatives by the government in Kerala with the aim of triggering the horticultural growth are the formation of the company, Vegetable and Fruit Promotion Council Keralam (VFPCK), the extension of KHDP, and the implementation of State Horticultural Mission programme, an extension of National Horticultural Mission (NHM) 2005.

The warm humid tropical climate with annual rainfall of above 3000 mm distributed over long duration and the topography ranging from 0 to2000 meters above sea level makes Kerala conducive for the growth of a variety of tropical horticultural crops. The horticultural crops of the state constitute spices like pepper, ginger, turmeric, cardamom and chilies, tubers like tapioca sweet potato and other tubers, fruits covering banana, plantain, mango, jack, pineapple, papaya etc, and vegetables such as pumpkin, snake ground, bitter guard, cucumber etc and floriculture. The major fruit crops produced in the state are; mango (30per cent), Banana (30 per cent), other plantain (28 per cent), pineapple (6 per cent) and papaya (5 per cent).

A national level study on the growth and variability of major horticultural subsectors between the periods 1991-92 to 2005-06 has found that in fruit sector, Kerala shows a change in area of 45 per cent, a change in production of 154 per cent and a change in yield of 75 per cent.[11] But still there is a huge gap between demand and supply.In the case of fruits, Kerala, produces 69.22 percent of total availability and the remaining 30.78 percent flows from neighboring states. As per ICMR norms, the total requirement of the state works out to 13 lakhs tons while the state production hardly around 6.07 lakh tons or 46.69per cent. (Annual action plan NHM 2005).

1.4 The Pineapple Scenario

Among the fruit crops cultivated and produced globally, Pineapple (*Ananas comosus*) is one of the popular tropical fruit crops. The name pineapple (or pine in Spanish) comes from the similarity of the fruit to a pinecone; *ananas* comes from "anana" the Tupi word for the fruit meaning "excellent fruit". *Comosus* mean tufted and refer to the stem of the fruit.

Pineapple is grown and yields the best in the areas with warm and relatively uniform climate year around. Current production remains restricted to the tropical regions of the world. Presently the total global production in the world is 23 MMT which is produced by approximately 80 countries around the world. World trade on fresh pineapple has shown 100 per cent increase during the last one decade. Of the various juices, the sale of pineapple juice was approximately of $174 million, grape juice about $158 million,citrus around $109 million and tomato juice around $22 million in the world market. The global trade is around 50 per cent as fresh fruit, 30 per cent as canned product and 20 per cent as juice concentrate .World pineapple importing

[11] Singh &Mathur 2008 op.cit

increased by 18 per cent in value and 14 per cent by quantity and exporting by 22 per cent in value and 18 per cent in quantity (Jacob and Soman2006, APEDA[12]).

The main pineapple producers are Brazil (13per cent), Thailand (12 per cent), Philippines (11per cent), Costa Rica (9per cent), India (7per cent) and China (7per cent) in the world. The most widely grown variety is Smooth Cayenne, Queen and MD2. About 60 per cent of the world's fresh pineapple exports came from Costa Rica, Ivory Coast, and Philippines. The share of top ten producers in exports are negligible with the exception of Costa Rica which has a share of (20 per cent) followed by Philippines (9 per cent).

On the import side, the main importers are USA (20per cent), Belgium (17percent) France (9per cent), Italy (8per cent), Germany (7per cent) Japan (6per cent) Canada (5per cent) UK (5per cent) and Netherlands (4per cent). More than 80 per cent of the pineapple imports in the world are to the EU and US. Out of this 20 per cent share is of the US. The biggest pineapple import market in Asia is Japan and South Korea, which together constitutes together 8per cent of the world imports.[13]

In India, pineapple is cultivated as a main fruit crop in the West Bengal, Kerala, North Eastern States such as Assam, Meghalaya, Manipur and Arunachal Pradesh and in Karnataka These areas have very suitable climate conditions for large scale production of pineapple .Though pineapple was introduced by Portuguese colonialists in India 1548 ,it's cultivation grew substantially only after independence and the Government supported the pineapple sector on a limited basis till in the 1960's and did not recognize pineapple as a core area for agricultural development before 1990's.Hence

[12] Padmini 2002 op.cit
[13] Ibid

pineapple production ,marketing and processing were generally based on private initiatives till 1990.[14] Today, India is the sixth largest pineapple producer in the world with 7 per cent of the world production of about 1.6 MMT. Main varieties cultivated are Kew and Mauritius. Kew is cultivated in the North Eastern States and in West Bengal and is mainly suited for processing, while Mauritius is mostly cultivated in Kerala and is a suitable table variety.

West Bengal has the highest per cent of production (19.7per cent) followed by Assam (17.1per cent), Karnataka (10.8per cent), Tripura (10.5per cent) and Kerala (4.6per cent).The productivity is the highest in Karnataka (62.7), followed by West Bengal (29.5), Bihar (27.1) and Assam (16.6). The Indian productivity is 14.9 MT/ha where as the world average is 23.2 MT/ha (Indian Horticulture Database 2013).

India's main export market for fresh pineapple was Middle East with about 58 per cent of total fresh pineapple export during 2012-13. The other major destinations were Nepal (18 per cent) and Maldives (15 per cent) (NHB 2013).Trade prospects of India is better as pineapple is considered as an under achiever. That means, the potential is not fully exploited[15].

The major fruit crops cultivated commercially in Kerala are Banana, Plantain, Pineapple and Mango. Among these fruit crops pineapple is emerging as a major fruit crop, especially after the implementation of horticultural development programmes in Kerala in the early 1990's. Although pineapple was being cultivated in Kerala in the districts Kannur and Thrissur, between 1950s and 1980s, it had been mainly catering to the needs of food processing industry. The pineapple cultivation in these districts experienced a sharp

[14] Padmini 2002 op.cit
[15] Jacob &Soman 2006 op.cit

decline, due to the fall in demand from the processing units as well as low yield of pure cultivation in uplands. But the Mauritius variety cultivated in Vazhakulam in Ernakulam district mainly as intercrop in rubber plantations and pure crop in reclined paddy lands since 1983 has initiated a new era in pineapple cultivation of Kerala[16]. The pineapple cultivation was extended commercially in early 1990's mainly after the implementation of KHDP in 1993. The commercial cultivation of pineapple gained its momentum when the farmers began to cultivate pineapple as an intercrop in new /replanted rubber plantations and coconut plantations and as a mono crop in converted paddy lands[17]. Presently more than 80 per cent of pineapple cultivation is done as intercrop in rubber plantations and in a limited area in coconut gardens and converted paddy land. (PFA).

The main reasons for the flourishing of pineapple cultivation as an intercrop in rubber plantations are: firstly, unlike annual intercrops, pineapple is cultivated in the first 3-4 years of the new / replanted rubber and it gives income to farmers when there is no income from rubber plantations. Secondly the intercropping of pineapple in rubber plantations prevents soil erosion and helps to reduce weed growth in rubber plantations (Jose (1993), Joy (2010). Thirdly, as a major part of pineapple cultivation is taken place in the leased lands, and considering the severe unemployment and high fragmentation of agricultural land in Kerala, the pineapple cultivation give an opportunity to the thousands of land less farmers to engage in agriculture and to earn a livelihood. Along with this, the wide expansion of pineapple cultivation during 1990's , after the implementation of KHDP, the Government also extended their support in the form of Research and Development (R&D) to the farmers through the

[16] Padmini 2002 op.cit
[17] Ibid

establishment of two Pineapple Research Stations (PRS), one at Vazhakulam in Ernakulam district and the other at Thrissur under the Kerala Agricultural University (KAU).

Main varieties of pineapple cultivated in Kerala are Kew and Mauritius. The variety mostly cultivated in Kerala is Mauritius, which is very much in demand as a fresh fruit throughout India and also in foreign countries because it is considered as the best in quality and has good flavor. Its advantages include longer shelf life, (compared with other varieties in India) sweetness, and can be consumed as fresh fruit. (Joy 2010). More than 95per cent of the pineapple produced in Kerala is marketable as fresh fruit throughout India.

The area and production of pineapple showed a increasing trend during 1997-2002 and 2002-2007, but the productivity was stagnant during the same period. Another major problem that faces the farmers is the erratic fluctuation of the price of the produce throughout the year. Studies have revealed that about 60 per cent of farmers engaged in pineapple cultivation are small operational holders (0-5 ha) and 25per cent are medium operational holders (5-10ha) and the remaining 15per cent are large operational holders (above 10 ha).[18]In Kerala, Ernakulam, Idukki and Kottayam districts together constitute 80 per cent of total area and 85 per cent of total production of pineapple in the state (Agricultuaral Statistics, Government of Kerala, various years).

1.5 Significance of the Study

In Kerala, the share of agriculture in Net Domestic Product shows a declining trend as against the share of industrial and service sector which shows significant advances. But agriculture still plays an important role in the

[18] Padmini 2002 op.cit

state economy as it continues to be the largest provider of employment and livelihood for around two fifth of the population (Geetha. 2006).

Agriculture in Kerala has undergone a structural change by the end of 1980's. The major change that has taken place in Kerala agriculture was the gradual shifting of the area under food crops like rice, tapioca and pulses which are less remunerable to more remunerable cash and plantation crops like rubber, coffee, cashew etc.[19] Mean time along with the national policy of promoting horticulture, the Government of Kerala identified the potential of horticulture crops as a means of livelihood for marginal and small farmers, formulated policy measures to boost up the horticultural sector in the State.

The shift in pattern of area of cultivation was favourable mainly to pineapple cultivation, one of the prominent fruit crop in Kerala. The statistics of shift in cropping pattern of area of cultivation showed a huge hike in area of pineapple cultivation and a decline in area of cultivation of traditional crops like ginger, turmeric and tapioca in the State. This favourable shift towards pineapple cultivation in Kerala definitely contributes significantly to agricultural revenue of the state and thereby enhances the economic growth of the state. An earlier statistics regarding the sales turnover of various crops revealed that pineapple was earned a sales turnover of 200 crores in 2005-2006 which increased to 300 crores in 2007-2008 which was more than the turnover of plantation crops like coffee (284 crores), cardamom (287 crores) and tea (294 crores). More over the cultivation generates employment of about 45 lakhs man days a year among the farmers, loading and unloading workers ,agricultural workers ,traders and retailers[20].Mean time the intercropped pineapple cultivation in rubber plantation is a source of income to farmers when there is no income

[19] Ibid
[20]PFA op.cit

from rubber in the initial stage. At the same time the owners of rubber plantation will get income as lease rent if the land leased out and pineapple cultivation in leased land has emerged as a source of livelihood for thousands of landless farmers who are interested in agricultural activities. The pineapple from Kerala can earn valuable foreign exchange through export, due to the proximity to countries of Middle East region, Geographic Indication (GI) certificate of Vazhakulam pineapple and the quality of the fruit. Thus it can be concluded here that the pineapple cultivation in Kerala has an important place in domestic economic growth as well as in terms of earning of foreign exchanges.The favourable conditions that help to the wide expansion and growth of pineapple cultivation in Kerala are the existence of warm and humid tropical climate throughout the year ,cultivation and propagation of Mauritius variety which has a good quality fruit,(Since the pineapple is cultivated in Kerala only for 3-4 years in the same place, the quality and size of the fruit can be maintained throughout the entire period of cultivation), availability of research& development support and other extension activities from Pineapple Research Stations (PRS) regarding the modern crop management, availability of land on lease and the existence of sufficient opportunity for export of pineapple from Kerala[21]. Besides this the Government has extended its institutional support by establishing Nadukkara Agro Processing Company Ltd (NAPCL) exclusively for the pineapple farmers for value addition in pineapple fruit. But according to Padmini (2002), the major challenges faced by the pineapple farmers were;

- High cost of cultivation due to high input cost.
- Poor post harvest management of the fruit.
- Low productivity as compared with other states.

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[21] Joy 2010 op.cit

- Erratic fluctuation of the price of the produce.
- Lack of implementation of modern technology in farming practices.

One of the peculiarities of land in Kerala is the higher fragmentation of the land in the state when compared with other states. The average operational land holding size is only 0.2 ha and marginal and small farmers have predominance in operational holding of land. This situation has prevented the farmers from enjoying the economies of large scale production and so is the case of pineapple cultivation also.

From the above discussions we can conclude that in Kerala, though there are problems facing the pineapple cultivation, there is potential for the development and growth of pineapple cultivation that could enhance the income level of the farmers and contribute to the economy of the state. According to Chand *et.al* (2008) and Singh & Mathur (2008), the high growth rate of horticulture witnessed during 1990's could not be sustained in the recent years because of slow down in the growth of fruits and vegetables sector. The growth rate in output of fruit and vegetable subsector from 1996-97 to 2005-06 is less than half of the growth rate from 1990-91 to 1999-2000. The slowdown in some crops may be by slowdown in productivity, some by declined prices and some by both. This is not conducive to the development of the fruit and vegetables sector. There is a need to identify the factors responsible for the small increase and even a decline in some states in the yield of fruit crops.

The aforesaid discussions may lead to some relevant research questions regarding the intercrop pineapple cultivation in Kerala. What is the trend of growth of pineapple cultivation regarding the area, production and yield in Kerala as well as in India? Does any significant trend break occur in the growth of pineapple cultivation after 1990's as expected in the policy changes? What is the present cost and return structure of pineapple cultivation? What is the present level of efficiency in utilizing the available resources? Whether the low productivity of crop is due to the inefficient use of inputs by the farmers? If inefficiency exists among farmers, then what are the probable factors that contribute to inefficiency? etc. So the present study is aimed to find out the probable answers to the above research questions.

1.6 Statement of the Problem

The wide spread acceptance of pineapple as an intercrop in rubber plantations in Kerala has resulted a shift in area of cultivation of other major intercrops. A statistics of shift in area of cultivation of crops from 1985-86 to 2004-05 period showed a 165 per cent hike in the area of cultivation of pineapple while the traditional crops like ginger showed a 36 per cent , turmeric 9 per cent and tapioca 56 per cent decline in area during the same period (Economics and Statistics Department, Government of Kerala,Agricultural Statistics 2005,2009).But statistics regarding the percentage increase of area, production and productivity of pineapple for the period 1992-2007 revealed that area of cultivation increased by 62 per cent, production increased by 68 per cent and productivity increased by mere 0.59 per cent between the period. A marginal percentage change in yield coupled with positive change in production implies that the total gain in production has come from area expansion alone. This situation is not favorable for the sustainable growth of the crop. The statistics above revealed that in Kerala the sustainable growth of pineapple cultivation lies more on productivity improvement than on area expansion. The low productivity may arise due to the inefficiency of input usage by farmers or may be of the inefficiency due to random factors outside the control of farmers or by both. It should be made clear about what type of inefficiency leads to low productivity before initiating actions to improve efficiency. Productivity can be improved through either by the efficient use of input resources or by improving the existing technology, and preference should be given for efficiency improvement in utilization of available resources than for the technology improvement. Since the pineapple cultivation requires heavy investments in the first year itself and faces erratic fluctuation in price, the inefficient use of inputs indeed will affect the profitability that results in low income or even a loss to the farmers. An empirical study on efficiency of input usage along with the probable determinants of inefficiency would help to decide whether it is possible to improve the efficiency or need to improve the existing technology of cultivation to raise the productivity. A proper assessment of trend and growth rates in area, production, productivity of pineapple in India and in Kerala and export of pineapple from India, the cost incurred and return received by the farmers, especially the small and medium, and the extent and nature of inefficiency if any along with the factors influencing inefficiency are important for the pineapple farmers and policy makers for sustainable development of pineapple cultivation.

1.7 Objectives of the Study

The main objectives of the present study is to analyse the growth and trend in pineapple cultivation and production in India and in Kerala, to evaluate the cost and return structure of pineapple cultivation in Kerala and estimating the efficiency of intercropped pineapple cultivation in rubber plantations of Kerala. More specifically the objectives are:

1) To study the growth and trend in area, production and productivity of pineapple cultivation in India and in Kerala
2) To study the trend and direction of pineapple export from India.
3) To analyse the cost and return structure of pineapple cultivation as intercrop in Kerala.
4) To estimate the technical efficiency of intercrop pineapple cultivation in Kerala.
5) To identify the determinants of inefficiency in the intercrop pineapple cultivation in Kerala.

1.8 Hypotheses of the Study

The following hypotheses are formulated for the present study.

1) There is no significant difference in the average cost of pineapple cultivation between the farm sizes.
2) There is no significant difference in the efficiency of pineapple cultivation between the farm sizes.

1.9 Methodology

The present study is descriptive and analytical in nature. Both primary and secondary sources were collected and used.

1.9.1 Primary data Source

The primary data was collected by conducting a sample survey among the pineapple farmers using a pre tested structured questionnaire. The primary data was collected for the analysis of cost and return structure and for the technical efficiency estimation. The data collection was done during the period from June to December 2013.The data was collected from farmers after classifying the farms in to two strata on the basis of operational holdings as given below.

a) Below 2 ha - Small farmers.

b) Above 2ha - Medium farmers.

The marginal farmers were included in the small farmers and the farmers who undertake the cultivation on large estates were excluded from the study because the cultivation practices of pineapple are different in large estates.

1.9.2 Secondary data Sources.

Secondary data used for fitting trend and estimating growth of pineapple cultivation, production, productivity and export were collected from UNCOMTRADE, FAO production statistics and CMIE data base. Other sources of secondary data were National Horticulture Board Database, Ministry of Agriculture Government of India, Directorate of Economics and Statistics, Government of Kerala, and periodicals and journals.

1.9.3 Sampling Frame

Multi stage sampling was used in the present study .In the first stage the districts of Ernakulam, Idukki and Kottayam were selected purposively since these districts contributed about 80% area of the total pineapple cultivation of Kerala. In the second stage, the blocks Muvattupuzha, Elemdesam and Kanjirappilly were selected from each district which represents the largest area of cultivation in each of the above districts. A list of farmers was prepared with the help of records of local Krishi Bhavans and PFA in these blocks. A stratification of farmers was done on the basis of operational holdings as mentioned above and a sample of 149 and 109 from each of the stratum was selected by proportionate stratified random sampling. The total sample size constitutes 258 farmers.

1.9.4 Tools of Analysis.

The primary data collected for cost and return analysis was analysed following ABC cost measures as given in the Manual on Cost of Cultivation Surveys published by the Ministry of Statistics and Programme Implementation, under Government of India, and averages and percentages. The technical efficiency estimation was done through regression analysis following Maximum likelihood (ML) estimation method. The results of the analysis were tested for significance using t test, Mann-Whitney U Test and Generalised LR (Log likelihood Ratio) test. The secondary data was anaysed using compound, exponential and kinked exponential growth models. A test of trend break had been carried to test the significance of difference between the two sub periods. The data used for analysis and formulation of models together with further explanation of the tools and their relevance are given in detail in the respective chapters. The method of imputation and apportionment of various cost items is explained in the appropriate chapters.

1.10 Chapter Scheme

The thesis is presented in nine chapters, viz;

Chapter 1 - Introduction

Chapter 2 - Review of Literature

Chapter 3 - Theoretical Background of Stochastic Frontier Analysis

Chapter 4 - Trends and Growth Rates of Pineapple Cultivation

Chapter 5 - Pineapple Export Scenario of India

Chapter 6 - Pineapple Cultivation Practice in Kerala and Profile of Farmers

1.11 Limitations of the Study

The following are the limitations that affect the present study.

1) The study does not cover the entire form of pineapple cultivation in Kerala. The pure crop and intercropping in coconut plantations are outside the scope of the present study.
2) The inherent limitation associated with the responses retrieved from the memory of the farmers may affect this study to some extent.
3) There exist differences in the fertility, texture of land and the availability of rain on cultivation, and these matters are not covered under the present study.
4) The present study does not consider the scale inefficiency and time varying inefficiency, if any which exists in the pineapple cultivation.

1.12 Operational Definitions

1. Pineapple cultivation

Pineapple cultivation means the intercrop cultivation of pineapple in new/replanted rubber plantations.

2. Pineapple farmer.

Pineapple farmers are those who cultivate pineapple on commercial basis as an intercrop in own rubber plantations or in leased rubber plantations. But those who cultivate pineapple on a joint venture basis in rubber estates are excluded.

3. Cost of cultivation

Cost of cultivation is the total expenses incurred in cultivating one hectare of pineapple.

4. Return

Return from pineapple cultivation is the difference between the total value received from the produce and cost of cultivation from one hectare of pineapple cultivation.

5. Production frontiers

The maximum producible output from given input bundles with given state of a technology.

6. Efficiency

Efficiency is the ability or capacity of a firm to produce the maximum possible output from a determined group of inputs and a technology.

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Chapter

2 REVIEW OF LITERATURE

Contents

A comprehensive review of past studies is highly essential for proper understanding of the concepts, research design and method of analysis of any research. Hence, a review of studies related to the objectives of the study is presented in this chapter. For the purpose of convenience and clarity, this chapter is divided into two sections. The theoretical aspects relating to technical efficiency is presented in a separate chapter.

1. Studies Relating to Growth Rates and Cost and Return Structure of Agricultural Products
2. Studies Relating to Technical Efficiency.

2.1 Studies Relating to Growth Rates and Cost &Return Structure of Agricultural Products.

Kadiri *et.al* (2014) investigated the profitability of paddy production in Niger Delta region of Nigeria, and to understand how inputs used in paddy production significantly affect the production of the crop. The data collected was analysed using descriptive statistics, multiple regression model and profitability model. The study showed that the average total value of output was 653963 naira per hectare obtained from about 4713kg of paddy. Total operating cost amounted to naira 334917 or 95.18% of the total cost of production, out of which labour cost was naira 324633 or 92% of the total production cost while fixed cost of 16975 naira accounted for 5% of the total cost of production. Rice farmers on the average made a net return of naira 246063per hectare that resulted in a return of 0.80 per every one naira invested. It was also revealed the resources used in rice production significantly affected the production.

Abdi *et.al* (2013) examined the wheat flour price shocks in Pakistan by using time series analysis of secondary data for the period 1961-2012. The study revealed that the wheat flour price trend was found to be increasing. There was price shock in the years 1965, 1988, 2000 and 2007 where nearly 70-80 per cent prices changed. The study further revealed that certain market variation and supply and demand shocks also played a positive relationship in price shocks in those wheat prices. The study further recommended that government should take certain active measures to stabilize prices of wheat in Pakistan.

Meena *et.al* (2013) conducted a study to determine the break even analysis and constraints of garlic production in the Baran district of Rajasthan. The study revealed that the small, medium and large farmers would not incur a loss if their actual yield of garlic declined by 56.22, 54.27 and 54.18 quintals per hectare respectively and would not incur a loss even if their actual price of the produce declined by Rs. 986.96, Rs. 1005.55 and Rs. 1014.77/quintals respectively. The study further revealed that break even yield and price would increased with increased size of holdings of farmers, and the most serious constraints faced by the farmers were the high price of garlic seed, high cost of cultivation, unfavourable product price and high cost of irrigation.

Rifin and Nauly(2013) attempted to analyse the competiveness of Indonesia's cocoa beans and cocoa product export before and after the implementation of export tax policy along with a comparison of other two cocoa beans producer, Ivory Coast and Ghana. The study pointed out that the implementation of cocoa beans tax shifted the cocoa products composition ie from cocoa beans to processed cocoa products. The share of cocoa beans reduced to 51.76 per cent from 75.30 per cent during the period 2009-2011, but the contribution of cocoa butter, paste and powder increased significantly. The study further revealed that, the implementation of export tax had decreased the competitiveness of Indonesia's cocoa beans and cocoa product export compared with the other major two producers, Ivory Coast and Ghana.

Achoja *et.al* (2012) investigated about the determinants of export -led cassava production intensification among small holder farmers in Delta state of Nigeria. The study reported a slow increasing trend in response to export opportunities. The study identified that farm size, credit availability; cassava product domestic prices, labour and frequency of extension contract had a positive effect on cassava output while the existence of efficient marketing system had a negative effect on cassava output. The study pointed out that inadequate finance and high cost of labour were the problems faced by cassava production intensification.

Srinivasan (2012) analysed the situation of paddy cultivation in Kole land in Thrissur district of Kerala in terms of input use, yield and profitability with a view to identifying the major constraints and opportunities of paddy cultivation. The study revealed that the yield per hectare of paddy is very high from Kole land but this is attained with higher input use raising serious concerns on both ecological and economic sustainability. The returns to scale are diminishing returns to scale and labour cost constitutes over 65 per cent of the total cost of cultivation. Higher inputs of labour were used for certain activities like land preparation, transplanting and harvesting. The farmers growing paddy in the Kole land realized a gross return of Rs.56730 per hectare, irrespective of the size of the land holdings or 'padasekharam'. The cost of cultivation per hectare of paddy is about Rs.45588. The analysis of cost of cultivation on landholding size- wise shows that small holder cultivators incur significantly lesser costs. The study finally pointed out the greater role for padasekharams and padasekhara samithi, as institutions to overcome the constraints imposed by the small size of holdings.

Pandit *et.al* (2009) empirically analysed the gains from the contract farming of potato farmers, who were under contract with the Frito lays of Pepsi in West Bengal. The analysis is done on two varieties ie; K. Jyoti (both contract and non-contract farming and Atlantic (only contract farming). The analysis shows that farmers had to spend Rs. 70705 and Rs. 74909 per hectare for cultivation of K. Jyoti and Atlantic respectively. For the same variety, K. Jyoti, the contract farmers spent about Rs. 4000 less per ha for cultivation as compared to non-contract farmers. The BC ratio is worked out at 0.72 for non-contract farmer 0.82 for contract farmers (K.Jyoti) and 1.20 for Atlantic variety during the study period. Contract farming gave good returns of around Rs. 15000 per hectare when non-contract farmers as well as K. Jyoti cultivation of contract farmers incurred losses. The DEA for technical efficiency estimation indicates that the contract method of production was more efficient than non-contract production. Technical inefficiencies could be improved through that adoption of best practices of their efficient farms and the problem of overall technical inefficiency can be tackled by solving the problem of increasing returns to scale.

Birthal *et.al* (2008) analysed the sources of growth in Indian agriculture for the period 1981-82 to 2004-05 focusing on the role of horticultural crops in speeding up agricultural growth. The major conclusions drawn from this study were, despite deceleration in its contribution, technology has remained an important source of growth in Indian agriculture, diversification of agriculture towards horticultural crops has considerable potential to accelerate agricultural growth and horticulture - led growth is an opportunity for small farmers to raise their income. The major implications of the study are decline in the contribution of technology especially when there is a declaration in yield growth, is a major issue of concern. Secondly, the factors underlying demand growth in horticultural products are robust and offer an opportunity to revitalise agricultural growth and augment income of the farmers through diversification of agriculture towards horticultural crops and finally horticulture- led growth can make substantial contribution towards improving livelihood of small farmers provided they are appropriately supported by infrastructure and institutions that enhance their capacity to invest, and link them to markets cutting down transaction costs.

Chand *et.al* (2008) examined the various patterns, trends and successes achieved in diversification towards horticulture since 1970-71 at national and state level with a view to identify the factors underlying its progress and explore further scope for diversification towards horticulture and also compare the productivity with major crop groups. The study revealed that the growth rate in output of fruits and vegetables reached 6 per cent and condiments and spices reached almost 5 per cent. During 1980-81 to 2005-06 the share of fruits and vegetables in total cropped area of the country increased from 2.8 to 4.9 per cent and their share in crop output increased from 15.95 per cent to 25.61 per cent. Among states, Maharashtra maintained more than 5.5 per cent growth rate and Andhra Pradesh has seen acceleration in growth rate from 4 to 5 per cent between 1990s, and 2000s. The last six years show rapid progress in the production of fruits and vegetables in Gujarat, Himachal Pradesh and Chhattisgarh exceeding 10 per cent annual rate of increase. Growth rate tuned out to be either negative or very low in Assam, Karnataka, Rajasthan, West Bengal and Uttarakhand.

Deshmukh (2008) had done a comparative analysis of horticultural sector scenario in post reform period since 1991. The variability in exports of horticultural products is analysed through Coefficient of Variation (CV). Compound Annual Growth Rate (CAGR) was estimated using the exponential regression model to examine the growth trends in the export of various horticultural products. The study revealed that the share of exports from horticultural sector in total agricultural exports has increased from 5.32 per cent in 1990-91 to 9.05 per cent in 2005-06. The study showed that India's share in world horticultural exports increased from 0.59 per cent in 1991 to 1.59 per cent in 2005. The share of vegetables in total horticultural exports of India was the highest followed by onion, fruits, grapes, mangoes and banana in 2006-07. India enjoyed comparative advantage in the export of mango, onion, fruits and vegetables during the period 1991-2005 but lacked comparative advantage in the export of banana. The study further revealed that the exports of Indian horticultural products in value terms have increased considerably in the post reform period, but still the share of India's horticultural trade is negligible.

Giri (2008) assessed the regional potential of triggering agricultural development through horticultural crops in India .The study revealed that in vegetable production, West Bengal and Orissa are the leading states and in the case of fruit production, Maharashtra and Andhra Pradesh are ahead of others. 6-8 per cent of gross cropped area and 8-9 per cent of gross cropped area respectively in West Bengal and Orissa are allocated to vegetable cultivation. In Maharashtra and Andhra Pradesh the area allocated to fruit production was 2-3 percent with an increment of 5-6 per cent during 2004-05. The study further revealed that land area released from food grain is utilized for crops other than fruits and vegetables in Maharashtra and Andhra Pradesh whereas the increased gross cropped area in West Bengal is allotted to food grains, vegetables and fruits.

Kumaresan *et.al* (2008) examined the performance of large scale farming in sericulture through the measurement of productivity and economic differences between large and small scale sericulture farming and analysed the sources of such differences as it is carried out in Tamil Nadu. The study revealed that the cost of production of cocoon was more for the large farmers (Rs. 100.61/kg of cocoon) than that of small farmer (Rs. 93.48/kg), as they produced less quantity of cocoon for almost the same expenditure which may be attributed to management problems in large scale rearing. Small scale silkworm rearers obtained higher revenue by realizing (Rs104666/acre/year) from the sale of cocoon and generation of byproducts than that of large scale rearers (Rs. 94732/acre/year), as the small scale rearers obtained better yield and price, compared to the large scale rearers. The net return earned by the large scale rearers and small scale rearers worked out to Rs. 30564 and Rs. 40128 acre/year.

Prakash *et.al* (2008) examined the current status of fruits and vegetables processing in India and its emerging trends, to identify the constraints experienced by fruits and vegetables processing industry and to suggest policy measures for strengthening the net work of this industry in India. The study revealed that the area and production of fruits and vegetables increased during 1987-88 and 2004-05 but yields of these crops are quite low in comparison to yields obtained in developed countries. Low productivity coupled with inadequate production technology, non availability of good quality raw material, poor quality of finished products, non-availability of refrigerated transport and cold storages, good quality packing, poor storage of quality seeds are the major constraints being faced by fruits and vegetables processing industry. He concluded that prospects of this industry is bright due to changing food habits and practices, reduced dependence on domestic servants/cooks, increasing health consciousness, status promotion and changing socio-economic scenario.

Rai and Rai (2008) conducted a study to evaluate the economics of guava production in Kanpur Nagar district of Uttar Pradesh. On an average input cost of Rs.31673.50 per hectare was incurred during establishment period on guava orchard at first to three year basis. The study observed that the guava orchard is economical up to 3-12 years age thereafter the size and quality both declined. Lack of innovative market access, lack of processing industries, cold storages and inefficient transportation are the major drawbacks which hamper the productivity and return to guava growers.

Singh and Joshi (2008) investigated the costs and returns to factors of production from crop and dairy farming on marginal and small farmers in Punjab for the year 2003-04. Four stage-stratified-random sampling techniques were adopted for the study; i.e. agro-climatic zone (first stage), development block (second stage), village (third stage) and operational holding (fourth stage). The per-hectare gross income from crop production was estimated to be almost same on marginal (Rs 23926) and small (Rs23714) farms. The total disposable income was found to be highest in zone II, on both marginal (Rs.64525) and small (Rs.99253) farms followed by zone III and zone-I. It has been found that a majority of the farm households are not able to meet their requirements from their income from crops and dairy farming. Further dairy farming has emerged as a major allied enterprise for supplementing the income of marginal and small farmers in Punjab.

Vasisht *et.al* (2008) made an attempt to empirically analyse the magnitude of price variability and integration that has taken place across the state level fruit and vegetable markets in India. Time series data on wholesale prices of two important fruits (apple and pineapple) and vegetables (Potato and cauliflower) for the period 1998-2006 were used for examining intra year price variations using the coefficient of average seasonal price variation, co-efficient of variation and the intra year price rise. The price relationships across the markets are studied within a framework of Augmented Dickey-Faller and Johnson multivariate co-integration and error correction model. The findings obtained in the study indicate that the horticulture in India can thrive for greater benefit of both producers and consumers only if better infrastructural facilities like cold storage, refrigerated trucks/vans for transportation, modern marketing infrastructure etc. as well as timely availability of market information, and better market intelligence etc. are developed fast across all the states.

Verma (2008) conducted a study to estimate the various marketing costs and margins and the onion grower's share in the consumer's rupee, marketing efficiency of onion and the problems faced by the onion growers in the marketing of onion in Indore district in Madhya. The study revealed that the onion growers in the study area sold their produce through three marketing channels ie. Channel-I producer-consumer, Channel -II Producer- Retailer-Consumer and Channel–III Producer-wholesaler-Retailer-consumer. The marketing cost was the highest in Channel III, followed by Channel II and I. the producer received the maximum share of consumer's rupee in channel-I followed by channel -II and Channel -III. In the present study, the marketing efficiency is inversely related to the total costs and margins. As the number of intermediaries increased, costs and margins increased and inverse was the marketing efficiency. The results of the study indicate that to reduce the price spread, the onion growers should be encouraged to sell their produce through co-operative marketing societies.

Suresh Kumar *et.al* (2007) made an attempt to analyse the cost and returns from apple orchards in Himachal Pradesh along with the problems faced by the orchardists in production and marketing of apples. The study revealed that the farmers have to incur cost on maintenance for about 7 years which ranges from Rs 34962 during the first year to Rs 67444 per hectare during the seventh year. The per hectare cost increased from Rs 51325(8^{th} year) to Rs 58924 per hectare (21-30 years) with the increase in the age of plants. The productivity of plants ranges from 7307 kg/ha in 8^{th} year to 15985/ha in 16-20 age group and declines to 12318 kg/ha in 31and above group.Net returns also vary with age of plants. Maximum per hectare returns are observed in case of 16-20 years of age group ie Rs 232541/ha followed by 21-30 years of age, i.e. Rs 181002/ha. Least net returns are noticed in case of 8^{th} year age group, i.e. Rs 81067/ha. The major problems faced by the apple farmers were support/procurement price problem, transportation problem, irrigation problem, picking, grading & packing problems etc.

Hazarika *et.al* (2006) conducted a study on marketing efficiency of pineapple cultivation in Assam. The study found that the marketing channels of pineapple consist of middlemen like retailers, wholesalers, wholesale commission agents, wholesale cum pre harvest contractor and the pre harvest contractor. It was observed from the study that the most effective channels were not always the most efficient channels. The efficiency of all the channels was found to be very low and the marketing costs were very high. The study pointed out that in the light of the above; there is an urgent need for the implementation of better post harvest management of perishable agricultural commodity like pineapple in Assam.

Alagumani (2005) analysed the cost, returns and resource use efficiency of the Tissue-Cultured Banana (TCB) and Sucker-Propagated Banana (SPB) in Theni district of Tamil Nadu. The study revealed that the total cost of cultivation of TCB is Rs. 141040 per hectare and for SPB is Rs.108294 per hectare and was higher for TCB by 30.24 per cent. The total cost for TCB was higher due to high plantlet cost and other variable cost. The Net Income for TCB is Rs.112262 per ha and for SPB is Rs.78855 per/ha. The net income was higher by 42.37 per cent in TCB than in SPB. The returns to scale of TCB is 1.06 which is very close to unity indicating constant returns to scale and of SPB is 0.69 that indicated the decreasing returns to scale. Using the probit mode analysis, it has been found that gross income and bunch weight are the major factors influencing the adoption of tissue-cultured banana.

Sreela (2005) conducted a study aimed at analysing the economics of vegetables like, bitter gourd, snake gourd and ivy gourd and to assess the technical efficiency, marketing efficiency and constraints faced by the vegetable growers. The study showed that total expenditure at cost C_3 at aggregate level was Rs.105717, Rs.103277 , Rs.137498 and Rs.98711 for bitter gourd, snake gourd, ivy gourd(main crop and) ivy gourd (ratoon crop) respectively. The net income for bitter gourd, snake gourd, ivy gourd (main crop and) ivy gourd (ratoon crop) were Rs.80478, Rs.13288, Rs.1951 and Rs.18636 respectively. The mean technical efficiency of the vegetables estimate was 0.85, 0.91 and 0.58 respectively for bitter gourd, snake gourd and ivy gourd. Among the marketing channel, producer- VFPCK market - wholesaler-retailer- consumer was the most important one for ivy gourd. The most important constraint faced by the vegetable growers in the study area was the incidence of pests and diseases.

Srinivas and Ramanathan(2005) examined the cost of cultivation, farm income measures and resource use efficiency of elephant foot yam in the states of Andhra Pradesh, Tamil Nadu and Kerala. The study reveals Cost C3 as Rs.173105, Rs.93450 and Rs.168032 per ha in Kerala, Andhra Pradesh and Tamil Nadu. Net returns is computed as Rs.63263, 35808 and Rs.83413 per ha in Kerala, Andhra Pradesh and Tamil Nadu respectively. In Kerala the utilization of inputs like hired labour, family labour and seed/planting material was optimal indicating that use of these inputs could be increased sufficiently. In Tamil Nadu, the inputs, manures, phosphatic fertilizers and irrigation- were used optimally, indicating that the utilization of these inputs could be increased sufficiently. In Andhra, Pradesh, the inputs planting material, phosphatic and potassium fertilizers were used optimally, indicating that the utilization of these inputs could be increased sufficiently where utilization of farm size, manures, nitrogenous fertilizers and hired labour was not at optimum levels. The study concluded that there is a scope to enhance the expenditure on planting material in Kerala and Andhra Pradesh while it has to be reduced in Tamil Nadu to achieve optimum productivity and thereby higher gross income.

Padmini (2002) estimated the cost and returns from pineapple cultivation and also aimed at identifying the problems faced by the pineapple farmers in Kerala. The study estimated cost of producing one tone of pineapple fruit as Rs 4280 for small farmers, Rs 3992 for medium farmers and Rs3992 for large farmers in the first year of cultivation. In the second year, the cost of production amounts to Rs 2526 for small farmers ,Rs 2362 for medium farmers and Rs 2248 for large farmers and in the third year, the cost of production amounts to Rs 1248 for small farmers, Rs 1097 for medium farmers and Rs 1033 for large farmers. The return from pineapple cultivation ascertained as Rs 19077 /ha for small farmers ,Rs 26964/ha for medium farmers and Rs 26202/ha for large farmers in the first year ,Rs 97905 for small farmers ,Rs 101100 for medium farmers and Rs 107450 for the large farmers in the second year and Rs 121955 for small farmers ,Rs 124900 for medium farmers and Rs 128925 for the large farmers in the third year. The study revealed that the major problems faced by the pineapple cultivators are high cost of chemical and bio- fertilizers, lack of financial assistance, high cost of labour , inadequacy of fertile land etc.

Karthikeyan (2001) analysed the economics of cool season vegetables like potato, garlic, carrot and cabbage, and seeks to estimate the technical efficiency and also to identify the constraints faced by the vegetable growers. Costs C3 per hectare were Rs.25951, Rs.34640, Rs.30566 and Rs.27768 respectively for potato, garlic, carrot and cabbage. The outputs per hectare were 8563 Kg, 3017 Kg, 5879 Kg and 16360 Kg respectively for potato, garlic, carrot and cabbage. The gross income per hectare was Rs.48699, Rs.37117, Rs.35040 and Rs.28948 for potato, garlic, carrot and cabbage. The net income per hectare was Rs.13328, Rs.2477, Rs.4474 and Rs.2384 for potato, garlic, carrot and cabbage. The average technical efficiencies of potato, garlic, carrot and cabbage were 0.78, 0.80, 0.71 and 0.63 respectively. The major marketing channel identified was producer - village merchant- commission agent- wholesaler retailer- consumer and the major constraint identified as the low price for the produce for the vegetables in the study area.

Sebastian (2001), examined the supply response, marketing channels and margins of cashew nuts, and identity the constraints experienced by the producers in the production and marketing of cashew nuts. The supply response of cashew nuts revealed that the price of cashew did not have a significant impact on yield, while the relative yield showed a positive and significant influence on yield. The annual maintenance cost at the aggregate level was computed to Rs.7709 per hectare. The material cost was worked out to Rs.1766 and labour cost was computed to Rs.5944. The gross and net returns per hectare at the aggregate level were worked out to Rs.21427 and Rs.13717 respectively. The study identified the major marketing channels were producer-village trader- primary wholesaler-secondary wholesaler-processor, producer-primary wholesaler-secondary wholesaler- processor and producer- secondary wholesaler- processor. The constraint analysis revealed that pests, diseases and low price of the produce were the most important problems faced by the producers in the study area.

Singh and Singh (2001) investigated the economic justification for the commercial cultivation of Damask rose cultivation and distillation in Himachal Pradesh from 1992-93 to 1997-98. The study revealed that Damask rose plantation is a capital intensive and highly specialized enterprise wherein heavy initial investment on plantation and installation of distillation plant is required. The study also shows that the highly variant and seasonal demand for labour especially during short plucking period may also pose management problems to the entrepreneurs for which the possibilities of contract labour need to be explored before taking this venture. At least four-hectare land unit is needed under Damask rose plantation while adopting large size rose oil steam -fed-single-distillation unit plant. The study concluded with the recommendation that based upon the peculiarities and specific requirements of Damask rose cultivation, it is emphasized that the farmers may be persuaded to start cultivation on collective or co-operative basis so that they may produce the minimum designed quantity for distillation in each village/region.

Balakrishnan (2000) examined the economics of the three different varieties of banana namely, nendran, poovan and palayonkodan and to assess the marketing efficiency and constraints experienced by banana growers. The study estimated the cost of production per quintal at cost C_2 were Rs.937, Rs.1045 and Rs.418 for nendran, poovan and palayankodan, respectively. Total receipts from the main product and byproducts at the aggregate level were Rs.223818, Rs.170802 and Rs.89125 for nendran, poovan and palayankodan respectively. The net income from nendran worked to Rs.34248 while it was Rs.50071 and Rs.11536 for poovan and palayankodan respectively. The production function estimation revealed that additional expenditure on plant protection chemicals and support can increase the total returns in nendran and additional expenditure on human labour, manures and plant protection chemicals would increase the total returns in poovan, while in palayankodan, additional expenditure on manures and plant protection chemicals would increase the total returns. The indices of marketing efficiency for nendran, poovan and palayankodan were 2.37, 2.33 and 1.23 respectively through the major channel.

Madan *et al.* (1999) conducted a study with regard to the economics of production and marketing of cauliflower in Ranchi district of Bihar. The study found that the medium size farmers had the biggest advantage of more family labour and better capacity to make capital expenditure on fertilizer, pesticides and irrigation. Small farmers had the advantage of more family labour relating to land size, but they lacked capital while the large farmers had a greater capacity to make capital expenditure, and compared to small and medium farmers, they had less family labour in relation to land. Among the various inputs, farmyard manure constituted 30.53 per cent of the total cost. The study comes with a remark that efforts must be made for easy availability of crop loans.

Pingali and Premarajan (1999) undertook a study on KHDP to measure the increase in area of the fruit and vegetable production and also to measure the resultant increase in yield and income of beneficiary farmers. The study revealed that there is an increase in area of fruit and vegetable cultivation by 86 per cent of which increase in area of banana by 26 per cent and vegetables by 4 per cent in owned land and 34 per cent and 12 per cent in case of leased land. About 12 per cent of farmers show an increase in income by 21-40 per cent and about 20 per cent farmers shows an increase in income by 1-20 per cent and another 25 per cent shows an increase in income but it can't be quantified. The study further revealed that major reasons for change in income is due to the change in farming practices (40 per cent) and increase in area and yield (30 per cent).

Sha (1998) examined the structural changes in the production pattern of various horticultural crops in Maharashtra and India as a whole. The study also examines the relative contribution of area yield and their interaction to the production of horticultural crops with a view to assess the factors responsible for rise or fall in various horticultural crop productions in the state overtime. The analysis shows that the share of Maharashtra in India for various horticultural crop production has fluctuated to a considerable extent. The share of Maharashtra has increased in India in the production of various fruits like grapes, oranges and cashew nuts. The share of the state has declined in the production of commodities like banana and onion. It is seen in the study that the rise in banana, grape, oranges and mosambi output in Maharashtra is due mainly to acreage expansion rather than yield. The effect of interaction between area and yield is found to be about 40 per cent for grapes and mosambi. The output increase in that case of onion is seen to be due to acreage expansion as the effects of yield and interaction of area and yield towards rise in production appeared to have been negative. Both area and interaction between area and yield have shown a negative effect on rise in production of cashew nuts and arecanuts.

Asokan and Chokshi (1997) investigated the problems and the potential for exporting Indian floricultural products and the constraints faced by the Indian exporters. India exported floricultural products valued at 16 million dollars during 1995-96, which is not even a fraction of one per cent of the global trade on floricultural products. The study pointed out that India can emerge as major exporter of flowers and allied materials as it has several advantages such as skilled and cheap labour and favourable agro climatic conditions for growing different types of flowers at different times of the year. India's export of floricultural products is mainly to Europe and North America followed by Japan. But India's export is negligible when compared to the size of these markets. Some of the reasons for India's inability to capture the international market are attributed to poor quality of products, lack of infrastructure for post-harvest care, production on small farms, poorly developed domestic flower market and restrictive trade practices.

Dhawan *et.al* (1997) attempted to look at the future prospects of fruit cultivation and its potential impact on crops and dairying in Punjab. Besides the appraisal of the existing production patterns of the sample farmers, normative programmes were computed for different farm size categories with the existing as well as with relaxed resource constraints. The findings of study conclusively pointed out that existing returns from both kinnow and mango failed to warrant their entries in the optimum plans of the farmers both at the existing and at relaxed resource constraints .Undoubtedly, milk production has been integrated in production programmes of the farmers. Kinnow and mango fruits, at given cost price yield spectrum, were relatively less profitable, and could not figure in normative production programmes of the farmers even at the enhanced resource supply. The findings of the study indicated a tremendous potential, especially on the small farms, for improving income, and employment by making judicious use of borrowed funds. In addition, the efficiency in the use of scarce resources was enhanced with the increase in the farm size.

Koshta and Chandrakar (1997) examined the cost of input use and returns of vegetable crops, marketing cost, utilisation of labour in farm activities and the constraints in the production and marketing of vegetables. The study shows that the cropping intensity of small and large vegetable farms was 204 and 176 per cent respectively. The labour cost was more in all the vegetables except tomato, cauliflower and cucumber. Marketing cost was maximum in ivy –gourd (34 per cent) and minimum in lady's finger (19 per cent). The returns from ivy-gourd, cabbage and bittergourd were comparatively higher than those from other crops on per hectare basis, whereas per quintal returns are found to be high in the case of bittergourd, cucumber, cauliflower and cabbage crops. The main constraints for the development of vegetable crops are poor quality of seed, lack of knowledge, imbalance in the use of fertilizers; selection of good pesticides, scarcity of hired labour supply etc.

Patil (1997) made an attempt to explain the trends in compound growth rates of area, production and productivity of potato, sweet potato onion, tapioca and banana in India using the data from CMIE (1996) for the period 1971-72-1994-95. The data was again divided into two-sub-periods, i.e. Period I covering the years 1971-72 to 1984-85 and period II – 1984-85 to 1994-95. The study reveals that during period I, the compound growth rate of area under potato had increased much more than the area under banana, while the percentage increase in area under sweet potato was negligible and the growth rate of area under tapioca had declined. The percentage growth rate of production of potato was comparatively higher than that of banana while that of tapioca was lower and sweet potato had negative growth ratios. In the period II the annual compound growth rate of area of potato was lower than in the period I. Other vegetables, viz, onion and banana had registered higher growth rates of area than in period I. Banana and tapioca registered a greater increase in yield per hectare than potato, onion and sweet potato. The study concluded that agriculturally developed states such as Punjab, Gujarat, West Bengal, Uttar Pradesh, Karnataka, Tamil Nadu, Maharashtra and Andhra Pradesh had higher yield per hectare than the national average yield in the case of potato, onion and banana.

Rao (1997) conducted a study to compare the employment potential and profitability of selected horticultural crops with traditional field crops revealed that horticultural crops like fruits vegetables and flower crops have higher employment potential compared to field crops, which is mainly due to spread over of the harvesting period in the case of flowers and vegetables. The lower investment costs and higher yields from fruits, flower and vegetable crops have resulted in favourable benefit cost ratios. The study revealed that highest number of man-days of employment was observed in the flower crops ie. jasmine and crossundra with 1210 and 913 man days. Among the fruit crops, papaya needed higher employment of human labour of 704 man days. Among the vegetables, brinjal required higher man days of 439, lady's finger with 314 man days and tomato with 236 man days respectively.

Singh *et.al* (1997) examined the crop composition adopted by the farmers and its main determinant factors and worked out the comparative advantage of different horticultural crops with other crops grown by the farmers of Uttar Pradesh for the year 1995-96. The cost structure of different enterprises showed a great variation on account of their input requirements. In the case of horticultural crops, like guava the cost per hectare per annum worked out to Rs. 11667, mango Rs. 13225 and roses Rs. 14205 (average for the first three years). In all the three crops human labour accounted for the highest share of nearly 27 per cent on their respective total cost. In the case of potato and vegetable crop groups, the per hectare cost C was worked out at Rs. 25920 and Rs. 8110 respectively. The findings of the study revealed that the comparative advantage lies in the production of mango, roses and guava as their income-cost ratio and net returns are higher than cereals, potatoes and vegetable crops. The income cost ratio in fruits and horticulture varies from 1:2.06 to 1.2:60, while their net returns varied from Rs. 12333 to Rs. 21745 per hectare per annum. In the case of cereals and vegetable crop groups, the income – cost ratio ranged between 1:1.13 and 1:1.25 only.

Thorve *et.al* (1997) studied the labour requirement for horticultural vis-a-vis conventional crops and compares the performance of horticultural and other crops in terms of gross income and profitability in Maharashtra. The crops selected for the study were banana and orange among horticultural crops and hybrid cotton, soya been and paddy among conventional crops. The study revealed that the horticultural crops required 129 male labour days per hectare as against 35 male labour days per hectare for the other crops. The result of the analysis indicated that the cultivation of horticultural crops is highly profitable in terms of net return and output-input ratio. The per hectare net return for horticultural crops on cost A basis was Rs. 14450 as against Rs. 6219 for other crops and the output- input ratio was 2.29 and 2.24 for horticultural and conventional crops groups respectively. The study indicates that the horticultural, crops being labour intensive, have great potential to create employment opportunities in the rural areas.

Maurya *et al.* (1996) conducted study on the profitability of banana plantation in Hajipur district of Bihar, reported that the per hectare production of banana was 42.5 tones which was less than the expected yield of 55 tones with recommended package of practices. The profit from banana cultivation worked out to Rs.29798 per hectare while the cost of production per tone was calculated as Rs.474. The price received by the producers came to Rs.1176 per ton thus leaving a substantial margin of profit to the producers.

Prasad and Bonney (1996) conducted a study in Trichur district in Kerala to delineate the constraints in the adoption of improved agricultural practices by commercial vegetable growers. The study found that 98 per cent of the respondents reported the most important constraint as increased cost of plant protection chemicals followed by inadequate market facilities (88 per cent) and poor storage and other post harvest facilities (74 per cent). The other major constraints were identified as inadequacy of capital, high labour charges and water scarcity.

Brhmaiah and Naidu (1993) undertook a study on Chilies found that labour was one of the major constituents of total cost incurred which had a direct impact on earnings. The study further revealed that there was a direct relation between farm size and total labour cost. The various cost components for large and small farms indicated that manures and fertilizers took the largest share in total expenditure followed by other inputs like lease rent on land, plant protection, human labour and bullock labour. The study concluded that the chillies in general were a responsive and labour intensive crop. Productivity was highest on large farms and directly related with farm size.

Dahiya and Pandey(1993) attempted to discuss the production, marketing, investment pattern, trends in exports and other agro climatic aspects of potato cultivation in the state of Himachal Pradesh. The study showed that the average cost (Cost C) was Rs 18475/ha. The farmers earned net returns of Rs 2998/ha and the output input ratio was 1.16. Category wise analysis of economics of potato production indicates that the large farmers earned the highest net returns of Rs 6903/ha ,followed by the marginal farmers Rs 5053/ha ,semi-medium farmers Rs 2920,small farmers Rs 2263 and medium farmers Rs 1932.Component wise analysis of cost of cultivation indicated that the seed input accounted for the highest average cost of 28.58 percentage followed by human labour (25.81per cent) ,rental value of land (23.24 per cent), bullock labour (8.58 per cent) ,fertilizers and manures (7.66 per cent). The study revealed that in a strategy for development of tribal and hill areas, the exploitation of comparative economic advantage enjoyed by vegetable crops like potatoes should be given top priority. The study further showed that the farm size and investment of fixed capital were positively correlated being Rs.34113/- per marginal farm and Rs.70225/- per large farm. Input use pattern on the sample farmer indicated that seed ratio was 18.39 /ha, fertilizer use N -110 kg/ha, P_2O -5122 kg/ha, K_2O -84kg/ha. and man day requirement is 201 on per hectare basis. In Shimla district the out- input ratio was 1.16 during 1989-90. The market structure was competitive in Manali market while it was oligopolistic in Shimla market.

Jose (1993) conducted a study to find out the benefits of growing pineapple as an intercrop, to work out the BCR and to study its feasibility when compared to other cropping systems. The net returns per hectare was found to be Rs 7038(Mauritius), Rs 5832 (loss for Kew) for first year, Rs 58596 (Mauritius), Rs 10825(Kew) for second year and Rs 77272 (Mauritius) ,Rs 14230 (Kew) for the third year. The BC ratio is worked out to be 1.27 .2.41and 2.48 respectively for the Mauritius for first ,second and third year. The BC ratio is estimated at 0.73, 1.33 and 1.30 respectively Kew in the first, second and third year. This indicates that Mauritius was relatively more profitable than Kew. The relative lower profitability of Kew is due to factors like lower price realisation, lower sucker production, more input requirement and more time required for attaining maturity of fruits. The study further revealed that soil erosion and weed growth are low or medium in pineapple intercropped plots. The study highlighted the potential of pineapple as an intercrop in rubber plantations in the Taluk.

Indira Devi *et al.* (1992) made an attempt to study the growth and performance of co-operative agricultural credit in Kerala for a period of 11 years from 1976-77 to 1987-88 based on crop-wise and source wise data on agricultural loan. The study revealed that in case of banana, the total credit increased by 17 per cent per hectare and credit supply by 8.37 per cent during the period. Correlation analysis emphasized the significant positive relation between credit supply and productivity (r = 0.67). Banana being a highly profitable crop with a benefit -cost ratio of 1:55, it was very likely that the loan amount availed was fully utilized for its cultivation expenses rather than for other consumption needs.

Senthilnathan and Srinivasan (1992) studied the economics of substitution between poovan, banana and paddy in wet lands of Tiruchirappally district of Tamil Nadu. The study revealed that a total of 6720 poovan bunches were harvested in the whole three years (planted crop, first ratoon and second ratoon) and with a mean price received per bunch of Rs.41.65, the total returns received after three years worked out to Rs.286914. The mean cost of cultivation for the three years came to Rs. 124678 per hectare and the net income received was Rs. 162236 per hectare.

Sharma *et al.* (1992) conducted a study on economics of vegetable farming in mid hills of Himachal Pradesh and revealed that lady's finger and chillies in kharif and cauliflower and cabbage in rabi were the most paying vegetable crops. However, cauliflower, cabbage and peas in rabi and bittergourd and brinjal in kharif were the most remunerative vegetable crops. The input-output analysis suggested that farmers can increase total output by enhancing the use of labour. The study also brought out that there was increasing returns to scale in cauliflower, potato and brinjal suggesting that more returns could be obtained if the use of the inputs like human labour, bullock labour and working capital were enhanced.

Krishnan *et.al* (1991) examined the trends in the growth rate of area, production and productivity of major crops of Kerala for the period of 1970-71 to 1986-87. The study also examined the magnitude of instability of these variables along with the percentage contribution of area and productivity towards increasing the production of major crops of Kerala. The study showed that the extensive phase of agricultural growth in Kerala is probably over by sixties and after 1970-71, the rate of increase in the intensity of cropping has also shown a decelerating trend. The study revealed that there was a shift in the cropping pattern in favour of plantation and commercial crops. The shift in the cropping pattern can also be attributed to the exorbitant wage levels. Socio economic factors such as the gulf boom have also contributed to the changing agricultural scenario in Kerala.

Chennarayudu *et al.* (1990) conducted a study on the land use efficiency of banana in Guntur district of Andhra Pradesh. The study revealed that the operational costs contributed to the extent of 69 per cent of the total cost of cultivation of banana. Among the various items under operational costs, manures and fertilizers contributed larger share (27 per cent) followed by human labour (22 per cent). The benefit cost ratio worked to 1:1 and the net income to Rs.8917 per hectare for the banana crop.

Indira Devi *et.al* (1990) analysed the trend in area, production and productivity of banana in Kerala during the period 1967-68 to 1986-87. The study also aimed to estimate the output response behavior of banana growers in the state. The analysis showed that the increase in production was due to intensive cultivation practices and the favourable price factors had a significant positive influence in banana production. The study reported that in Kerala, the intensive use of resource is very much important as the scope of expanding area under cultivation is meager. So it calls for more in-depth research on various cultivation aspects and transfer of modern technologies to the field. Assuming that the same trend continues, the crop will turn out to be a much more profitable enterprise.

Bastine and Radhakrishnan (1988) conducted a study in Irinjalakkuda block in Trichur district of Kerala which revealed that the cost of cultivation of banana per hectare was Rs 36249. The returns worked out to Rs 45068 and the net income worked out to 8819 on cost C basis and at cost excluding rental value of land was Rs 17833. The main items of expenditure in the cost of cultivation of banana per hectare were the cost of labour, both family and hired (26.98 per cent) and manures (24.60 per cent). The contribution of family labour showed a decreasing trend as the size of holding increases. The farm business income, family labour income and farm investment income amounted to Rs 20439, Rs.11061 and Rs.18197 per hectare respectively.

2.2 Studies Relating to Technical Efficiency.

Jiang and Sharp (2014) estimated the cost efficiency of dairy farming separately for North Island and South Island of New Zealand. The average cost efficiency for diaries in the North Island was estimated at about 83 per cent, while the overall mean efficiency was 80 per cent for the South Island dairy farms. The result of the study pointed out that there existed a significant negative relationship between cost efficiency and capital intensity and livestock quality, and a positive relationship between cost efficiency and herd size. The study came to an end with the concluding remark that there were opportunities for New Zealand diaries to improve cost efficiency and thus the competitiveness.

Ogundari (2014) made an attempt to find out the level of technical efficiency estimates of African agriculture and to identify the driving forces of efficiency levels for three decades (1984-2013) of research on productivity of African agriculture using a Meta Regression Analysis (MRA). The study revealed that the overall mean farm level technical efficiency was about 0.68 indicating that there was a scope for improving the efficiency by about 32 per cent if agricultural production was on the frontier level in the region. The result of MRA indicated that mean technical efficiency estimates of African agriculture from the primary studies decreased significantly as year of survey increased which, implied negative efficiency change characterized by development of African agriculture and food production. The other key drivers of efficiency levels of African agriculture and food production over the years were education, years of experience, extension, credit, farm size and membership of co-operative society. The study concluded that these findings had policy implications for strengthening food security through efficiency improvement in African agriculture and food production.

Suresh (2013) conducted a study to identify the trends in the total factor productivity (TFP) growth of rice in India for the period from 1980 - 81 to 2009-10 and also carried out a sub period analysis, i.e. from 1980-81 to 1994-95 period I, and from 1995-96 to 2009-10 (Period II). The study used Malamquist Productivity Index approach through DEA to estimate the TFP.

The study pointed out that for the whole period, the TFP change has been at a moderate rate of 0.2 per cent per year with large interstate variations. The positive TFP growth had been associated with a mean technical progress of 0.3 per cent and a deterioration of the mean technical efficiency by -0.1 per cent per year. The study further identified that during period II the share of current and capital inputs in total cost of cultivation had reduced and input intensification had slowed down. The result of the study revealed that the recent yield stagnation in rice was not due to technology fatigue, but could be due to the sluggish input intensification.

Watto (2013) conducted a study to estimate the efficiency of ground water use in cotton production in the Punjab province of Pakistan. The results obtained by DEA sub vector and slack based models indicated that low levels of technical inefficiency with water buyers had been more inefficient relative to tube well owners .But the ground water use inefficiency was more pronounced than the respective technical efficiency. The study again pointed out that majority of cotton growers were operating at increasing returns to scale, suggesting that efficiency could be improved by expanding the scale of operation. The study concluded that the level of education, seed quality and extension services had positive significant impact on technical and ground water use efficiency.

Rahman *et.al* (2012) estimated the farm level technical efficiency of large, medium, small and marginal rice growers in Bangladesh. The average technical efficiency estimated for large, medium, small, and marginal and all farmers were 0.88, 0.92, 0.94, 0.75 and 0.88 respectively indicating, that on an aggregate level, the farmers could increase 12 per cent output with proper application of inputs and production technology. The study further revealed that there was significant technical inefficiency in the production of rice for marginal farmers and pointed out that proper farm management could help in increasing production in marginal farms. The study further found out that cost of fertilizer, manure, irrigation, insecticide and area, and experience were important factors to increase rice production.

Amor and Muller (2010) estimated the farm level inefficiency of Tunisian irrigated crop production for three crops (cereals, fruit trees and vegetables) using stochastic frontier analysis by fitting a Cobb Douglass production function. The estimated value of gamma is 0.948, 0.896 and 0.903 respectively for cereal, fruit trees and vegetables. The mean technical efficiency is estimated to be 0.54 for vegetables, 0.77 for cereals and 0.80 for fruit trees. The generalized likelihood ratio tests of the nullity of the variance parameter, is rejected indicating the dominance of inefficiency in production. 75 per cent of the farmers are below 50 per cent efficiency, in the case of vegetables. The study concluded that there is considerable room for efficiency improvement for vegetables in Tunisian agriculture. However, cereals and fruit-trees correspond to more reasonable efficiency levels.

Kachroo *et.al* (2010) explored the technical efficiency of wheat farmers under dry land and irrigated conditions in the Jammu district of J&K state. The inputs specified in the production model were area under wheat, quantity of seed used, quantity of fertilizers used, family labour used, and hired labour used. The variables in the linear regression model for estimating the technical inefficiency were farm size, number of man days, and proportion of children as helpers and education level of the selected farmers. The study confirmed that the farmers under irrigated conditions are technically more efficient than under dry land conditions. The mean technical efficiency has been found as 0.84 per cent for dry land condition and 0.88 per cent for irrigated condition. The study further showed that 99 per cent under dry and 88 per cent under irrigated condition of that observed inefficiency was due to farmers inefficiency in decision making and only 1 per cent and 12 per cent of it was due to random factors outside their control. Education under both the farming system is contributing negatively to the technical efficiency. The study concludes that technical efficiency of wheat growers in the Jammu district of J&K state can be improved by the use of proper technology.

Kaur *et.al* (2010) investigated the level of technical inefficiency present in wheat production in the Punjab state, along with the influence of various farm specific socio-economic factors on these inefficiencies. The study is based on the cross sectional data collected from a random sample of 564 farm households of these 58 from semi-hilly region, 318 from central region and 188 from south-western regions for the year 2005-06. The mean technical efficacy is 87 per cent for semi-hilly region, 94 per cent for central region and 86 per cent in the south-western region and 87 per cent for the Punjab state. Across the different regions, the area of wheat has contributed positively and significantly. An analysis of variables that influence efficiencies shows that, age, education and experience of farmer, and percentage area under the crop significantly and positively influence the efficiency.

Narala and Zala (2010) analyzed the technical efficiency in rice production, along with the influence of various socio-economic factors, on efficiency of the rice farms in the central Gujarat. The value of gamma is 0.86 in all farms which indicates the presence of significant inefficiencies in the production of rice crop. The values of gamma were 94 per cent, 66 per cent, 100 per cent and 97 per cent in marginal, small, medium and large size farms respectively. The average level of technical efficiency has been estimated as 72.78 per cent on farms as a whole and as71per cent, 81per cent, 99 per cent and 86 per cent respectively for marginal, small, medium and large farmers.

Operational area, experience, education and distance of field from canal structure have been identified as the most influential determinants of technical efficiency. They are also the shifting factors of the production frontier.

Sekhon *et.al* (2010) conducted a study to find out the technical efficiency in crop production, in Punjab by dividing the state into three zones: sub mountainous zone, central plain zone and south western zone. Technical efficiency of individual farm was estimated through stochastic frontier production function analysis. The inputs included were human labour, number of irrigations per acre, seed value, cost of fertilizer, plant protection and machine cost (Rs/acre). The inefficiency variables included were age, education, farm size, family size, number of occupations and experience in agriculture of the sample farmers. The study shows that in Punjab there is a need to improve the technical efficiency of majority of the farmers. The average technical efficiency has been estimated to be about 76 per cent. The value of gamma has been found as 0.52, 0.93 and 0.99, and overall 0.88. The main drivers are the experience in agriculture and age of the farmer. The study concluded that the state would benefit more if policy interventions are developed at the local levels.

Oyewo *et.al* (2009) attempted to estimate the technical efficiency among maize farmers in Oyo state. The estimated gamma parameter is only 0.13 indicating that 13 per cent of the total variation in maize output is due to the technical inefficiencies in the study. The mean technical efficiency is 84 per cent with a range between 66 per cent and 99 per cent. The sources of inefficiency were specified as those relating to education, experience, family size and land right. The determinants of technical efficiency include farm size, hired labour and seed. The study has concluded that there is a positive and significant relationship between the farm size, quality of seed used with the maize output.

Bamiro (2008) analyzed the technical efficiency and its determinants in pig production in Ogun state, Nigeria .The predicted farm specific technical efficiencies ranged between 0.20 and 0.92 with a mean of 0.43. The technical efficiency shows that about 55 per cent of the farmers had technical efficiency below 0.40 and about 45 per cent had technical efficiency ranging between 0.40 and 0.92. The gamma was estimated as 80 per cent and is the presence of technical inefficiency effects in pig production is confirmed by a test of hypothesis for the presence of inefficiency effects using the generalized likelihood ratio test. The technical efficiency is influenced by number of sew and feed intake.

Sharma *et.al* (2008) estimated the input efficiency with respect to cereals like maize, wheat and paddy in the state of Himachal Pradesh. The analysis of cross sectional data has revealed inefficiency in terms of inputs application. The mean technical efficiencies have revealed that a considerable portion of frontier output is left untapped and it is 35-42 per cent in maize, 44-50 per cent in paddy and 61-67 per cent in wheat. The ratio of marginal value productivity and marginal factor cost has been found to be more than one in the case of 50 per cent inputs for all the crops. The results have indicated that there is scope to increase the returns from wheat production by using more farmyard manure, chemical fertilizers, male labour, female labour and bullock labour. In the case of maize, the yield could be increased by increasing the use of more of farmyard manure, chemical fertilizers male labour and seeds.

Singh (2008) undertook to estimate the farm specific economic efficiency under different categories of fish farms by estimating technical and allocative efficiencies in South Tripura district of Tripura state during 2004-05. The samples were collected from, two farm types, category I farms and category II farms. The mean technical efficiency (TE) is 69 per cent, 65 per cent and 68 per cent respectively for that category I, category II, and for all farms. The estimate of gamma indicates the presence, as well as the dominance, of inefficiency effect over random error in category I, II and all farms. In the case of allocative efficiency (AE), the gamma estimates indicate that more than 77 per cent of the difference between observed cost and frontier cost is due to allocative inefficiencies. The highest number of farmers have AE between 0.60- 0.70 in category I and 0.70-0.80 in category II, representing about 20and 27per cent of the sample farmers respectively. The corresponding median AE levels were of 61, 50 and 57per cent. The mean and median economic efficiency (EE) are found higher in category I farms than in category II farms. The mean EE in over all farms is estimated at the level of 44 per cent. The TE appeared to be more significant than AE as a source of gains in EE.

Singh (2007) assessed the technical efficiency of wheat farmers in Haryana at the aggregate level and three farm-size level by the method of Corrected Ordinary Least Square (COLS). For this, farm level cross sectional data pertaining to rabi season of the year 1998-99 was used. All the coefficients of independent variables such as agro chemicals, labour and land were found statistically significant and depicted the expected signs at the aggregate level and for small and medium size forms. The mean technical efficiency turned out to be 73 per cent at the aggregate level, 75 per cent for small farmers, 74 per cent for the large farmers and 73 per cent for the medium farmers. The study has indicated high degree of technical inefficiency in wheat farming in Haryana which has been attributed to the low level of education of farmers, poor extension services and labour usage.

Belloumi and Matoussi (2006) investigated the technical efficiency measures of private and GIC date farms in Southern Tunisia using stochastic production frontier models. The inputs included in the model are irrigated water, labour, phosphate, farmyard manure and water salinity. The farm specific variables were farmer's age, farmer's education, farmer's experiences, land fragmentation, farm size etc. The study finds out that on an average, the private system is found to be slightly more efficient than the GIC one. The mean technical efficiency of GIC farms is 67 per cent and private sample is 69 per cent.The yield of date could be explained mainly by four variables. Water quantity applied per palm tree, labour per palm tree, and phosphate per palm tree and water salinity. The study concluded with the recommendation of further studies to investigate sources of inefficiency and compare those two systems, such as the determination of allocative and economic inefficiencies.

Goyal *et.al* (2006) estimated farm specific technical efficiency for paddy farmers in Haryana, using the stochastic frontier approach for panel data for the period 1996-1999. The variables family size, age and schooling are included in the model for the technical inefficiency effects to indicate the possible effects of farmer's characteristics on the efficiency of paddy production. The parameter gamma is estimated to be close to one due and is statistically significant at 1 per cent level indicates that inefficiency effects are highly significant. The mean technical efficiency is estimated as 80 per cent for the first year, 79 per cent for the second year 73 per cent for the third year and 77 per cent for the whole period. The mean technical efficiency declined from first year to last year indicating that average technical efficiency deteriorated through years in paddy production. Further, the technical inefficiencies of production of farmer are significantly related to age and year of observation but not significantly related to schooling and land.

Ogundari *et.al* (2006) examined the cost efficiency of small scale maize farmers in Ondo state, Nigeria using stochastic frontier cost function and also aims at investigating the factors that determine the cost efficiency of farmers, as well as to determine the economics of scale of the farmers. The maximum likelihood estimates of the parameters of the stochastic cost frontier have the expected sign with cost of labour, cost of seed, annual depreciation cost and maize output is significant at 5 per cent level. The estimated gamma parameter of the model is 0.81 indicating that about 81 per cent of the variation of the total cost of production among the sample farmers was due to differences in their cost efficiencies. The mean cost efficiency of the farms was estimated at 1.16, indicating that an average maize farm in the sample area has costs that are about 16 per cent above the minimum, defined by the frontier.

Shanmugam and Venkataramani (2006) attempted to measure the technical efficiency (TE) of agricultural production in 248 districts spread across 12 major states. This study incorporates health as a factor that influences production indirectly, through direct effects on TE. The study shows that the mean technical efficiency for the districts is 79 per cent, indicating, on an average; agricultural output can be increased by about 21 per cent with existing resources. Nearly half of the sample districts (123 out of 248) have the TE value lie below 80 per cent and out of this 84 districts are spread across four states, i.e. Utter Pradesh (38) Madhya Pradesh (27), Maharashtra 917) and Rajasthan (12). The study has shown that health, education and infrastructure can be powerful drivers of efficiency at the district level. The study has also shown that the relative importance of the determinants of technical efficiency across districts depends greatly on environmental factors, such as agro-climatic zones, technological factors and crop mix.

Arsalanbed (2005) examined the agricultural production in the north – west of Iran in the west Azerbaijan province among the corps wheat, barley, sugar beet, sunflower, potato and tomato. The data on six variables were used to estimate the production functions as monetary value of output in toomans, land in hectares and costs of seed, fertilizer, machinery and labour in toomans. One tooman is equivalent to ten rials. All the coefficients of the production function are different from zero at less than one per cent level of significance. Since the sum of coefficients of production is larger than 1, increasing returns to scale prevailed. Mean technical efficiency was estimated to be 93 per cent, 0.39 per cent of farmers had efficiencies of less than 80 per cent, 7.89 per cent of them had efficiencies between 80 and 90 per cent and 91.72 per cent of the farmers had efficiencies more than 90 per cent.

Mruthyunjaya *et.al* (2005) conducted a study to examine the technical, allocative and scale inefficiencies in oil seeds and oil production in India and identified the factors responsible for the inefficiencies and has suggested ways to address them. The study has covered groundnut, rapeseed and mustard, soyabean, and sunflower, which accounted for more than 80 per cent of the total oilseeds area and 90 per cent of the total oil seeds production in the country. The mean technical efficiency (TE) in different states ranged from 64 to 75 per cent for groundnut, 65 to 67 per cent for rapeseed and mustard, 59 to 73 per cent for soyabean and 69 to 79 per cent for sunflower. The analysis of data revealed the presence of 25 per cent to 30 per cent technical inefficiencies in oil seed production at the average level and even more at the farm/ processing unit level along with allocative and scale in efficiencies. Soil quality, seed replacement and education have been found as determinants of technical efficiency in oilseed production, whereas availability of adequate raw material and higher oil recovery determine the technical efficiency in oil production. Lack of assured market for oil seeds and lack of timely and assured supply of quality seeds and raw materials for processing are some of the important factors for the poor performance of the oil seed industry.

Reddy and Sen (2004) conducted a study to quantify technical inefficiency in rice production and investigate the influence of farm specific socio-economic characteristics on inefficiency in the Sone canal command area of the state of Bihar. The estimates of all independent variables considered have positive coefficients except human labour. Area, fertilizers, plant protection chemicals, bullock labour and machine labour were positively significant. The gamma value was found to be 0.83 indicating the presence as well as dominance of inefficiency effect over random error. Technical inefficiency of sample farmers ranged between 6.67 and 66.42 per cent with an average of 25.55 per cent. Technical inefficiency in the production of rice is negatively related with farm size, education of the farmer, experiences, extension contacts and percentages of good land and positively related with age and fragmentation of the land.

Uma Devi and Prasad (2004) conducted a study to determine the technical efficiency in black tiger shrimp production in the coastal Andhra Pradesh using data envelopment analysis (DEA) approach and to investigate the factors affecting technical efficiency through multiple linear regression analysis. The mean technical efficiencies for the extensive systems varied from 80 per cent to 88 per cent and for the semi- intensive system from 85 per cent to 88 per cent. In the extensive and semi intensive systems the mean technical inefficiencies were lower in west Godavari and Visakhapatnam districts compared to Nellore District. Among the farm specific variables, the farm size and farmer's experience had no influence on the technical efficiency. Owner managed farms, having better concentration on sustainability of the shrimp farming were found to be more efficient than the tenant farmers in extensive farms of the Nellore district.

Iraizoz *et.al* (2003) estimated the technical efficiency of tomato and asparagus production using non-parametric and parametric frontier production function approach. Under parametric approach the mean technical efficiency estimated was 0.80 with a standard deviation of 0.13 for asparagus and 0.89 with a standard deviation of 0.07 for tomato production. They conclude that future agriculture policies could include measures to improve the capacity of farmers to apply the available technology more efficiently. This can be done by improving access to extension services, or trying to raise the educational level of farmers.

Rama Rao *et al* (2003) examined the levels of technical efficiency in the production of three major crops viz; rice, ground nut and cotton in the state of Andhra Pradesh. Both OLS regression and ML estimates of technical efficiency are estimated for the crops. The average technical efficiency of rice is estimated as 85 per cent ground nut is 79 per cent and cotton is 72 per cent. In the case of rice, all input variables were significant. In the case of groundnut also all the variables included in the model significantly influence the yield of ground nut. In the case of cotton, except the expenditure on plant protection, all other variables excreted a positive and significant influence on the yield of cotton. It was also found that education influenced technical efficiency significantly, and there for, efforts should be strengthened to promote both formal and informal education.

Shanmugam (2003) attempted to measure the farm specific technical efficiency of raising major principal crops - rice in Kharif (season - I) and Samba (season-II) seasons, irrigated and rain fed groundnut and cotton in various agricultural zones in Tamil Nadu. An attempt is also made to identify the factors determining the technical efficiency of farms in producing these crops. The estimated value of gamma are 0.85, 0.76, 0.43 and 0.91 for rice, irrigated groundnut, rain fed groundnut and cotton respectively. The estimated mean TE values of the respective crops are 82 per cent, 68 per cent, 76 per cent and 67 per cent indicating that the sample farmers, on an average could increase the output of rice II crop by 18 per cent, irrigated groundnut and cotton by 32 per cent and rain fed groundnut by 33 per cent. The factor ,high proportion of family members with above middle school education are more efficient in groundnut and farmers having larger area, are more efficient in cultivating cotton crop.

Wadud (2003) estimated the technical, allocative and economic efficiency of farms in Bangladesh using both the Stochastic Frontier and DEA approach. The study shows the estimated mean value of technical, allocative and economic efficiency as 80, 77 and 61 per cent respectively under the SFA. This indicates that there are considerable inefficiencies in production and there is a possibility for production gain through efficiency improvement. The mean value of technical, allocative and economic efficiency are 86, 91 and 78 percent respectively under CRS DEA analysis and 91, 87, and 79 percent under VRS DEA analysis. Thus the result of both SFA and DEA analysis reveal substantial inefficiencies in production.

Job and George (2002) conducted a study in Kuttanad area of Alappuzha district, to assess the technical efficiency in rice cultivation during the Puncha season and Virippu season. A stochastic production function of Cobb-Douglas type fitted with inputs like man days per hectare, plant protection cost per hectare and chemical fertilizers per hectare. The technical efficiency varied between 58 per cent and 99 per cent with a mean and efficiency of 85 per cent during Puncha season and 84 per cent during Virippu season. The study concluded that the results showed that with proper allocation of the existing technology, there exists a potential for improving the productivity of rice. So efforts should be made to strengthen the extension machinery to improve farmer's practices through extension service and training programmes.

Wilson *et.al* (2001) tried to explain the influence of management on the technical performance of wheat farmers in eastern England. The study differs from much previous research into the estimation and explanation of technical efficiency by including variables that relate to both personal aspects and aspects of the decision making process of the farmers. The variables hypothesized as influencing technical efficiency are area of the farm, experience of the farmer, higher education, profit maximisation objective, maintaining the environment and information seeking. Technical efficiency is estimated by using translog function and the mean efficiency is estimated as 87 per cent with a minimum of 49 per cent and a maximum of 98 per cent .The inefficiency variables such as profit maximisation and concern for maintaining information are shown to have a significant and positive effect on level of technical efficiency. Moreover, increasing farm size and seeking information are also associated with higher levels of efficiency.

Awudu and Huffman (2000) investigated the household's profit efficiency and the relationship between farm and household attributes and profit inefficiency in Northern Ghana. The data used for the study was the subsamples of random sample survey conducted in 1992-93 of 256 farmers of Northern Ghana. The study was conducted by fitting a translog profit frontier function. The study find out that the translog function is consistent with profit maximisation and with prices playing a major role in farmer's production decision. The study shows that mean efficiency is relatively high but significant variation in efficiency and inefficiency exists .The average inefficiency is 27 per cent and analysis, of inefficiency suggests that higher household head's education, access to credit and greater specification, and being located in districts where extension services and better infrastructure are available, are significant variables for increasing profit efficiency.

Mythili and Shanmugam (2000) made an attempt to measure the farm level technical inefficiency of rice farmers using farm level panel data in the state of Tamil Nadu. The study shows that paddy cultivation in Tamil Nadu experienced a constant return to scale. The estimated value of gamma is 0.82, implying that about 82 per cent of the difference between the actual and potential outputs are primarily due to technically inefficient performance of the farms. The estimated mean TE is 82 per cent, indicating that on an average the sample farms in Tamil Nadu state tend to realise only 82 per cent of their technical abilities. This is found to be higher than the measures determined by earlier studies using data of earlier period for the same region with cross section analysis. Various factors may be responsible for the observed differential in efficiency which needs further analysis.

Ramaswamy and Kailasam. (2000) examined the technical efficiency of sugar cane production in Coimbatore district of Tamilnadu using Correlated Ordinary Least Square (COLS) method and Maximum Likelihood Estimation (MLE) method. Two functions were estimated, one for planted crop and another for ratoon crop and the values of R^2 in the two equations were smaller (0.51 and 0.61) showing small exploratory power but are statistically significant at one percent level. The coefficients of labour and capital were also statistically significant at one percent level and had the positive sign. In the case of ML estimates, the coefficient of both labour and capital were statistically significant at one percent level and had positive signs. The functional coefficient had values less than unity and the values were found to significantly differ from unity. Farmers were less technically efficient in ratoon crops as compared to planted crop.

Sharma and Leung (1998) investigated the technical efficiency and its determinants of fishpond farms from the Tarai region of Nepal using a stochastic production frontier involving a model for technical inefficiency effects. The results of the maximum likelihood estimates of the show that the coefficients associated with seed, labour and fertilizer were highly significant while those for forage seed ratio and feed were not significant. The estimated technical efficiencies for the overall sample farms ranged from 18per cent to 95 per cent with an average efficiency of 77 per cent .Efficiency scores for intensive farms ranged from 22 per cent to 95per cent with a mean efficiency of 80 per cent and those for extensive farms varied from 18 per cent to 90 per cent with a mean score of 69 per cent. The study concludes that given the present state of technology in the country, fish produces have potential for enhancing productivity by increasing input levels, especially seed, fertilizer and feed.

Wilson *et.al* (1998) attempted to find the technical efficiency in U.K. potato production through a stochastic frontier production function using a translog model. Variations in the technical efficiency are explained through a number of managerial and farm characteristics variables. The variables of production function are the area, fertilizers, labour and mechanization. The inefficiency variables included experiences of the farmer, irrigation area of the farm etc. The study finds out that the minimum estimated efficiency is 33 per cent, the maximum is 97 per cent and the mean is 89 per cent. Irrigation of the potato crop and storage of potatoes after harvest are positively correlated with technical efficiency. Number of years of experience of growing potatoes, small scale farming practice and chitting of seed potatoes are negatively correlated with technical efficiency. The study ended with the need of more detailed information about management decision making.

Yao and Liu (1998) conducted a study on China's grain production by applying a stochastic frontier production function by using a panel data set on 30 provinces from 1987-92. The national average level of technical efficiency during 1987 -1992 is estimated to be 64 per cent with the variance ratio gamma is high as 98 per cent. The efficiency levels of the majority of provinces range between 50-70 per cent indicting that there exists a substantial potential for efficiency improvements in grain production. Efficiency differentials account for about two-thirds of yield difference between high and medium yield regions. The efficiency level is negatively correlated with the disaster index and positively correlated with R&D. There is strong evidence that low efficiency is caused by labour congestion in many region.

Barrett (1997) highlighted several crucial weaknesses in contemporary methods of estimating economic efficiency parameters. While the efficiency of peasant producers is an issue of considerable policy importance, the methodological short comings of efficiency estimation render most existing empirical findings uninformative. If there are differences between the marginal value product of an input and its price, then there are indeed economic gains from correcting management or market failures. The commentary concludes that as the literature currently stands, researchers and policymakers would be wise to approach estimates of the allocative scale or scope efficiency of peasant agriculture with a healthy skepticism.

Bravo-Ureta and Pinheiro(1997) conducted a study to assess the possibilities for productivity gains by improving the efficiency of small scale agriculture in the Dajabon region of the Dominican Republic by estimating the farm level technical (TE), Economic (EE) and allocative (AE) efficiency. The analysis reveals hat average levels of technical allocative and economic efficiency equals to 70 per cent, 49 per cent and 31 per cent respectively. All parameter estimates are statistically significant at 1per cent level except the parameters for labour and seeds and draft power. The estimated value of gamma is 0.49 which means that 49 per cent of the total variation in farm output is due to technical inefficiency. Contract farming, agrarian reform status, farm size, schooling, producer's age and household size are the various attributes of the farm and farmer examined. An important conclusion arising from the analysis is that AE appears to be more significant them TE as a source of gains in EE.

Tadesse and Krishnamoorthy (1997) examined the level of technical efficiency across ecological zones and farm size groups in paddy farms of state of Tamil Nadu. Overall, the mean technical efficiency of 83 per cent is achieved by paddy farms in the state showing the scope for increasing paddy production by17per cent. The value of gamma is 0.90 and the study showed that with the use of more fertilizers and land, the production of rice could be increased and the farmers were over using animal power in rice cultivation. A significant variation was observed in the mean level of technical efficiency among the four major rice growing zones of the state and small and medium sized farmers achieved a higher level of technical efficiency than those with large holdings. The study concludes that the paddy farmers in general, could be advised on the use of less animal power and more consolidated use of land.

Coelli and Battese (1996) investigated the agriculture production of Indian farmers by using a stochastic frontier production function which incorporates a model for the technical inefficiency effects. Farm level data obtained from the International Crops Research Institute for the semi-Arid Tropics (ICRISAT) were used in the study. A panel data for three villages viz, Aurepalle, Kanzona and Shirapur were collected for 10 years. The inefficiency variables included are age, schooling, land and year of sample farmers. The estimated coefficient of land and labour were positive for all the three villages. The coefficient of the ratio of hired labour to total labour is estimated to be negative for Aureplale and Kanzara, indicating the hired labour is less productive than family labour. The coefficient of the cost of other inputs is estimated to be positive for all three villagers. The study concludes that there are significant differences in the behavior of value of output and inefficiency of production among the three villages under study.

Sharif and Dar (1996) examined the inter and intra crop patterns of technical efficiency in rice cultivation in Bangladesh by estimating stochastic production frontiers by using both COLS and ML estimates. The study also assesses the role of household endowments and other characteristics in explaining farmer differences in efficiency. The study is related to the three rice crops grown in the village of Khilghati in Bangladesh during the crop cycle beginning in April- the "Aus" (spring) crop, the "Aman" (summer) crop, and the "Boro" (winter) crop. The estimate shows that farmers appear to be most efficient in Aman cultivation, with the average level of technical efficiency lying in the 90-95 per cent range. Although technical efficiency is quite high in the HYV Boro crop, it is even higher in the traditional Aman crop. The variability in technical efficiency can be traced partly to differences in education and farm size. More educated farmers are more efficient than smaller farmer.

Banik (1994) conducted a study to estimate technical efficiency of individual farms by employing the stochastic frontier model on cross sectional data for 99 farms in the Choto Asulia village of Bangledesh for 1988-89 period. The results show a wide variation in the level of technical efficiencies across farms. The minimum and maximum technical efficiencies were 10 per cent and 97 per cent respectively. The average technical efficiency of the farm is 78 per cent indicating that there is considerable scope for increasing the technical efficiency of the sample farms as a group. Thirteen farms shows technical efficiency in the range of 91 to 100 per cent. 10 out of 13 most efficient farms belonged to the category of small farms. It is also observed that owner tenant / tenant farms are technically more efficient than owner farms.

Bravo-Ureta and Evenson (1994) investigated the levels of technical, allocative and economic efficiency for a sample of cotton and casava farmers of Eastern Paraguay. The relationship between efficiency and various socio economic characteristics of the peasant farmers is also investigated. The analysis shows an average economic efficiency of 40 per cent for cotton and of 52 per cent for cassava, which reveals that there is considerable room for improvement in the productivity of the farms in the sample. The results suggests that the farmers could increase output and thereby, household income through better use of available resources given the state of technology. An examination of the relationship between efficiency and various socio economic variables did not reveal a clear strategy that could be recommended to improve performance.

Kalirajan and Shand. (1994) conducted a study to demonstrate empirically how to measure separately the influence of technical and allocative risks on production using the stochastic frontier production function. This model was applied to a sample of cotton farmers in Tamil Nadu. The mean economic efficiency with technical and allocative risk was 68per cent. On an average about 20 to 25 per cent of economic efficiency appears to have been lost by the sample farmers owing to their perceived technical risk. Similarly about 6 to 7 per cent of economic efficiency seems to have been lost owing to their perceived allocative risk. The study suggests that the elimination of both risks with better information on best practices and market conditions has the potential of substantially raising output and profits for the large majority of farmers.

Kumbhakar *et.al* (1991) demonstrated a model to estimate the determinants of technical inefficiency along with other parameters of the model. Empirical results based on US dairy farms show that levels of education of the farmers are determining factors of technical inefficiency. Returns to scale of the large sized farms were lower than those of small and medium sized farms and given the output price, large farms were found to be minor efficient relative to small and medium sized farm.

Kumbhakar *et al* (1989) conducted of economic efficiency of Utah dairy farms in USA. Results of the study indicate that large farms were technically more efficient than small farms. Due to allocative inefficiency costs of small farms on the average, were increased by 5.91per cent, where as the figures are 3.74 per cent for medium sized farms and 3.58 per cent for large farms. Most of the farmers in all size categories are found to be scale inefficient. The study pointed out that education is associated with greater productivity because it improves managerial ability and enhances the productivity of capital and labour. The larger the off-farm income the less time the farm operator spends managing farm operations. As a result production decisions based on insufficient information were less efficient.

Ali and Flinn (1989)examined the level of profit inefficiency in basmati rice production of Gujranwala district of Pakistan Punjab. The study reveals that the mean level of inefficiency at farm resources and price levels was 28 per cent with a wide range (5 per cent -87 per cent). Average loss of profit was Rs.1222 per hectare. The longest farm specific profit loss was Rs.3141 per hector and there exist clear opportunities to increase the profit levels of most Basmati rice producers in Gujranwala district, given their technology, prices and levels of fixed factors. Socio economic factors related to profit loss were the farm household's education, non agricultural employment, and credit constraint. Institutional determinants of profit loss were water constraint and the late application of fertilizer. The study concluded with the remark that if 25 per cent of the estimated loss in profit were eliminated on the 0.8 million hectares of Basmati rice grown in the Pakistan Punjab, grower returns would increase by Rs.244 million each season.

Ali *et.al* (1996) estimated the cost inefficiency of farms in North West Frontier Province (NWFP) in Peshawar (Pakistan). The study uses the behavioral and stochastic cost frontier functions. In stochastic frontier approach, the translog cost function is specified and direct estimation is conducted without using share equations, and the derived measure of inefficiency is related to socioeconomic, demographic and farm size variables. Secondly translog cost function is estimated as a function of shadow prices of inputs and cost share equations were estimated jointly with cost equation using cross-equation restrictions. Moreover the use of allocative inefficiency is introduced through the parameters that were related to behavioral variables underlying the inefficiency. The estimates reveal that the value of lamda (λ) is 1.49 implies the dominance of error term 'U' and the discrepancy between the observed cost and the frontier cost is primarily due to both technical and allocative inefficiencies. The average inefficiency was 11.5 per cent and the maximum and minimum inefficiency was 41.5 per cent and 3 per cent respectively indicated that a substantial amount of extra cost was incurred due to inefficiency. The behavioral approach of cost minimization is in conformity with translog stochastic cost frontier approach and suggests that farmers are inefficient in the use of their resources. In the behavioral approach, the inefficiency parameters are related to a number of factors. The most significant ones are land size, education of the house hold, subsistence needs and availability of credit.

Kalirajan and Shand. (1986) conducted a study to identify whether the rice farmers operating in the Kemubu irrigation project in Malayasia were technically efficient and compare the farm specific technical efficiencies of these farmers with that of farmers operating outside Kembu. Two sub groups of farmers were considered viz, tenant operators and owner tenant operators. The results show that the mean technical efficiency for the owner tenant farmers operate inside Kemubu is 65 per cent and 69 per cent for the owner tenant farmers operate outside Kemubu. The tenant operators have a lower mean technical efficiency, namely 61per cent, inside and 64per cent outside Kemubu. This means that in both locations, the owner tenant farmers are operating relatively closer to that frontier than the pure tenant operators. The study concludes with the remarks that even in areas well endowed with irrigation and other input facilities, there remains scope for substantial increases in production levels.

Belbase and Grabowski (1985) estimated the technical efficiency in Nepalese Agriculture. The results show technical inefficiency as a more severe problem in maize than in rice production. The correlation coefficients were calculated to determine the relationship between the technical efficiency and variables like farming experience, education, nutrition and income. Nutrition, income and education were found to be significantly positively related to technical efficiency, while no relationship was found for farming experience. Although some technical inefficiency was detected in maize production, it does not seem likely that significant increases in output will be achieved by concentrating only on improving the technical efficiency of Nepalese farmer.

From the review of studies cited above, it can be found that no major studies are reported about a comprehensive cost and return analysis and efficiency estimation of intercropped pineapple cultivation in Kerala. The present research is aimed to fill this gap.

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Chapter 3

THEORETICAL BACKGROUND OF STOCHASTIC FRONTIER ANALYSIS

Contents

3.1 Introduction

Firm performance is conventionally judged by measuring economic efficiency, which is generally assumed to be made up of two components-technical efficiency and allocative efficiency (Kalirajan and Shand,1999). Technical efficiency (TE) refers to the achievement of maximum potential output from given amounts of factor inputs and technology taking into account physical production relationship. Allocative (or price) efficiency (AE) measures the firm's success in choosing the optimal input proportions, given their respective prices (Farrell, 1957).

While the concept of technical efficiency is as old as neoclassical economics, the interest in its measurement is not, because the neo classical theory presupposes full technical efficiency. There are two major arguments that can be raised for the measurement of technical efficiency. The first and most compelling reason lies in the recognition that there exists a gap between the theoretical assumption of full technical efficiency and empirical reality (Leibenstien 1966). The second lies on *a priori* reasoning ; there is a high probability that ,where technical inefficiency exists ,it will exert an influence on economic efficiency. Following this logic, technical efficiency becomes central to the achievement of high levels of economic performance at the firm level and does its performance[1].

The basic concept underpinning the measurement of technical efficiency starts with the description of production technology. Production technologies can be represented by using isoquants, production functions and cost functions or profit functions. These four models provide four different tools for measuring technical efficiency. Although analysis based on these models appear to be distinct, they constitute the same basic approach and ideally their results should converge[2].

Theoretically, the production frontier function means the most efficient way of technical transformation of inputs to outputs. The text book definition of a production frontier holds that it gives the maximum possible output which can be produced from given quantities of a set of inputs. (Forsund *et.al* 1980). The production frontier can be *input oriented* (the minimum input bundles required to produce various outputs) or *output oriented* (the maximum possible output producible with various input bundles and a given technology). Both the input oriented and output oriented production frontier gives the same production frontier when constant returns to scale exist.[3] (Fare and Lovell, 1978). A vast majority of econometric work of measuring technical efficiency is based on output oriented production frontier and input oriented production

[1] Kalirajan&Shand1999 op.cit

[2] Ibid

[3] All equations and its explanations are adapted from Coelli TJ,D.S Prasda Rao and G.E.Battese (1998), An Introduction to Efficiency and Productivity Analysis ,Kluwer Academic Publishers, Boston ,Kumbhakar SC and CAK Lovell (2000), Stochastic Frontier Analysis , Cambridge University Press ,New York and Bogetoft, P., and Otto, L. (2010). Benchmarking with DEA, SFA and R. Springer .New York.

frontier which is more used in the estimation and decomposition of cost efficiency. (Kumbhakar and CAK Lovell 2000).

The production frontier provides the upper boundary of production possibilities and the input-output combination of each producer is located on or beneath the production frontier. The central problem in the measurement of technical efficiency is to measure the distance from the input output combination of each producer to the production frontier.

A production frontier is a function of $f(x) = \max\{y: y \in P(x)\} = \max\{y: x \in L(y)\}$ and an output vector $y \in p(x)$ is technically efficient if and only if $Y^1 \notin p(x)$ for $Y^1 > Y$ or equivalently $y \in \text{Eff } p(x)$, holds that an output vector is technically efficient if and only if no increase in any output is feasible. Thus technical efficiency is defined in terms of membership in an efficient subset (provided the input vector is fixed).

With two inputs and one output, assuming constant returns to scale, the ratio of each input X_1 and X_2 to produce the output Y may be plotted in a scatter diagram. A line joining the lowest of these points represents the frontier production function. If the assumption of constant return is not followed and a functional form is specifying, a smooth curve may be drawn through the lowest of the points of inputs X_1 and X_2 in the scatter diagram that represents the frontier function (Kalirajan & Shand 1986).

Extending the above model to a one output and *m* inputs, the frontier production Y* can be expressed as follows:

$$Y^* = f(Xi; \beta).TEi \quad \text{.......} \quad (1)$$

Where Y* is the maximum possible output a firm can obtain by using the inputs (Xi's) in a technically efficient way and β is a vector of technology parameters to be estimated. The firm's specific technical efficiency can be written as:

$$TEi = \frac{Yi}{Y^*} = \frac{Yi}{f(Xi;\ \beta).} \quad \text{...(2)}$$

Which defines technical efficiency as the ratio of observed output to maximum possible output. Yi achieves its maximum possible value of f (Xi; β) if and only if TEi =1, because TEi <1 provides a measure of the shortfall of observed output from maximum possible output.

But it can't be expected that all firms may be technically efficient and consequently, not all firms may be operating on their production frontiers. There are some circumstances such as regulatory-competitive environments, weather, luck, socio-economic and demographic factors, uncertainty etc out of the agent's control. Moreover any specification problem is also considered as inefficiency. (Kalirajan &Shand 1986, Luis R Murillo-Zomorano 2004). Therefore the production function of the i^{th} firm at any particular period can be written as follows.

Yi= f (Xi; β).exp {-Ui} ....(3)

Where Ui is the farm specific technical efficiency parameter. If the firm is technically efficient, Ui takes the value zero and the production frontier function is the same as Y*, Ui takes the value less than zero for the firms which are not technically efficient and the firms accordingly obtain their output Yi < Y*. The negative value of Ui will vary among firms depending up on their technical efficiency accordingly to how close they are to the frontier.(Kalirajan and Shand 1986).

Assuming that f (Xi; β), takes the log-linear Cobb-Douglas form[4] ,the production frontier model becomes:

$\ln Yi=\beta_0+\Sigma_n\beta_n \ln X_{ni}$ -Ui ....(4)

where Ui ≥ 0 guarantees that Yi ≤ f (Xi; β).

In *equation* 3 the entire shortfall of observed output Yi from maximum feasible output Y* is attributed to technical inefficiency. Such a specification ignores the fact that output can be affected by random shocks that are not under the control of a producer .Thus the production function given in *equation* (3) is deterministic in nature. To incorporate producer specific random shocks into the production function a random variable Vi is added to the model. To do so, we rewrite *equation* (1) and (3) as:

Y^*=f (Xi; β).exp {Vi}TEi ....(5)

and

Yi= f (Xi; β).exp {Vi-Ui} ....(6)

Assuming that f (Xi; β), takes the log-linear Cobb-Douglas form, the production frontier model in *equation* (4) becomes:

$\ln Yi=\beta_0+\Sigma_n\beta_n \ln X_{ni}$ +Vi –Ui .... (7)

Introduction of Vi in *equation* (5) and (6) means that Y^*& Yi is stochastic and that Vi captures other random factors such as errors in measurements and deviation from the true functional relationship. The value of Vi therefore may either be positive, negative or zero. Thus the stochastic production frontier model is a composed error model ε_i = Vi-Ui where Vi is

[4] Instead of specifying the Cobb –Douglas form, a more flexible form like Translog form is used by many researchers .But Koop and Smith (1980),Krishna and Sahota(1991),Ahmad and Bravo Ureta (1996)concluded that functional specification has a small impact on estimated efficiency. Greene (1990) provides the details of specification test for different functional forms.

the two sided noise (random) component and Ui is the one sided non negative technical inefficiency component of the error term. The two sided noise component Vi is assumed to be independently and identically distributed (iid) and symmetrically distributed independently of Ui. But the composed error term ε_i = Vi-Ui is asymmetric since Ui ≥ 0.

The firm specific technical efficiency given in *equation (2)* can be rewritten as:

$$TEi = \frac{Yi}{Y^*} = \frac{f(Xi;\ \beta).exp\ \{Vi - Ui\}}{f(Xi;\ \beta).exp\ \{Vi\}} = \exp(-Ui) \quad \ldots\ldots(8)$$

Which defines technical efficiency as the ratio of observed output to maximum feasible output in an environment characterized by exp {Vi}. Now Yi achieves its maximum possible value of [f(Xi; β).exp {Vi}] if, and only if TEi =1,because TEi < 1 provides a measure of the shortfall of observed output from maximum possible output.

Technical efficiency is estimated using either the deterministic production frontier model by *equation* (3) or the stochastic production frontier model given by *equation* (6). Since the former model ignores the effects of random shocks, and the latter model includes their effects, the latter model is preferred.

3.2 Deterministic Production Frontier

The deterministic production frontiers may be parametric and non parametric frontiers. The parametric frontiers rely on a specific functional form while the non parametric frontiers do not relay on specific functional form. The deterministic non parametric production frontiers are solved using mathematical programming techniques while the deterministic parametric production frontiers are estimated through econometric techniques. (Boris. E. Bravo Ureta & Antonio E Pinheiro.1993, Murillo-Zomorano 2004)

Consider the frontier production function specified in *equation* (3) which is deterministic in nature. The deterministic specification forces all observations to be or below efficient frontier so that all deviations from the efficient frontier are attributed to inefficiency .In deterministic specification all deviations from the efficient frontier are under the control of the agent. However there are some circumstances out of the agent's control that can also determine the suboptimal performance of units, regulatory-competitive environments, weather, luck, socio-economic and demographic factors, uncertainty etc that should not be properly considered as technical efficiency. The deterministic approach does so however. (Murillo-Zomorano 2004).

Drawing inspiration from Koopmans (1951) and Debreu (1951), Farrell (1957) was the first to measure productive efficiency empirically. Farrell showed how to define cost efficiency and how to decompose cost efficiency into its technical and allocative components .He also provided an empirical application to US agriculture, although he did not use econometric methods but uses a linear programming technique. The method developed in Farrell (1957) for the measurement of productive efficiency is based on a production possibility set consisting of convex hull of input – output vectors. This production possibility set was represented by means of a frontier unit isoquant. Due to that specification and the efficiency measures which are completely data-based, no specific functional form is pre defined and so method of measurement is treated as a non parametric deterministic method.

Winsten (1957) suggested that the deterministic frontier specified in *equation* (3) could be estimated using Corrected Ordinary Least Squares (COLS) method, which consists of two steps. In the first step ordinary least squares (OLS) is used to obtain consistent and unbiased estimates of the slope parameter and a consistent but biased estimate of the intercept parameter. In the second step the biased intercept is shifted up (corrected) to ensure that the estimated frontier bounds the data from above till no positive error term remains.

Aigner & Chu (1968) showed that the deterministic frontier specified in *equation* (3) could be estimated using mathematical programming (goal programming) approach. The goal programming approach consists of two models. The first model consists of a linear model, in which the aim is to calculate a parameter vector β for which the sum of the proportionate deviations of the observed output of each producer beneath maximum feasible output is minimized. The deviations are then converted to measure of technical efficiency of each agent. The second model consists of a quadratic programming model, where the aim is to calculate a parameter vector "β" for which the sum of squared proportionate deviations of the observed output of each producer beneath maximum feasible output is minimized. A major drawback of the goal programming approach is that the parameters are calculated (using mathematical programming) rather than estimated (using regression techniques) which complicates statistical inference concerning the calculated parameter values. Later Schmidt (1976) showed that the programming estimators of Aigner and Chu were consistent with maximum likelihood estimation with one sided errors distributed as either exponential or half normal. After estimation, an estimate of mean technical inefficiency in the sample was provided by $E(-U) = E(V-U) = -(2/\pi)^{1/2}u$ in the normal half normal case and by $E(-U) = E(V-U) = -\sigma U$ in the normal exponential case.

Timmer (1971) introduced a probabilistic frontier production model extending the above model. Timmer estimated a series of frontier production functions dropping at each stage the extreme observation. This process continues until the rate of change of the parameter estimates stabilizes. These entire deterministic programming approaches yield with undefined statistical properties.

Afriat (1972) and Richmond (1974) proposed a deterministic parametric model named Modified Ordinary Least Squares (MOLS), a variation on COLS. They pointed out that in the deterministic frontier specified in *equation* (3) could be estimated by OLS, under the assumption that distribution follows an explicit one-sided distribution like half normal or exponential. The MOLS also have two step procedures where the first step is estimation using OLS and the second step is after the estimation by OLS, the estimated intercept is shifted up (modified) by means of the one sided distribution.

Charnes *et.al* (1978) developed and named a non parametric deterministic frontier called Data Envelopment Analysis (DEA).They considered the single input /output efficiency measure of Farrell and generalized it to a multiple input /output case and reformulated it as a mathematical programming technique. DEA has no accommodation for noise and therefore can be initially considered non statistical technique where the inefficiency scores and the envelopment surface are calculated rather than estimated[5].

Although the contribution of the above authors is different in a number of important respects, each estimated a deterministic production frontier, either by means of linear programming techniques or by modifications to the least square techniques requiring all residuals to be non positive. All variations in output are not associated with variations in inputs that are attributed to technical inefficiency .None of these techniques makes allowances for the effect of random shocks which might also contribute (positively or negatively)

[5] Murillo-Zomorano 2004 op.cit

to variation in output. This brings the origin of Stochastic Production Frontier (SFA) estimation of technical efficiency.

3.3 Stochastic Production Frontier:

Consider the production frontier function in *equation* (6) which can be written as:

$Yi= f(Xi; \beta).\exp(\varepsilon_i)$ ....(9)

where $\varepsilon_i = (Vi-Ui)$

The above production function is a stochastic production function because the error ε_i is a composed error term which has two components. The first component Vi is a two sided (random) error component which captures the random effects (noise components) outside the control of the producer and is symmetrically distributed. The second component Ui is a one-sided non negative error component which captures deviation from the frontier due to inefficiency.

Stochastic Production Frontier Analysis or Stochastic Frontier Analysis for cross sectional data, (which abbreviate SFA) originated with three independent papers, published nearly simultaneously by three teams. Meeusen and van den Broeck (MB)1977, Aigner,Lovell and Schmidt (ALS) 1977 and Battese and Corra(BC) 1977[6]. These original SFA models shared the composed error structure mentioned previously. The estimation of a stochastic frontier function can be accomplished in two ways. First, if no explicit distribution for the efficiency component is made, then the production frontier can be estimated by a stochastic version of COLS. On the other hand, if an explicit distribution of the

[6] Pitt and Lee (1981), Schmidt and Sickles (1984) extended cross sectional maximum likelihood estimation techniques to panel data .

error component is assumed, then the frontier is estimated by Maximum likelihood (ML) methods. (Boris .E .Bravo Ureta & Antonio E Pinheiro.1993)

3.4 Maximum Likelihood Estimators (MLE)

The concept of maximum likelihood (ML) estimation is underpinned by the idea that a particular sample of observation is more likely to have been generated from some distributions than from others. The maximum likelihood estimate of an unknown parameter is defined to be the value of the parameter that maximizes the probability (or likelihood) of randomly drawing a particular sample of observation.

Our two objectives are to obtain estimates of the production technology parameter and to obtain estimates of the error term of each producer in *equation* (9). But under the assumption that the Ui's are distributed independently of the inputs, OLS provides consistent estimates of the β_ns but not of β_0, since $E(\varepsilon_i)= -E(Ui) \leq 0$. Moreover for obtaining estimates of ε_i for each producer, we need separate estimates of the statistical noise Vi and technical inefficiency Ui which requires distributional assumptions on the two error components. Thus by additional assumptions, and a different estimation technique, we can obtain a consistent estimate of the intercept and estimates of the technical efficiency of each producer. A maximum likelihood method is adopted to estimate β and Ui in which the first step involves the use of OLS to estimate the slop parameter and the second step involves the maximum likelihood estimate of the intercept and the variances of the two error components. The various distributional models used for the error terms Vi and Ui are the following:

1 The Normal Half Normal Model.

$V_i \sim iid(0,\sigma^2 v)$, $U_i \sim$ iid $N^+(0, \sigma^2 u)$ ie as non negative half normal. Vi &Ui are distributed independently of each other and of the regressors.

2 The Normal Exponential Model.

$V_i \sim iid(0,\sigma^2 v)$, $U_i \sim$ iid exponential. Vi &Ui are distributed independently of each other and of the regressors.

3 The Normal Truncated Normal Model: Stevenson (1980)

$V_i \sim iid(0,\sigma^2 v)$, $U_i \sim$ iid $N^+(\mu, \sigma^2 u)$ non negative half normal. Vi &Ui are distributed independently of each other and of the regressors

4 The Normal Gamma Model: Green (1980 a, b, 1990) Stevenson (1980)

$V_i \sim$ iid $(0,\sigma^2 v)$, $U_i \sim$ iid gamma. Vi &Ui are distributed independently of each other and of the regressors.

Meeusen & van den Broeck assigned an exponential distribution to Ui, Battese &Corra assigned a half normal distribution to Ui and Aigner,Lovell &Schmidt considered both exponential and half normal distribution for Ui . Parameters to be estimated include β, σ^2 & λ where $\sigma^2 = \sigma^2 v + \sigma^2 u$ and $\lambda = \frac{\sigma u}{\sigma v}$. The maximum likelihood estimates (MLE) of β, σ^2 and λ are obtained by setting its first order partial derivatives with respect to the elements equal to zero and solving them simultaneously. The MLE of $\sigma^2 u$ and $\sigma^2 v$ can be obtained from the MLE of σ^2 and λ using the relation $\sigma^2 u = \frac{\lambda^2}{1+\lambda^2}\sigma^2$ and $\sigma^2 v = \sigma^2 - \sigma^2 u$.

Battese &Corra estimated the same parameters except λ which is replaced by $\gamma = \frac{\sigma^2 u}{\sigma^2}$.[7] Either distributional assumption on U implies that the

[7] The estimation of the parameter γ, which lies between zero and one is expected to be preferable to the direct estimation of the variance parameter σ^2. This parameterization has advantages during estimation, because the parameter space for γ can be searched for a

composed error ε is negatively skewed and statistical efficiency requires that the model is estimated by maximum likelihood method. One of the important issues that concerns the stochastic frontier models is the distributional assumption made for the one sided error. Much of the literature to date has followed the half normal distribution as originally proposed by Aigner, Lovell and Schmidt , despite the fact that more flexible distributions are available.[8]

Schmidt and Lovell (1979) estimated the stochastic cost frontier for the cross sectional data by using the model Ei = C(Yi,Wi,β).exp(Vi+Ui),where E is expenditure or cost incurred by the i^{th} producer, Yi is a vector of outputs produced by the i^{th} producer, Wi is a vector of input price of the i^{th} producer, β is a vector of technology parameters to be estimated. [C(Y,W,β).exp(Vi)] is a stochastic cost frontier and Ui is intended to capture the cost of technical and allocative inefficiency. Note that the composed error exp (V+U) is positively skewed since Ui ≥ 0 and must have non zero means (positive).

Jondrow, Lovell, Materov and Schmidt (JLMS) (1982) and Kalirajan and Flinn (1983) independently proposed a model to provide estimates of the technical inefficiency of each producer in the sample as either the mean or the mode of the conditional distribution [Ui/ε_i].

suitable starting value for an iterative maximization algorithm. G H. Wan and G.E. Battese (1992), Battese and Coelli(1993).

[8] Greene (1990) examined the sensitivity of the efficiency results to distributional assumptions and concluded that for his data, efficiency levels were essentially the same for the half normal, truncated normal and exponential distributions, while the gamma model yielded higher efficiency. But Bauer (1990) concluded that additional empirical as well as theoretical work is needed to arrive at a better understanding of the effects that alternate distributional assumptions which might have on efficiency.

If efficiency varies across producers, it is natural to seek determinants of efficiency variation[9] .There exists two approaches in this regard, a two stage procedure and a single stage procedure .In the two stage procedure, firstly Ui is predicted from the stochastic frontier production function and then in a second stage these estimates are regressed on a vector of variables that are assumed to explain differences in Ui (or TEi) between farmers. (eg Parrekh and Shah 1994.) But Battese and Coelli (1992) pointed out that this process involves a fundamental contradiction of assumptions .In the first stage Ui is assumed to be identically distributed, while in the second stage specifies Ui as a function of a number of explanatory variables and hence contradicts the identical distribution assumption of the first stage. Kumbhakar *et.al* (1991), Haung and Liu (1994),Coelli(1995) and Battese and Coelli(1992,1995) overcome this problem by estimation of the parameters of the stochastic production frontier and inefficiency model simultaneously. In this case the explanatory variables are incorporated directly into the inefficiency error component. In this approach the Ui's are assumed to be non negative random variables independently distributed and arising from the zero of the normal distribution with variance σ^2 and mean $Zi\delta$ where Zi is a vector of variables which are assumed to explain technical inefficiency and δ is a vector of co efficient to be estimated. For both the stochastic frontier model and the inefficiency effects model, the maximum likelihood method can be used to estimate the coefficients of the two functions simultaneously.(Battese1992, Wilson *et.al* 1998).

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[9] A detailed discussion regarding the incorporation of exogenous variable's influence on efficiency estimation is presented in Kumbhakar and Lovell (2000) pp 261-278.

Chapter

4 TRENDS AND GROWTH RATES OF PINEAPPLE CULTIVATION

Contents

The present chapter analyses the trends in area, production and productivity of pineapple cultivation in India and in Kerala. The chapter also analyses the growth rates of area, production and productivity of pineapple cultivation in India and in Kerala.

4.1 Trends in Area, Production and Productivity of Pineapple Cultivation in India

To understand the trend in area, production and productivity of pineapple cultivation in India, a detailed trend analysis has been carried out using the time series data for the period 1961-2013 obtained from time series data of FAO (2014) statistics.

Exponential trend equations have been fitted for the area, production and productivity of pineapple cultivation in India. An exponential trend equation for the period from 1961 to 2013 has been fitted to the data using the following *equation*.(Gupta and Kapoor 1994, Gujarati 2004)

$Y_t = ae^{bt}$ ....(1)

where Y_t = Area / Production/Productivity of pineapple cultivation of the time period 't'

a = constant

b = rate of growth

However the exponential model gives only a single growth rate for the whole period which may not give a true picture for comparison among the different periods .Hence a single kinked exponential model has also been fitted since the study intends to make a comparison between growth rates in the two sub periods. A distinctive feature of kinked exponential growth models, is that it makes use of information regarding the values of the variable in question throughout the time series in estimating the growth rate for a given sub period. Kinked exponential models which impose continuity restrictions at the break points between sub periods, eliminates the discontinuity bias and there provides an improved basis for growth rate comparisons. In the absence of special circumstances such as definitional changes or natural disasters, kinked exponential models are preferable to discontinuous ones for growth rate comparisons (Boyce J K 1986).

A single kinked exponential trend had been fitted by dividing the time series data in to two sub periods; ie period I consists of the years from1961 to 1991 and period II consists of the years from 1992 to 2013.The division of the data in year 1991 is based on the fact that globalization of the economic activities has an impact on the agricultural sector also. Moreover government has recognized the fact that, horticulture, especially, the fruit sector has a major role in triggering the agricultural growth, and has earmarked more plan funds in the Five Year Plans towards the agricultural sector. The enhanced supporting of horticulture sector begins with VIII Five Year Plan onwards (1992-1997) and with these two reasons it is believed that there arises a trend break in the area, production and productivity of pineapple cultivation in India.

Single Kinked Exponential model has been fitted for the data by dividing the data into two sub periods by breaking the data in the year 1992 (k=31) and fit the following model:

$\ln Y_t = \alpha_1 + \beta_1 (D_1 t + D_2 k) + \beta_2 (D_1 t - D_2 k) + u_t$ ....(2)

The OLS estimates of β_1 and β_2 from *equation* (2) give the exponential growth rates for the two sub periods. $D_1$and D_2 are sub period dummy variables assumes the value 1 accordingly and 0 otherwise. There is a kink between the two trend lines whenever $\beta_1 \neq \beta_2$ .Significance of the trend breaks has been estimated by replacing the value of β_2 by($\beta_1 + \beta$) in the regression of the trend *equations* so that the resultant equation turns to be:

$\ln Y_t = \alpha_1 + \beta_1 t(D_1 + D_2) + \beta D_2 t + u_t$..(3)

The significance level of β is the indicator of the significance level of the trend break of two sub periods.(Singh.R 2011).

Trend equations with percentage of variance explained are as follows

I. Exponential Trend Equations

1. Area of pineapple cultivation

   $\ln Y_t = 9.95 + 0.003\, t$ ....(4)

   Variance explained =72.8%

2. Production of pineapple cultivation

   $\ln Y_t = 12.27 + 0.004t$ ....(5)

   Variance explained = 84.1%

3 Productivity of pineapple cultivation

$\ln Y_t = 2.29 + 0.004\ t$ ....(6)

Variance explained = 59%

II. Single Kinked Exponential Trend Equations

4 Area of pineapple cultivation

$\ln Yt= 9.75 + 0.046\ (D_1t+D_2k) + 0.011\ (D_2t-D_2k)$..................................(7)

Variance explained = 81.14%

5 Production of pineapple cultivation

$\ln Yt= 12.04 + 0.056\ (D_1t+ {}_2k) + 0.010\ (D_2t-D_2k)$...................................(8)

Variance explained = 90.98%

6 Productivity of pineapple cultivation

$\ln Yt= 2.29 + 0.009\ (D_1t + D_2k) + 0.009\ (D_2t-D_2k)$.................................(9)

Variance explained = 62.97%

An analysis of trend fitting shows that all exponential and kinked exponential trends lines are lines of good fit except the trend lines of productivity due to the low value of R^2.

4.2. Growth Rate Analysis of Area, Production and Productivity of Pineapple Cultivation in India

Compound growth rate is computed for the area, production and productivity of pineapple cultivation in India for the period 1961-2013.The growth rates are computed for the whole period as well as for two sub periods by dividing the data into period I; i.e. 1961-1991 and period II; i.e. 1992-2013. For obtaining more clarity regarding the sub period growth, single kinked exponential growth model is also fitted to the data. The significance of trend break has been carried out between the two sub periods. Compound growth rate is computed using the following *equation.*

$$Y=AB^t \qquad (10)$$

For linearization, log transformation is carried out and the resultant relation turns out be

$$\log Y=\log A+t \log B \qquad (11)$$

Table 4.1: Growth Rates of Area of Pineapple Cultivation in India for the Period 1961-2013.

Period	Compound growth		Kinked growth		Whole period
	Period I (1961-1991)	Period II (1992-2013)	Period I (1961-1991)	Period II (1992-2013)	1961-2013
Growth rate	0.5%***	0.2%***	4.6%***	1.16%*	0.3%***
Std error	0.004	0.005	0.004	0.006	0.002
P value	0.000	0.000	0.000	0.07	0.000

*** Significant at 1% level * Significant at 10% level.

Table 4.2: Test of Trend Break for Area of Pineapple Cultivation in India

Coefficient	Std error	P value
-0.008***	0.003	0.011

*** Significant at 1% level

From the table it can be seen that the compound growth of period I is only 0.5 per cent p.a and it reduced to 0.2 per cent p.a during the period II. Both the coefficients are significant at 1per cent level of significance. The kinked exponential model also shows the same pattern of growth rates in the sub periods with 4.6 per cent of growth p.a in the first period and reduced to 1.16 per cent growth p.a in the second sub period. The coefficients are significant at 1 per cent level and 10 per cent level of significance. The whole period shows an Compound Annual Growth Rate (CAGR) of 0.3 per cent and is significant at 1per cent level. The coefficient of test of trend break (Table 4.

2) is significant at 1per cent level and the negative sign of the coefficient confirms the decrease of growth rate in the second period with the first period. The growth rate analysis shows that in both compound model and kinked model, there is a decrease in the growth rate of area of cultivation in second period as compared with the first period.

Table 4.3: Growth Rates of Production of Pineapple Cultivation in India for the Period 1961-2013.

Period	Compound growth		Kinked growth		Whole period
	Period I (1961-1991)	Period II (1992-2013)	Period I (1961-1991)	Period II (1992-2013)	1961-2013
Growth rate	0.5%***	0.1%***	6.3 %***	1.8%***	0.3%***
Std error	0.003	0.006	0.003	0.005	0.002
P value	0.000	0.004	0.000	0.000	0.000

*** Significant at 1% level

Table 4.4: Test of Trend Break for Production of Pineapple Cultivation in India

Coefficient	Std error	P value
-0.007***	0.002	0.01

*** Significant at 1% level

Table 4.3 presents the CAGR and sub period growth rates of pineapple production in India for the period 1961-2013. The kinked exponential and compound model for the sub periods shows that growth rate for the first period is more than the growth rate for the second period. The growth rates are significant at 1 per cent level for both the periods in compound model and kinked model. The coefficient of regression is smaller in compound model than in kinked model. However the compound growth rate for the whole period is only 0.3 per cent p.a which is the same growth rate of area and is also significant at 1 per cent level. The table of trend break (Table 4.4) shows that the trend break is significant at 1per cent level of significance and the negative coefficient confirms the decrease of growth rate in the second period as compared with the first period.

Table 4.5: Growth Rates of Productivity of Pineapple Cultivation in India for the Period 1961-2013

Period	Compound growth		Kinked growth		Whole period
	Period I (1961-1991)	Period II (1992-2013)	Period I (1961-1991)	Period II (1992-2013)	1961-2013
Growth rate	0.3%***	0.2%**	0.9%***	0.9%***	0.4%***
Std error	0.002	0.004	0.001	0.002	0.001
P value	0.02	0.005	0.000	0.001	0.000

*** Significant at 1% level, ** Significant at 5% level.

Table 4.6: Test of Trend Break for Productivity of Pineapple Cultivation in India.

Coefficient	Std error	P value
0.001	0.001	0.365

Table 4.5 presents the compound and kinked exponential growth rate of productivity in the sub periods and CAGR for the whole period 1961-2013. The period I shows a growth of 0.3 per cent in the compound model, but in the kinked model the period I shows a growth rate of 0.9 per cent. Both the growth rates are significant at 1per cent level .But the growth rate decreases in the second period both in the compound model and the kinked model and is significant at 5 per cent level in both model. The whole period growth rate is 0.4 per cent and is significant at 1per cent level of significance. The above analysis shows that the productivity growth is not up to the growth of area and production .Moreover table 4.6 which shows the test of trend break also is not significant and the value of coefficient is very small.

An analysis of growth rates under different models reveals that the growth in area and production is better when compared with productivity of pineapple cultivation. This result is in par with previous study (Padmini 2002) with regard to area and production of pineapple cultivation, but it contradicts with productivity growth, where it shows a negative growth. The exploratory nature of kinked exponential model has brought out a clear picture of area, production, and productivity even with two sub periods. A sub period growth rate analysis shows that growth rate was decreasing in the period II (1992-2013) as compared with the period I (1961 -1991). The test of trend break for growth rate is significant for both area and production but insignificant for productivity. So one must also consider the inconsistency of growth before making any final conclusion regarding growth of area, production and productivity of pineapple cultivation in India.

Table 4.7: Coefficient of Variation (**CV**) of Area, Production &Productivity of Pineapple Cultivation in India for the period 1961 -2013

Variable	CV
Area	40.25
Production	50.37
Productivity	17.39

Table 4.7 presents the coefficient of variation of area, production and productivity of pineapple cultivation in India for the period 1961-2013. The table shows that the coefficient of variation seems to be larger for area and production while it is in the tolerable level in the case of productivity. This shows the inconsistency in area and production of pineapple cultivation in India and any conclusion regarding the trend and growth should be taken only after considering this matter seriously.

4.3 Trends in Area, Production and Productivity of Pineapple Cultivation in Kerala.

To understand the trend in area, production and productivity of pineapple cultivation in Kerala, a detailed trend analysis has been carried out using the time series data for the period 1982-2013 obtained from CMIE.

The trend for area, production and productivity of pineapple in Kerala for the period 1982-2013 has been fitted by using exponential trend. For obtaining a clear picture regarding the trend, a kinked exponential model is fitted by dividing the data into two sub periods. The two sub periods thus formed are Period I which consists of the years 1982-1992 and Period II which consists of the years 1993-2013.The kink has been made on the year 1993 on the assumption that there occurred a trend break in 1993 for area production and productivity of pineapple cultivation in Kerala due to the introduction of the Kerala Horticultural Development Progamme (KHDP), a joint programme of Kerala government and European Union in the year 1993.

I. Exponential Trend Equations.

1. Area of pineapple cultivation

   $\ln Y_t = 1.42 + 0.02\ t$..(1)

   Variance explained =79.4%

2. Production of pineapple cultivation

   $\ln Y_t = 3.84 + 0.006\ t$ ....(2)

Variance explained = 64.1 %

3. Productivity of pineapple cultivation

$\ln Y_t = 2.45 + - 0.007 t$ .... (3)

Variance explained = 50.3%

II. Single Kinked Exponential Trend Equations.

4. Area of pineapple cultivation

$\ln Yt = 1.356 + 0.041 (D_1 t + D_2 k) + 0.042 (D_2 t - D_2 k)$ ....(4)

Variance explained = 86.16%

5. Production of pineapple cultivation

$\ln Yt = 4.02 + -0.004 (D_1 t + D_2 k) + 0.032 (D_2 t - D_2 k)$ ....(5)

Variance explained = 71.07%

6. Productivity of pineapple cultivation

$\ln Yt = 2.665 + -0.046 (D_1 t + D_2 k) + -0.005 (D_2 t - D_2 k)$............(6)

Variance explained =71.86%

An analysis of trend lines reveals that trend lines fitted for the area, production and productivity of pineapple cultivation in Kerala are lines of good fit in both exponential trend and kinked exponential trend except for the exponential trend line of productivity. The corrected R^2 for the exponential trend line of productivity is not sufficient for explaining the variability of the data.

4.4 Growth Rate Analysis of Area, Production and Productivity of Pineapple Cultivation in Kerala.

Compound growth rate has been estimated for the area, production and productivity of pineapple cultivation in Kerala for the period 1982-2013. Compound and single kinked exponential growth rates are computed for the two sub periods by dividing the data into Period I; i.e. 1982-1992 and Period II; i.e. 1993-2013. A test for trend break has been carried out to test the significance of trend break between the two sub periods.

Table 4.8: Growth Rates of Area of Pineapple Cultivation in Kerala for the Period 1982-2013.

Period	Compound growth		Kinked growth		Whole period
	Period I (1982-1992)	Period II (1993-2012)	Period I (1982-1992)	Period II (1993-2013)	1982-2013
Growth rate	0.3%	1.1%***	4.13%***	4.21%***	2.02%***
Std error	0.007	0.003	0.013	0.006	0.002
P value	0.379	0.002	0.002	0.000	0.000

*** Significant at 1% level

Table 4.9: Test of Trend Break for Area of Pineapple Cultivation in Kerala.

Coefficient	Std error	P value
0.036***	0.008	0.000

*** Significant at 1% level

Table 4.8 shows that the growth rate of area of cultivation in Kerala for the period 1982-2013 under different models. The table shows that in the compound model, the period I shows only 0.3 per cent growth p.a in area, but it is increased to 1per cent in period II. The same increasing growth is shown in the kinked model also. But the difference is smaller in kinked model as compared with compound model. In all the models growth rates appear significant at 1 per cent level except for the growth rate of the period I in compound model. The compound growth rate for the whole period is 2.02 per cent p.a and is also significant at 1 per cent level. Table 4.9 which show the results of the test for trend break shows that the trend break between the two sub periods is significant at 1per cent level of significance

Table 4.10: Growth Rates of Pineapple Production in Kerala for the Period 1982-2013

Period	Compound growth		Kinked growth		Whole period
	Period I (1982-1992)	Period II (1993-2013)	Period I (1982-1992)	Period II (1994-2013)	1982-2013
Growth rate	-0.6*	2.5%***	-0.1%	3.27%***	0.6%***
Std error	0.001	0.006	0.010	0.004	0.001
P value	0.001	0.001	0.91	0.000	0.000

* Significant at 10% level,*** significant at 1% level.

Table 4.11: Test of Trend Break for Pineapple Production in Kerala

Coefficient	Std error	P value
0.026***	0.008	0.005

*** Significant at 1% level

Table 4.10 presents the detailed annual growth rate structure of pineapple production in Kerala for the period 1982-2013. The table shows that in the compound model, a significant negative growth rate occurs in the sub period I while the sub period II shows a positive significant growth rate. The kinked exponential model also shows the same pattern.The whole period growth rate is just 0.6 per cent p.a even though it is significant at 1per cent level. A test of trend break between the two sub periods (Table 4.11) has been carried out and the coefficient is significant at 1per cent level which indicates that there is a trend break between the two sub periods and the production of pineapple cultivation in Kerala. The growth rates of the compound model and kinked model also reveal that there is a change in growth rate from the negative growth in the period I to a positive growth in the period II .

Table 4.12: Growth Rates of Pineapple Productivity in Kerala for the Period 1982-2013.

Period	Compound growth		Kinked model		Whole period
	Period I (1982-1992)	Period II (1993-2013)	Period I (1982-1992)	Period II (1993-2013)	1982-2013
Growth rate	-1.2%***	0.1%	- 4.63%***	-0.5%	-0.7%***
Std error	0.003	0.002	0.007	0.003	0.001
P value	0.002	0.637	0.000	0.174	0.000

*** Significant at 1% level

Table 4.13: Test of Trend Break for Pineapple Productivity in Kerala.

Coefficient	Std error	P value
-0.010	0.008	0.242

Table 4.12 depicts the growth rate of productivity of pineapple cultivation in Kerala for the period 1982-2013. From the table one can find that the growth rate of productivity is negative 1. 2 per cent p.a and is significant at 1 per cent level for the sub period I in the compound model and is just 0.1 per cent p.a in the sub period II for the same model but not significant. But the kinked model shows that the growth rate is negative in both sub periods and the difference among the sub periods is larger than the compound model. The growth rate is significant at 1 per cent level in the first sub period and non significant in the second sub period. The growth rate for the whole period is also negative and significant at 1 per cent level. The co-efficient of the test of trend break (Table 4.13) is negative but not significant and it indicates that the trend break between the two sub periods is not significant and the negative sign of the coefficient is only indicative in nature.

The growth rate analysis of area, production and productivity of pineapple in Kerala can be concluded by pointing out that increase in pineapple production in Kerala is due to the increase in area of cultivation. This result is confirmed with the result depicted by the early study conducted by (Padmini 2002) .The shift in growth rate from the period I to period II may be due to the impact of various promotional measures taken up by the government in support of various horticultural crops. The productivity of the cultivation is not impressive due to the low or negative growth. But there are signs of improvement in the second period both in the kinked model and in compound model regarding the productivity. It should also consider the inconsistency in area, production and productivity of pineapple cultivation before making any final conclusion regarding the growth rate.

Table 4.14: Coefficient of Variation (**CV**) of Area, Production &Productivity of Pineapple Cultivation in Kerala for the period 1982 -2013.

Variable	CV
Area	38.38
Production	27.96
Productivity	19.91

Table 4.14 presents the coefficient of variation of area, production and productivity pineapple cultivation in Kerala for the period 1982-2013. The table shows that the coefficient of variation seems to be larger for area and production than that of productivity. This implies that inconsistency is more in area and production of pineapple than in productivity. The major reasons that can be attributed to this inconsistency may be that pineapple is raised as in intercrop in rubber plantation mostly and also due to different varieties of the crop cultivated. Added to this the shifting tendency that can be noticed in the farmers to hire the land for cultivation in different places so that the exact assessment becomes vacillated.

Chapter

5 PINEAPPLE EXPORT SCENARIO OF INDIA

Contents

Fruits and vegetables produced in India are believed to have great potential for export. But the share of India in global exports of fruits and vegetables is considered negligible. (Singh and Mathur 2005). Pineapple is one of the most internationalized fruits traded globally, second only to banana and citrus in this regard. Trade prospects for developing countries are very promising as pineapple is rated as an under achiever implying huge potential to be tapped (Jacob and Soman 2006). In this context the pineapple export scenario of India is analysed. The export scenario of India is analyzed under two heads – Direction of India's pineapple exporting, and Growth rate analysis. Before analyzing the export scenario of India, a brief analysis of major exporters and importers of fresh and processed pineapple in the world is presented with the following tables.

5.1 A Snap Shot of World Pineapple Trade

The following tables give a brief picture of world pineapple trade.

Table 5.1.1: Per cent of Export of Pineapple (Fresh) for the Period 2003 - 2013

Top Exporters	Per cent of quantity	Per cent of value
Costa Rica	44.62	32.03
Philippines	9.76	3.89
Belgium	9.23	17.11
Netherlands	5.57	10.42
Côte d'Ivoire	5.31	3.62
USA	3.58	6.40
Ecuador	3.32	2.42
France	2.51	3.99
Honduras	2.07	1.82
Others	14.03	18.30
World(Total)	100	100

Source: Computed from www.uncomtrade.com

Table 5.1.1 gives the per cent of decadal averages of major exporters of fresh pineapple (both in quantity and value) for the decade 2003 -2013. The table reveals that about half of the quantity exported during the period is from Costa Rica alone.In value terms also Costa Rica comes to the top during the period. The second position in the quantity exported is held by Philippines (9.96 per cent), and the third position in the quantity is held by Belgium (9.23 per cent). In the case of value of export, Belgium (17.11 per cent) holds the second position and Netherlands (10.42 per cent) holds the third position. It must be considered that countries like Belgium and Netherlands are not pineapple cultivating countries and export from these countries are in the form of re-exports.

Table 5.1.2: Per cent of Import of Pineapple (Fresh) for the Period 2003 – 2013.

Top Importers	Per cent of quantity	Per cent of value
USA	27.83	23.77
Belgium	11.06	12.57
Japan	6.97	5.17
Germany	6.57	8.11
Netherlands	6.39	6.92
France	6.03	6.06
Italy	5.71	6.72
Spain	4.49	5.02
United Kingdom	4.43	5.42
Others	20.52	20.24
World(Total)	100	100

Source: Computed from www.uncomtrade.com

Table 5.1.2 depicts the per cent of decadal average of import of fresh pineapple (quantity and value) for the period 2003-2013.The table shows that USA is the top importer in quantity (27.83 per cent) and the value is (23.77 per cent) during the decade. In terms of quantity imported, Belgium (11.06 per cent) is in the second position followed by Japan (6.97 per cent) ,Germany(6.57 per cent) and Netherlands (6.39 per cent).In value terms, Belgium is the second (12.57 per cent) followed by Germany (8.11 per cent),Netherlands (6.92 per cent) and Italy (6.72 per cent). The table reveales that USA is the main importer in terms of quantity and value followed by the European countries. Among the European countries the import of Belgium and Netherlands is mainly for re export purpose. The share of Asian countries is found minimal except Japan.

Table 5.1.3: Per cent of Export of Pineapple (Processed)for the Period 2003 to 2013.

Top Exporters	Per cent of quantity	Per cent of value
Thailand	43.04	44.91
Philippines	19.46	13.48
Indonesia	12.88	11.82
Kenya	5.77	6.26
China	5.13	4.4
Germany	2.28	4.02
Singapore	1.61	1.41
Netherlands	1.54	3.02
Malaysia	1.51	1.35
Others	6.78	9.33
World(Total)	100	100

Source: Computed from www.uncomtrade.com

Table 5.1.3 shows the major exporters of processed pineapple (per cent of decadal average of quantity and value) for the period from 2003 to 2013. The table reveals that Thailand is the topper in quantity (43.04 per cent) and value (44.91 per cent). Thailand alone holds nearly about fifty per cent share in quantity and value of world trade in the processed category. In quantity exported, Philippines is the second with a share of 19.46 per cent followed by Indonesia (12.88 per cent) and Kenya (5.77 per cent). In value exported also Philippines is the second with share of 13.4 per cent followed by Indonesia (11.82 per cent) and Kenya (6.26 per cent). It can be concluded from the table that the Asian countries dominate in the processed pineapple export in contrast to the fresh pineapple export.

Table 5.1.4: Per cent of Import of Pineapple (Processed) for the Period 2003 to 2013.

Top Importers	Per cent quantity	Per cent of value
USA	30.16	30.91
Germany	10.85	10.38
Russian Federation	5.19	2.95
Spain	4.44	5.46
U K	4.22	4.71
Japan	4.05	4.29
France	3.23	3.73
Netherlands	3.19	3.67
Canada	2.48	2.10
Others	32.19	31.80
World(Total)	100	100

Source: Computed from www.uncomtrade.com

Table 5.1.4 shows the major importers of processed pineapple (per cent of decadal average of quantity and value) for the period from 2003 to 2013.The table shows that USA is the topper with 30.16 per cent in quantity and 30.91 per cent in value for the period. In the case of quantity imported Germany is the second with 10.85 per cent share followed by Russia (5.19 per cent), Spain (4.44 per cent) and UK (4.22 per cent). In terms of per cent of value again, Germany is in the second position (10.38 per cent), followed by Spain (5.46 per cent), UK (4.71 per cent) and Japan (4.05 per cent). From the table we can observe that USA is the major importer of processed pineapple products, followed by the European countries. Japan is the only major Asian country which has a notable share in the imports of processed pineapple products.

Table 5.1.5: Leading Pineapple Producing Countries &their share in Export of Fresh & Processed Pineapple for the Year 2013.

Country	Per cent share of production	Per cent share of export value (Fresh)	Per cent share of export value (Processed)
Thailand	11.3	0.1	47.3
Costa Rica	10.61	44.1	0.2
Brazil	10.6	0.1	0.0
Philippines	10.2	7.8	16.3
Indonesia	7.6	0.0	12.5
India	6.7	0.1	0.1
Nigeria	6.1	0.0	0.0
China	4.3	0.1	2
Mexico	3.2	1.3	0.1
Others	29.39	46.4	21.5
World	100	100	100

Source: Computed from www.uncomtrade.com

The table 5.1.5 shows that the major pineapple producing countries are Asian countries in which Thailand is the top with a share of 11.3 per cent followed by Costa Rica (10.61 per cent), Brazil (10.6 per cent), Philippines (10.2 per cent) and Indonesia (7.6 per cent). In the case of share of export of fresh pineapple, Costa Rica is the topper with about 44.1 per cent of the total value of export. It can be observed from the table that other major producing countries except Philippines have no significant share or even no share in fresh pineapple export. In the case of processed pineapple exports, Thailand is the topper with a share of 47.3 per cent followed by Philippines 16.3 per cent and

Indonesia 12.5 per cent. Thus the processed pineapple export is completely dominated by Asian countries, who were the major producers of pineapple. Thus it can be concluded that the major producers are dominated either in the fresh exporting or in the processed products, but the share of India in both area is negligible. This indicates the potential of India which is yet to be tapped, in pineapple exporting being a major producer in the world but, can be explored by the formulation of proper policy measures.

5.2. Direction of India's Pineapple Export

The direction of India's pineapple export is investigated by computing decadal averages of export of fresh pineapple, processed pineapple, pineapple juice of brix value > 20 and brix value <= 20 to various countries. The data for anlysing the direction of export is obtained from time series data of UNCOMTRADE data.

5.2.1 Direction of Fresh Pineapple Export.

The direction of fresh pineapple exports is analysed by computing decadal averages of the time series data for the period 1983-2013. The entire period is divided into three sub periods such as 1983-1992, 1993-2002 and 2003 -2012. Decadal averages of the quantity (tons) and value ('000$) of fresh pineapple exported along with their respective parentage to total is computed. The countries are ranked up to ten on the basis of average quantity exported during the respective decade.

Table 5.2.1: Direction of fresh pineapple export -Decade I (1983-1992)

No	Country	Average quantity(tons)	Average value ('000 $)
1	USSR/Russia	193 (47.4)	124.95 (53.7)
2	Nepal	58 (14.3)	17.60 (7.6)
3	Czechoslovakia	50 (12.3)	30.16 (13.0)
4	UAE	28 (6.8)	14.36 (6.2)
5	Kuwait	16 (3.9)	8.22 (3.5)
6	Yugoslavia	16 (3.9)	10.97 (4.7)
7	Pakistan	14 (3.4)	5.27 (2.3)
8	Saudi Arabia	13 (3.2)	7.86 (3.4)
9	Bahrain	10 (2.5)	7.46 (3.2)
10	Oman	4 (0.9)	1.76 (0.8)
11	Others	6 (1.4)	4.39 (1.6)
12	World(Total)	408 (100)	233 (100)

Source: Computed from www.uncomtrade.com, Figures in bracket shows percentage to total.

Table 5.2.1 shows the decadal average of fresh pineapple export for the period 1983-1992. The table shows that USSR comes to the top with 47.4 per cent of the average quantity exported and 53.7 per cent of the average value exported during the decade. Nepal comes the second (14.3 per cent) and Czechoslovakia is the third (12.3 per cent) in quantity exported and Czechoslovakia comes to the second (13 per cent) and Nepal is the third (7.6 per cent) in terms of value, exported during the decade. From the table it can be observed that the export to European countries constitute more than 60 per cent in quantity and value during the decade. The major Asian countries are Nepal and UAE which constitute together more than 20 per cent of the quantity exported during the decade.

Table 5.2.2: Direction of fresh pineapple export -Decade II(1993-2002).

No	Country	Average quantity (tons)	Average value ('000 $)
1	Sri Lanka	168 (27.8)	12.1 (6.0)
2	UAE	55 (9.2)	23.0 (11.3)
3	Bhutan	50 (8.3)	15.7 (7.7)
4	Nepal	49 (8.1)	6.6 (3.3)
5	USSR/Russia	46 (7.6)	28.0 (13.8)
6	Saudi Arabia	30 (4.9)	14.9 (7.4)
7	France	26 (4.3)	10.4 (5.1)
8	Bangladesh	25 (4.1)	5.8 (2.9)
9	Pakistan	23 (3.9)	5.6 (2.8)
10	Spain	22 (3.6)	10.8 (5.3)
11	Others	111 (18.2)	70.1 (34.4)
12	World(Total)	605 (100)	203 (100)

Source: Computed from www.uncomtrade.com, Figures in bracket shows percentage to total.

Table 5.2.2 depicts the decade wise average export of fresh pineapple (both quantity and value) for the period 1993-2002.The table shows that exports to Sri Lanka is in the top position with a share of 27.8 per cent followed by UAE (9.2 per cent) and Bhutan (8.3 per cent) of the total average export quantity of the period. One noticeable fact understood from the table is that, in the first decade, export to European countries is more than the 60 percent of the average export, which is now changed to export to Asian countries in the second decade, with a share of more than 50 per cent of the average quantity which is the combined per cent of first three countries. The European countries together have the share of only about 15 per cent of the average export during the decade. In the case of value of export, for the decade, the USSR comes with top position with a share of 13.8 per cent followed by UAE (11.3 per cent) and Bhutan (7.7 per cent) of the average export value of fresh pineapple exported during the decade. Thus in terms of value USSR comes in the top position even though it has only fifth position in the average quantity exported.

Table 5.2.3: Direction of fresh pineapple export- Decade III(2003-2012).

No	Country	Average quantity (tons)	Average value ('000 $)
1	Nepal	1119 (39.0)	140.6 (16.5)
2	UAE	627 (21.8)	223.7 (26.2)
3	Saudi Arabia	183 (6.4)	79.5 (9.3)
4	Netherlands	116 (4.0)	45.6 (5.3)
5	Zambia	101 (3.5)	24.6 (2.9)
6	Maldives	98 (3.4)	53.0 (6.2)
7	Pakistan	92 (3.2)	26.6 (3.1)
8	Spain	80 (2.8)	34.0 (4.0)
9	Oman	69 (2.4)	31.9 (3.7)
10	Bangladesh	53 (1.9)	9.0 (1.1)
11	Others	331 (11.6)	184.7 (21.7)
12	World(Total)	2869 (100)	853.2 (100.0)

Source: Computed from www.uncomtrade.com, Figures in bracket shows percentage to total.

Table 5.2.3 presents the decadal average of quantity and value of fresh pineapple exported from India for the period 2002-2012 along with their respective percentages. From the table it can be observed that Nepal, with 39 per cent of the average quantity exported in the top position was followed by UAE (21.8 per cent) and Saudi Arabia (6.4 per cent). The share of European countries, being the major importers of the world imports, reduces to about 7 per cent and is much lower than that of the first and second decades. In terms of average value of export, UAE comes the first with a share of 26.2 per cent followed by Nepal, 16.5 per cent, and Saudi Arabia 9.3 per cent respectively during the decade. The shares of European countries together constitute only about 9 per cent of the average value exported during the decade.

The decadal analysis for investigating the fresh pineapple exporting from India for the period 1983-2012 reveals that, among the three decades, the exporting to European countries, being the major importers of the world ,is decreasing from the first decade to the third decade. The main exporting of India is to the Asian countries like Nepal, UAE and Saudi Arabia during the decades. Padmini (2002) reported that the major hindrances that may affect the export of pineapple from India were higher cost of production and higher price for the produce, poor post harvest management, poor processing technology and poor quality when compared with international markets.

5.2.2 Direction of Processed Pineapple Export.

Table 5.2. 4: Direction of Processed Pineapple Export -Decade I (1983-1992).

No	Country	Average quantity (Tons)	Average value ('000$)
1	Czechoslovakia	331 (52.00)	180.4 (55)
2	USSR/Russia	304 (47.53)	145.1 (44.42)
3	China	10 (0.16)	6.0 (0.18)
4	Nepal	10 (0.16)	2.4 (0.07)
5	UAE	6 (0.10)	4.8 (0.15)
6	Saudi Arabia	2 (0.03)	1.9 (0.06)
7	Netherlands	1 (0.02)	1.0 (0.03)
8	Oman	1 (0.02)	2.7 (0.08)
9	Others	0 (0.00)	0.3 (0.01)
	World(Total)	665 (100)	344.6 (100)

Source: Computed from www.uncomtrade.com, Figures in bracket shows percentage to total.

Table 5.2.4 presents the decadal average of processed pineapple export from India (both quantity and value) for the period 1983-1992.The table shows that almost hundred per cent of the average quantity exported in the decade is to two European countries , Czechoslovakia and USSR . Exports to Czechoslovakia amounts to 52 per cent and exports to USSR amounts to 47.53 per cent. Exports to other European countries and Asian countries are negligible. On the value side also the above two European countries constitute almost the entire average export value of the decade.

Table 5.2.5: Direction of Processed Pineapple Export -Decade II(1993-2002).

No	Country	Average quantity (tons)	Average value ('000$)
1	Portugal	108 (18.9)	86.8 (12.8)
2	Germany	86 (15.1)	119.0 (17.5)
3	Ukraine	80 (14.0)	113.3 (16.7)
4	USSR/Russia	78 (13.7)	93.1 (13.7)
5	Oman	53 (9.2)	71.1 (10.5)
6	USA	48 (8.4)	45.4 (6.7)
7	Netherlands	40 (7.0)	64.8 (9.5)
8	Belgium	20 (3.5)	32.6 (4.8)
9	Italy	18 (3.2)	21.8 (3.2)
10	Liberia	17 (3.0)	8.4 (1.2)
11	Others	23 (4.0)	24 (3.4)
	World(Total)	571 (100)	680.3 (100)

Source: Computed from www.uncomtrade.com, Figures in bracket shows percentage to total.

Table 5.2.5 give the detailed picture of processed pineapple export from India for the period from 1993 to 2002. The table shows that Portugal stands in the first position with 18.9 per cent of the average quantity exported followed by Germany, 15.1 per cent, and Ukraine, 14 per cent. More than 75 per cent of the average quantity exported is to the European countries during the period and export to Asian countries is minimal when compared with the fresh pineapple exporting. In the case of value exported, Germany comes the first with a per cent of 17.5 followed by Ukraine (16.7 per cent), USSR (13.7

per cent) and Portugal (12.8 per cent). The pattern of export is the same as in the case of quantity exported.

Table 5.2.6: Direction of Processed Pineapple Export -Decade III (2003-2012).

No	Country	Average quantity (tons)	Average value'000$
1	Netherlands	266.6 (33.7)	256.4 (27.6)
2	Germany	77.1 (9.8)	79.7 (8.6)
3	Israel	74.0 (9.4)	98.6 (10.6)
4	Belgium	50.3 (6.4)	84.7 (9.1)
5	Nepal	49.4 (6.3)	74.6 (8.0)
6	UK	44.5 (5.6)	56.3 (6.1)
7	Kuwait	37.3 (4.7)	32.6 (3.5)
8	Zambia	30.4 (3.8)	42.1 (4.5)
9	UAE	25.1 (3.2)	35.3 (3.8)
10	Japan	21.6 (2.7)	37.8 (4.2)
11	Others	114.0 (14.4)	129.4 (13.9)
	World(Total)	790.3 (100.0)	927.5 (100.0)

Source: Computed from www.uncomtrade.com, Figures in bracket shows percentage to total.

Table 5.2.6 presents the detailed decadal average of processed pineapple export from India for the period from 2003 to 2012. The table reveals that Netherlands comes in the top position with 33.7 per cent of the total average quantity exported .Germany comes the second with 9.8 per cent and Israel comes the third position with 9.4 per cent .In the case of value of export of processed pineapple , Netherlands comes in the top with a share of 27.6 per cent followed by Israel (10.6 per cent) and Belgium (9.1 per cent).In this decade also as in the former decades, export to European countries has more share of India's processed pineapple than that of Asian countries.

The analysis of direction of processed pineapple shows that in all three decades, the major pineapple exporting countries of India are the European countries in contrast to fresh pineapple exports, where the major countries are Asian countries. As suggested by Padmini (2002) there exists much more potential for exploring new markets for processed products than the fresh pineapple; and this is probably the area where India has to improve through proper policy measures.

5.2.3 Direction of Pineapple Juice Export (Brix value >20).

Table 5.2.7: Export of Pineapple Juice Brix value > 20 from INDIA for the Period 2003 to 2012.

No	Country	Average quantity (tons)	Average Value ('000$)
1	Netherlands	120 (37.75)	114 (29.50)
2	Germany	69 (21.73)	75 (19.56)
3	Nepal	42 (13.19)	70 (18.13)
4	Belgium	25 (7.89)	42 (10.79)
5	UK	12 (3.69)	20 (5.10)
6	Israel	9 (2.90)	13 (3.25)
7	UAE	8 (2.53)	10 (2.63)
8	Japan	5 (1.70)	10 (2.63)
9	Australia	4(1.36)	4 (1.01)
10	Maldives	4(1.20)	3 (0.65)
11	Others	19 (6.06)	26 (6.75)
	World(Total)	317 (100)	387 (100)

Source: Computed from www.uncomtrade.com , Figures in bracket shows percentage to total.

Table 5.2.7 presents the direction of pineapple juice export (Brix value >20) from India for quantity and value exported and computed on average basis for the period 2003 -2012. From the table, it can be observed that

Netherlands holds the top position both in quantity and value (37.25 per cent and 29.50 per cent) followed by Germany (21.73 per cent) and Nepal (13.19 per cent). The European countries which hold more than 70 per cent of the quantity exported and 60 per cent of the average value exported for the period, but there is no significant export to USA, being the major importer in the world. Since the export to USA is minimal, proper policy measures are needed to explore the markets of USA along with maintaining the share of European countries.

5.2.4 Direction of Pineapple Juice Export (Brix value <=20).

Table 5.2.8: Export of Pineapple Juice Brix value <= 20 from INDIA for the Period 2003 to 2012.

No	Country	Average quantity (tons)	Average Value ('000$)
1	Netherlands	86 (71.67)	77 (68.75)
2	Germany	19 (15.83)	18 (16.1)
3	Nepal	9 (7.5)	14 (12.25)
4	UK	3 (2.50)	1 (1)
5	USA	3 (2.50)	2 (1.81)
	World(Total)	120 (100)	112(100)

Source: Computed from www.uncomtrade.com, Figures in bracket shows percentage to total.

Table 5.2.8 depicts the direction of pineapple juice export (Brix value <=20) from India for the period 2003 -2012 on average basis for both quantity and value exported. The table reveals that Netherlands holds the top position with 71.67 per cent in average quantity exported and 68.75 per cent of the average value exported for the period followed by Germany (15.83 per cent of average quantity and 16.1 per cent of average value exported).The three European countries ie Netherlands, Germany and UK holds about ninety per cent of the quantity exported and 86 per cent of the value exported. The export to USA, being the top importers of the world is negligible compared to the European countries.

5.3 Trend Analysis of Pineapple Export

To understand the trend in export of fresh and processed pineapple from India, a detailed trend and growth rate analysis is carried out using the time series data for the period 1983-2013 obtained from time series data of UNCOMTRADE data.

Exponential and kinked exponential trend lines are fitted in this study . An exponential trend equation for the whole period is fitted as well as a single kinked exponential trend is fitted by dividing the time series data in to two sub periods; ie period I consists of the years from 1983 to1995 and period II consists of the years from 1996 to 2013.

The Uruguay round Agreement on Agriculture (AOA) of 1995 under WTO was the first step towards the reforms in international agricultural trade. It places emphasis on agricultural export as an instrument of growth that ultimately gives benefits to the farmers of developing countries (Singh 2011). The division of whole period into two sub periods in the year 1995 is on the assumption that the signing of Agreement On Agriculture (AOA), led to the globalization of agriculture, and policies were changed in compliance with the free trade regime advocated by WTO in AOA.

Single Kinked Exponential model is fitted for finding out the trend of fresh and processed pineapple (both quantity and value) along with the percentage of variance explained for the data .The data are divided into two sub periods by breaking the data in the year 1995(k =13) . A test for trend break has been carried to test the significance of trend break between the two sub periods. The significance level of β is the indicator of the significance level of the trend break of two sub periods.

Trend Equations with percentage of variance explained are as follows

I. Exponential Trend Equations.

1. Export of fresh pineapple (quantity).

   $\ln Y_t = 11.3 + 0.12\ t$ ....(1)

   Variance explained = 71.76%

2. Export of fresh pineapple (value).

   $\ln Y_t = 10.6 + 0.09\ t$ ....(2)

   Variance explained = 40.3%

3. Export of processed pineapple (quantity).

   $\ln Y_t = 13.09 + 0.\ \text{-}04\ t$ ....(3)

   Variance explained = 61.23%

4. Export of processed pineapple (value).

   $\ln Y_t = 12.7 + 0.\ \text{-}01\ t$ ....(4)

   Variance explained = 21.03%

II. Single Kinked Exponential Trend Equations.

5. Export of fresh pineapple (quantity)

   $\ln Yt = 12.5 - 0.06\ (D_1t + D_2k) + 0.218\ (D_2t - D_2k)$ ....(5)

   Variance explained =79.76%

6. Export of fresh pineapple (value)

   $\ln Yt = 12.38 - 0.14\ (D_1t + D_2k) + 0.24\ (D_2t - D_2k)$ ....(6)

   Variance explained = 78.97%

7. Export of processed pineapple (quantity)

$\ln Yt = 15.21 - 0.32\,(D_1t + D_2k) + 0.13\,(D_2t - D_2k)$................................(7)

Variance explained = 33.23%

8. Export of processed pineapple (value)

$\ln Yt = 14.32 - 0.23\,(D_1t + D_2k) + 0.12\,(D_2t - D_2k)$................................(8)

Variance explained =27.72 %

An analysis of trend lines fitted shows that only the line of export of fresh pineapple (quantity) appears to be the line of good fit with per cent of variance explained in the exponential from. So it is better to try out other forms for obtaining the line of good fit. In the case of single kinked exponential trend line, the lines of export of fresh pineapple (quantity) and export of fresh pineapple (value) seem to be the lines of good fit. A two kinked model may be applied for obtaining satisfactory level of R^2

5.4 Growth Rate Analysis of Pineapple Export

CAGR for the fresh and processed pineapple export are computed for the whole period and for the sub period. A kinked exponential growth rate for the fresh and processed pineapple export is also computed for the period 1983-2013 under the two sub periods..

Table 5.3.1: Growth Rates of Fresh Pineapple Export (Quantity) from India for the Period 1983-2013.

Period	Compound growth		Kinked growth		Whole period
	Period I (1983-1995)	Period II (1996-2013)	Period I (1983-1995)	Period II (1996-2013)	1983-2013
Growth rate	-0.6%*	1.8%**	- 6.6% *	21.8% **	0.9%**
Std error	0.003	0.003	0.38	0.02	0.02
P value	0.060	.000	0.09	0.00	0.00

** Significant at 1% level,* Significant at 5% level

Table 5.3.2 Test of Trend Break for Fresh Pineapple Export (Quantity) from India.

Coefficient	Std error	P value
0.092***	0.050	0.076

*** Significant at 10% level.

Table 5.3.1 presents the growth rates of fresh pineapple (quantity) exports from India for the period 1983-2013. Estimates of compound growth rates shows that during the period I, a significant negative growth of 0.6 per cent occurred and in the period II ,a positive growth of 1.81 per cent occurred and is significant at 1 per cent level of significance. In the Kinked model, the growth rates show the same pattern of negative growth rate in the period I and there is a positive growth rate in period II with significance at 1 per cent level and 5 per cent level. Both the model shows the same pattern but the rate of growth is smaller in compound as compared with kinked exponential model. The whole period CAGR is only 0.9 per cent p.a and significant at 1 per cent level. Table 5.2.2 which gives the result of trend break suggests that there is a trend break between the two periods and is significant at 10 per cent level of significance. The positive coefficient of regression also indicates that there is a change in growth from a negative growth to a positive growth from period I to period.

Table 5.3.3 Growth Rates of Fresh Pineapple Export (value) from India for the Period 1983-2013.

Period	Compound growth		Kinked growth		Whole period
	Period I (1983-1995)	Period II (1996-2013)	Period I (1983-1995)	Period II (1996-2013)	1983-2013
Growth rate	-1.3%*	2.12%**	-14.45%**	24% **	0.8%**
Std error	0.04	0.003	0.034	0.021	0.002
P value	.005	.000	0.000	0.000	0.000

* *Significant at 1% level,* Significant at 5% level

Table 5.3.4 Test of Trend Break for Fresh Pineapple Export (value) from India.

Coefficient	Std Error	P value
0.095*	0.051	0.07

* Significant at 10% level.

Table 5.3.3 shows the growth rates of value of fresh pineapple exports from India for the period 1983-2013. In the compound model, the period I shows a negative growth of 1.3 per cent p.a and period II shows a positive growth of 2.12 per cent p.a. In both periods the growth rates are significant at 5 per cent level of significance and 1 per cent level of significance. The same pattern is followed in the kinked exponential model but, with coefficients which are large and are significant at 1 per cent level of significance. The whole period CAGR shows a positive growth of only 0.8 per cent which is also significant at 1 per cent level. The test of trend break (Table 5.3.4) is also significant at 10 per cent level which shows that there is a trend break between the two periods.

Table 5.3.5 Growth Rates of Processed Pineapple Export (quantity) from India for the Period 1983-2013.

Period	Compound growth		Kinked growth		Whole period
	Period I (1983-1995)	Period II (1996-2013)	Period I (1983-1995)	Period II (1996-2013)	1983-2013
Growth rate	-3.6%**	0.4%	-32%**	13.30%*	-4.1%
Std Error	0.01	0.004	0.089	0.059	0.038
P value	0.02	0.290	0.001	0.035	0.49

** Significant at 1% level,* Significant at 5% level

Table 5.3.6 Test of Trend Break for Processed Pineapple Export (quantity) from India.

Coefficient	Std Error	P value
0.245*	0.080	0.004

* Significant at 1% level

Table 5.3.5 presents the growth rates of export of the processed pineapple (quantity) from India for the period 1983-2013. In the compound model, period I shows a negative growth which is significant at 5 per cent level, and the kinked model also shows a negative growth which is significant at 1 per cent level. But the growth rate in the kinked model is more than the growth rate in compound model. During period II, the compound model shows a positive growth rate but not significant and the kinked model also shows positive growth rate but significant at 5 per cent level. The growth rate under kinked model is much higher than that of the compound model growth rate. The CAGR for the whole period is a non significant negative growth rate of – 4.1 per cent p.a. Table 5.3.6 which presents the result of test of trend break shows that there is a significant trend break between the two sub periods. The positive coefficient of the test of trend break shows that there is a change of negative growth in period I to a positive growth in period II and is significant at 1 per cent level.

Table 5.3.7 Growth Rates of Processed Pineapple Export (value) from India for the Period 1983-2013.

Period	Compound growth		Kinked growth		Whole period
	Period I (1983-1995)	Period II (1996-2013)	Period I (1983-1995)	Period II (1996-2013)	1983-2013
Growth rate	-2.6%**	0.5%	- 23.4% **	12% **	-1.3%
Std error	0.010	0.003	0.074	0.049	0.031
P value	0.031	0.149	0.004	0.022	0.872

** Significant at 1% level,* Significant at 5% level

Table 5.3.8 Test of Trend Break for Processed Pineapple Export (value) from India.

Coefficient	Std error	P value
0.180***	0.067	0.012

*** Significant at 10% level.

Table 5.3.7 shows the growth rates computed for the value of processed pineapple exports from India for the period 1983-2013. The table shows that in the compound model, during the period I experiences a negative growth rate of 2.6 per cent p.a and period II experiences a positive growth of only 0 .5 per cent p.a . The growth rate of period I is significant at 1 per cent, but the coefficient of period II is not significant. The same pattern is followed in kinked model also; i.e. in period I experience a negative growth and period II experiences a positive growth and the coefficients are significant at 1 per cent level and 5 per cent level of significance. But the value of the coefficients is more as compared with the compound growth rate . The CAGR computed for whole period experiences a negative growth of 1.3 per cent p.a but it is not significant. The test of trend break (Table 5.3.8) shows that the coefficient is significant at 5 per cent level and it indicates the break between the sub periods which is significant.

Table 5.4 Coefficient of Variation (CV) of Pineapple Export (Fresh& Processed) from India for the period 1983-2013.

Variable	CV
Pineapple Fresh (quantity)	125.36
Pineapple Fresh (value)	110.36
Pineapple Processed (quantity)	190.82
Pineapple Processed (value)	149.78

Table 5.4 presents the coefficient of variation of pineapple export (fresh & processed) from India for the period 1983-2013. Coefficient of variation is computed for both quantity and value exported from India. The table shows that the coefficient of variation seems to be very large in for both fresh and processed category in terms of quantity and value. This indicates the intensity of instability in pineapple exporting from India.

Chapter

6 PINEAPPLE CULTIVATION PRACTICE IN KERALA AND PROFILE OF FARMERS.

Contents

6.1 Pineapple Cultivation Practice in Kerala[1]

Pineapple is one of the prominent fruit crops in the horticulture sector. In India, the major varieties of pineapple cultivated are Kew and Mauritius. Mauritius is recommended for commercial cultivation mainly in Kerala due to its shorter duration for harvesting the crop (as compared with Kew), better fruit quality, and long shelf life. In this chapter the package of practices (POP) of Mauritius variety of pineapple cultivation, as recommended by Kerala Agricultural University, are given in the first section. Along with that, the farming practices which are followed presently by sample farmers regarding the variety Mauritius also are explained. The second section of this chapter presents the profile of the sample farmers with the help of tables.

6.1.1 Season of cultivation:

The main seasons of planting of Mauritius variety are April-May and August-September, but it can also be planted in all months except during heavy rain of June-July and the best time for planting is August.

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[1] Inputs from "Production technology for Vazhakulam Pineapple (Mauritius)", Dr P P Joy, Associate Professor & Head, Pineapple Research Station (Kerala Agricultural University), Vazhakulam 686670, Muvattupuzha, Ernakulam (dist), Kerala, India

6.1.2 Cropping system:

Mauritius variety can be grown as a pure crop in garden land, reclaimed lowlands and wetlands and as an intercrop in coconut and newly planted/replanted rubber plantations. In rubber plantation, it can be grown for the first 3-4 years only. However, in Kerala, the major cropping system is intercrop in rubber plantations.

6.1.3 Land preparation:

6.1.3.1 Pure crop:

Land preparation is done by digging the area to be planted at 90 cm width in rows /strips, leaving the interspaces undisturbed. However, ploughing can be adopted in level land. Planting is done in paired rows of 45 cm distance between rows and 30 cm between suckers. Suckers may be planted in triangular method in the paired rows and interspaces between the paired rows are kept at 150 cm. Contour planting may be adopted in sloppy areas.

6.1.3.2 Intercropping in coconut garden:

Land preparation, spacing and planting methods are the same as in the case of pure crop. However, there can be three-paired rows in between two rows of coconut.

6.1.3.3 Intercropping in rubber plantations:

Land preparation, spacing and planting methods are the same as in the case of intercropping in coconut garden, but there will be only one paired row of pineapple in between two rows of rubber.

6.1.3.4 Wetlands / lowlands:

Pineapple crop is highly sensitive to water stagnation and high moisture regimes. Hence it is important to provide good drainage, if it is grown in wetlands. In paddy lands, pineapple is planted in paired rows at 45 x 30 cm spacing on ridges taken at 60-90 cm height, depending on the water table and drainage requirement. The ridges are separated by drainage channels having 60 cm width. The width of the ridges varies from 120 to150 cm and wherever water stagnation and poor drainage are expected, a wider and deeper channel is given in between ridges.

6.1.4 Planting:

After the land preparations, planting is done in small pits of 10-15 cm depth at a spacing of 45 cm between rows and 30 cm between plants in the rows. Suckers are selected from disease and pest free healthy plants and suckers are to be graded into those having 500-750 gm and 750-1000 gm. The graded suckers are planted in different blocks or plots, to get uniformity in growth and flowering. Bigger suckers give early yield. Dipping of suckers in 1 per cent Bordeaux mixture and 0.05 per cent quinalphos will protect the suckers against diseases and pests. The recommended plant density for Mauritius in intercropped rubber plantations are 25000 suckers /ha.

Plant density in sample pineapple farms

Table 6.1.1: Plant density /ha in sample farms.

Farm	Size	No/ha
Small farm	≤2ha	19720
Medium farm	>2ha	22453
All farms		21591

Source: Primary data.

Table 6.1.1 shows the plant density per hectare among the sample farms. Small farms plant 19720 suckers/hectare, medium farms plant 22453 suckers per hectare which is 13.36 per cent more than the small farms. The sample farmers altogether have plant density of 21591 suckers/hectare of pineapple cultivation, which is about 14 percent below the recommended number of sucker per hectare. It can be observed from the table that the different categories of farmers are not planting the recommended number of suckers in one hectare of rubber plantation.

6.1.5 Nutrient management:

At the time of planting, apply compost / Farm Yard Manure) FYM at the rate of 25 t/ha. Apply fertilizers at the rate of 8:4:8 (gm) N: P2O5: K2O per plant per year (per hectare per year (kg) is 320:160:320). Full dose of P2O5 is applied as basal at the time of planting. Nitrogen and K2O are applied as four equal split doses after planting. First dose may be applied at 40-50 days after planting and thereafter at 60-70 days intervals. After application of fertilizers, cover the soil by scraping the sides of trenches. The following table presents the manure and chemical fertilizer use pattern of sample farmers. The table below presents the manure and chemical fertilizer used by farmers.

Manure & Chemical fertilizer use pattern of the sample farms (kg/ha)[2]

Table 6.1.2: Manure &Chemical fertilizer use pattern of pineapple cultivation (kg/ha).

Year	First			Second			Third		
Farm size / Trade name	Small	Medium	All farms	Small	Medium	All farms	Small	Medium	All farms
Manure	6156	4716	5170	Nil	Nil	Nil	Nil	Nil	Nli
Factomphos	1352	1271	1297	1820	1429	1553	409	614	548
Potash	911	928	922	910	717	777	473	712	636
Rajphos	220	290	268	Nil	Nil	Nil	Nil	Nil	Nil
Urea	500	576	552	Nil	Nil	Nil	743	712	1000
Total	2983	3065	3039	2730	2146	2330	1625	2038	2186

Source: Primary data.

[2] The fertilizer materials are mentioned in table instead of chemical combination.

Table 6.1.2 presents the manure and chemical fertilizer use (Kilogram per hectare) in pineapple cultivation for the three years for the two categories of farms. Manures are used only for the first year by all farms. Manures are used more by small farms (6156 kg/ha) than by the medium (5170 kg/ha). This may be due to the fact that homemade manure is more available to small farmers than the other farmer categories. As regard to the chemical fertilizers use also, the medium farms use more chemical fertilizer than the small farms in the first (3 per cent more) and third year (about 25 per cent more) .But the number of plants planted in one hectare is low in the case of small farmers as compared with the medium farms. But in the second year small farms use more quantity chemical fertilizer (27 per cent more) than medium farms. The table further reveals that the farms do not use the manure and chemical fertilizers as per the recommended quantity.

6.1.6 Weed control

Pre-emergence, ie before the emergence of weeds, spray of diuron @ 1 kg/ha in 600litres of water can keep the field free of weeds for about four months. For subsequent weed control, herbicide application is repeated Spraying should be done in moist soil, avoiding rainy periods. Weeds that exist in interspaces can be controlled by spraying glyphosate 0.8 kg/ha or a mixture of 2,4-D 0.5 kg/ha and paraquat 0.4 kg/ha. While spraying in interspaces, care should be taken that weedicides shall not fall on pineapple plant.

Table 6.1.3: Weedicides use pattern of pineapple cultivation[3] (kg/ha)

Year	First			Second			Third		
Farm size / Trade name	Small	Medium	All farms	Small	Medium	All farms	Small	Medium	All farms
Klass	4.40	5.13	4.90	Nil	Nil	Nil	Nil	Nil	Nil
Gramaxone	7.44	10.23	9.35	6.00	10.30	8.94	6.35	9.96	8.82

Source: Primary data.

[3] Only popular brand names are mentioned and not the chemical combinations.

The table 6.1.3 depicts the weedicides usage pattern of the sample farmers. The weedicide ‘Klass’ is used as a pre emergence spray against the weeds and is applied by all farms once in early first year of cultivation. The dosages applied by all categories of farms are above the recommended level. Medium farms use more quantity (17 per cent more) than small farms which may be due to the more plant density. Similarly the weedicide ‘Gramaxone’ is used at least 3 times in the first and second year of cultivation, and is also above the recommended level. In all years medium farms use more quantity of this weedicide (37per cent,72 per cent and 57 per cent more) than small farm. This is probably due to the fact that small farmers rely more on manual weed control than chemical weedicide to control. The per cent of family labour in small farms is more than in medium farms. In the third year of cultivation, this weedicide is used to clear the entire plantation itself besides its use as weedicide.

6.1.7 Pest and Disease management

For control of mealy bugs, the major pest affected in pineapple cultivation, spray quinalphos at 0.025%, fenitrothion 0.05% or fenthion 0.05% or chlorpyriphos 0.05% or dimethoate 0.05% or monocrotophos 0.05%. Destroyed grasses and other monocot weeds, which serve as alternate hosts for the pest, and due care should be taken that the spray shall reach the base and also the sides of the plant. For the control of mealy bugs, control of ants is a must. Hence apply carbaryl to control ants in its colonies in the farm. The spraying of chemicals for the control of mealy bugs, as mentioned above, will be sufficient for the control of scale insects.

No serious diseases are noticed in the crop except for light incidence of leaf spot disease .For control of leaf spot, spray with any one of the fungicides such as Bordeaux mixture 1%, 225 liter / ha, Zineb 1 kg in 225 liter water / ha, Mancozeb 1 kg in 225 liter / ha, Ziram 1 kg in 225 liter / ha as and when symptoms of the disease are noticed .Root rot / heart rot / fruit rot is caused by poor drainage conditions. Providing drainage is the most essential for controlling Root rot / heart rot / fruit rot. The water table should be at least 60 cm below the soil surface. Badly affected plants should be destroyed and the remaining plants should be drenched with 1% Bordeaux mixture in the soil.

Table 6.1.4: Plant protection chemical use pattern of pineapple cultivation[4] (kg/ha).

Year	First			Second		
Farm size / Trade name	Small	Medium	All farms	Small	Medium	All farms
Hilban&Indofil	5.01	5.30	5.21	0.41	2.04	1.53

Source: Primary data.

Table 6.1.4 presents the sample farmer's practice regarding the usage of plant protection chemicals in pineapple cultivation. Among the different farm sizes, small scale farmers use relatively less quantity (16 per cent less) of chemical pesticides than the medium sized farmers especially in the second year. No farmers use the recommended dosage of chemical pesticides, but the usage is less in the second year as against the first year. No pesticides are usually applied by the farmers in the third year of cultivation. Normally all the farmers apply the pesticides one time soon after the planting in the first year of cultivation, and apply 1-4 times in the later years of cultivation according to the necessity.

[4] Only popular brand name is mentioned.

6.1.8 Flower induction

For inducing uniform flowering, 25 ppm ethephon is applied on physiologically mature plants having 39-42 leaves (7-8 months after planting). The solution for application in1000 plants is prepared by adding 1.25 ml of ethephon (3.2 ml of 39% ethrel or 12.5 ml of 10% ethrel), 1 kg urea and 20 gm calcium carbonate to 50 liters of water. Pour 50 ml of the prepared solution to the heart of the plant during dry weather conditions (when there is no rain during the time of application).Flowering starts by 30 days and completes within 40 days of growth regulator application. Fruits will be ready for harvest by 130-135 days after the application of growth regulator.

6.1.9 Mulching

During summer months it is necessary to protect the fruits from scorching sun by putting dried grasses, coconut or arecanut leaves or using the paper. Mulching the crop with dry leaves at 6 t/ha will help to conserve moisture.

6.1.9 Water management

During summer months, pineapple variety, Mauritius, should be irrigated wherever possible at 0.6 IW/ CPE ratio (50 mm depth of water). It requires five or six irrigations during dry months at an interval of 22 days.

Irrigation status of sample farms:

Table 6.1.5: Distribution of Irrigation status of sample farms.

Farm Size	Irrigated	Percent	Rain fed farms	Percent	Total No. of farms
Small	96	64.43	53	35.57	149
Medium	82	75.23	27	24.77	109
All farms	176	68.22	82	31.78	258

Source: Primary data.

Table 6.1.5 displays the distribution of farms on the basis of irrigation done in pineapple cultivation. About 68.22 per cent of farms were irrigated and 31.78 per cent of sample farms were not irrigated ie they were rain fed farms. In small farms, about 64.43 per cent were irrigated and 35.57 per cent were rainfed. In the case of medium farms, the irrigated were 75.23 per cent and the rainfed were 24.77 per cent. The table shows that medium farmers had more irrigated farms than the small farmers.

6.1.10 Harvesting

With the application of ethephon and fertilizers the first yield is obtained within 11-12 months. Observing the colour change is the most common method of determining the maturity of fruits. When at least two or three rows of eyes at the base turn yellow, pineapple is ready for harvest. Harvesting is done by cutting the fruit stalk and placing the fruits in piles or on to the vehicles. Fruits for fresh fruit market are often marketed with crowns. The fruits are sorted to different grades such as A,B,C and D on visual observations relating to the colour, shape and size.

6.1.11 Ratoon cropping

The plant after harvest can be retained as ratoon crop for two more years. After the harvest of the crop, chopping the side leaves of the mother plant should be done for easy farming operations. The suckers retained should be limited to one or two per mother plant. Excess suckers if any should be removed. Earthing up should be done after the harvesting. Other management practices are the same as for the plant in the second and third year of cultivation.

6.2 Profile of Farmers

This part of the chapter is focused on identifying the profile of the sample farmers. The primary data collected contains details of many personal and occupational factors like age, experience, education level, occupation of farmers, land holding pattern, irrigation pattern and farm extension advice that is received by the farmers that may influence the efficiency in cultivation. The sample consists of 258 farmers of which 149 are small farmers, and 109 are medium farmers. The data collected with respect to personal and other profiles of farmers are presented in the following tables.

6.2.1 Age of Farmers:

Table 6.2.1 gives the age wise distribution of small, medium and aggregate farmers. The farmers are classified into six classes such as below 30 years, 30-40 years, 40-50 years, 50-60 years, 60-70 years and 70 and above.

Table 6.2.1: Age wise distribution of sample farmers

Class	Frequency (Small farmers)	Frequency (Medium farmers)	Frequency (All farmers)
Below 30	4 (2.68)	1(0.92)	5(1.94)
30-40	27(18.12)	21(19.27)	48(18.60)
40-50	35(23.49)	46(42.20)	81(31.40)
50-60	55(36.91)	24(22.02)	79(30.62)
60-70	20(13.42)	13(11.93)	33(12.79)
70 above	8(5.38)	4(3.66)	12(4.65)
Total	149(100)	109(100)	258(100)

Source: Primary data, Figures in bracket shows percentage to total.

In small scale farmers, about 36.91 per cent of the samples come under the class 50-60 years followed by age group 40-50 (23.49 per cent) and 30-40 (18.12 per cent).In medium scale farmers, about 42.20 per cent of the farmers come under class 40-50 years followed by the class 50-60 (22.02 per cent) and 30-40 (19.27 per cent). In all farmers, about 31.40 per cent of the sample farmers come under the class 40-50 years, about 30.62 per cent of farmers come under 50-60 class and about 18.60 per cent of farmers come under 30-40 age group. It can be observed from the table that medium farmers are younger than small farmers as the largest per cent of medium farmers come under the age group 40-50 (nearly half) than the 50-60 age group, which is the largest per cent among small farmers.

6.2.2 Experience of Farmers:

Table 6.2.2 presents the experience wise distribution of sample farmers. The farmers are classified into four classes such as below 10 years of experience, 10 -20 years of experience, 20-30 years of experience and above 30 years of experience in pineapple cultivation.

Table 6.2.2: Experience wise distribution of sample farmers (No. of years).

Class	Frequency (Small farmers)	Frequency (Medium farmers)	Frequency (All farmers)
Below 10	37(24.83)	30 (27.52)	67 (25.97)
10-20	62(41.61)	41(37.62)	103(39.92)
20-30	43(28.86)	36(33.03)	79 (30.62)
Above 30	7(4.70)	2(1.83)	9 (3.49)
Total	149 (100)	109 (100)	258 (100)

Source: Primary data, Figures in bracket shows percentage to total.

Among the small farmers, 41.61 per cent of farmers come under the class 10-20 years of experience .About 28.86 per cent of farmers come under the class 20-30 years and about 24.83 per cent come under the class below 10 years of experience. In medium farmers, 37.61 per cent of farmers come under the class 10-20 years of experience, followed by the class 20-30 years (33.03

per cent) and below 10 years of experience. (27.52 per cent).In all farmers about 39.92 per cent of farmers come under the class 10-20 years of experience followed by 20-30 class (30.62 per cent) and below 10 years of experience class (25.97 per cent).The experience wise classification of farmers shows that small farmers are more experienced than medium farmers as per cent of farmers with experience less than 10 years are more in medium farmers (nearly one third) and farmers with experience more than 30 years are found more in small farmers than in medium farmers.

6.2.3 Educational Qualification:

Table 6.2.3 depicts the educational qualification wise distribution of sample farmers. Farmers are classified into five groups such as SSLC & below, Pre degree, Degree, Postgraduate and Diploma & Others.

Table 6.2.3: Educational qualification wise distribution of sample farmers.

Qualification	Frequency (Small farmers)	Frequency (Medium farmers)	Frequency (All farmers)
SSLC& below	82(55.03)	35(32.11)	117(45.35)
Pre degree	31(20.81)	28(25.69)	59(22.86)
Degree	22(14.78)	25(22.94)	47(18.22)
Postgraduate	8(5.37)	14(12.84)	22(8.53)
Diploma& Others	6(4.03)	7(6.42)	13(5.04)
Total	149(100)	109(100)	258(100)

Source: Primary data. Figures in bracket shows percentage to total.

About 55.05 per cent of the small farmers have only the qualification of SSLC and below followed by pre degree (20.81 per cent) and degree (14.77 per cent). More than half of the farmers have only the qualification of SSLC and below in small farmers. In case of medium farmers also SSLC and below farmers are more, but the Pre degree and Degree qualified farmers have some significant share also. The percentage share of farmers who possess the qualification of SSLC and below are less in medium segment when compared with small farmers. In case of all farmers about 45.35 per cent of the small farmers have only the qualification of SSLC and below, followed by Pre degree (22.87 per cent) and degree (18.22 per cent).The age wise classification of farmers shows that nearly half of the farmers were under the category of the qualification SSLC & below even though it is less per cent in medium farmers.

6.2.4 Family Size of Farmers:

Table 6.2.4 presents the family size wise distribution of sample farmers of pineapple cultivation. The family size is classified into three classes, viz, below 4 members, 4 -6 members and above 6 members.

Table 6.2.4: Family size of sample farmers.

No. of Members	Frequency (Small farmers)	Frequency (Medium farmers)	Frequency (All farmers)
Below4	10(6.71)	21(19.27)	31(12.02)
4 to 6	103(69.13)	60(55.05)	163(63.18)
Above 6	36(24.16)	28(25.68)	64(24.80)
Total	149(100)	109(100)	258(100)

Source: Primary data. Figures in bracket shows percentage to total.

Out of 149 small farmers, majority of the farmers belong to class 4-6 members in the family, ie about 69.13 per cent followed by the class above 6 (24.16 per cent) and below 4 members (6.71 per cent).About 55.05 per cent of medium farmers are in the 4-6 class followed by the class above 6 (25.69 per cent) and below 4 members in the family (19.27 per cent) .About 63.18 per cent of all sample farmers' family size belongs to 4-6 classification followed by above 6 members (24.81 per cent) and below 4 members (12.02per cent).

The family size wise analysis shows that more than half of the sample farmers belongs to the class of 4- 6 family members.

6.2.5 Land Ownership and Holding Size (No of farms):

Table 6.2.5: Land ownership & holding size (No of Farms).

Farm size	No. of farms (owned)	Per cent	No. of farms (leased)	Per cent	Total No. of farms	Average farm size (ha)
Small	61	40.93	88	59.07	149	1.17
Medium	31	28.44	78	71.56	109	3.47
Total	92	35.65	166	64.35	258	2.14

Source: Primary data.

Table 6.2.5 depicts the land holding pattern of sample farmers on the basis of number of farms. About 35.65 per cent of the sample farmers are doing their cultivation in their own land and remaining 64.38 per cent (about two third) of the sample farmers doing the cultivation on leased land. Among small farmers, 40.93 per cent have own land for cultivation and 59. 07 per cent do the cultivation in leased land. In case of medium farmers, 71.55 per cent is doing cultivation in leased land and 28.44 per cent is doing the cultivation in own land. The table reveals that more than half of the small farmers and more than seventy per cent of medium farmers doing their cultivation on leased land. The average farm sizes of small farmers were 1.17 ha while for medium farmers, it comes to 3.47 ha and for all sample farmers it comes to be 2.14 ha.

6.2.6 Land Ownership & Holding Size (Area in ha):

Table 6.2.6: Land ownership & holding size (Area in ha).

Farm size	Own (ha)	Per cent of total (ha)	Lease (ha)	Per cent of total (ha)	Total (ha)
Small	60	34	115	66	174
Medium	117	31	262	69	379
Total	177	32	377	68	553

Source: Primary data.

Table 6.2.6 depicts the land holding pattern of the farmers on area basis.32 per cent (one third) out of the 553 hectares were owned land and the remaining 68 per cent (nearly two third) were leased land .34 per cent of small farmers and 31 per cent of medium farmers come under the category of owned farm and the remaining 66 per cent of small farmers, 69 per cent of medium farmers come under the leased farm category. Thus both on the basis of number of farmers (table 6.2.5) and on the area of holding lease farming is the major form of pineapple cultivation in Kerala.

6.2.7 Access to Farm Extension Service of Sample Farmers.

Table 6.2.7: Distribution of farmers on the basis of access to farm extension service.

Farm Size	No. of farmers seek advice.	Per cent	No. of farmers not seek advice.	Per cent	Total No. of farmers
Small	38	26	111	75	149
Medium	42	39	67	61	109
Total	80	31	178	69	258

Source: Primary data.

Table 6.2.7 presents the distribution of farmers on the basis of access to farm extension services from agricultural department and experts from the pineapple research station of Kerala Agricultural University (KAU) regarding the cultivation aspects. Out of 258 samples, only 31 per cent (one third) seek any kind of expert advice and the remaining 69 per cent (two third) is not interested to seek any type of advice from the experts. About 26 per cent of small farmers and 39 per cent of medium farmers seek the expert advice, while 75 per cent of small famers and 61 per cent of medium farmers do not seek any advice from the agricultural experts. The table shows that medium farmers seek advice more than small farmers in respect of farming aspects of pineapple cultivation.

6.2.8 Ownership of Cultivation of Sample Farmers.

Table 6.2.8: Distribution of farmers- ownership of cultivation.

Farm size	Partnership	Per cent	Single	Per cent	Total
Small	85	57.05	64	42.95	149
Medium	91	83.48	18	16.52	109
Total	176	68.21	82	31.79	258

Source: Primary data

Table 6.2.8 shows the distribution of farmers on the basis of ownership of cultivation; sole or jointly. The table reveals that nearly two third of farmers do their cultivation on partnership (jointly) and the remaining one third do their cultivation on sole basis. Majority of medium farmers do the cultivation jointly (more than three fourth) and the proportion of joint cultivation to sole cultivation is more in medium farms than in small farms. In small farmers also, more than half of them do the cultivation in partnership form.

6.2.9 Mode of Sale by Sample Farmers.

Table 6.2.9: Mode of sale by sample farmers.

	Own farm sale		Wholesale		Retail/Local Sale	
Year	Small	Medium	Small	Medium	Small	Medium
I st	85%	90%	13%	8%	3%	2%
II nd	73%	77%	20%	14%	7%	9%
III rd	54%	58%	35%	32%	11%	10%

Source: Primary data

Table 6.2.9 shows the percentage distribution of farmers on the basis of mode of sale of the fruit. The table shows that, in all categories of farmers majority of the fruit sale is as own farm sale (the wholesaler or his agent come to the farm and make a deal with the farmer and collect the fruit from the farm itself and transport it to destination of the trader at his own expense) and only a small per cent is sold through wholesalers and retailers in the first year. In the second year, the own farm sale amounts to about three fourth of the total sale and in the third year, it is about fifty per cent of the total sale. The share of own farm sale moves on a decreasing direction from the first year to third year of cultivation. The reason for this decreasing trend may be due to the fact that after the first harvesting there is a possibility of receiving the fruits on small quantities instead of bulk quantities, and the own farm sale can be effected mainly for bulk harvesting. In short the major mode of sale is through own farm sale, even though its percentage comes down from the first year to the third year.

6.2.10 Productivity of sample farms (ton/ha).

Table 6.2.10: Productivity of sample farms (ton/ha).

Farm Size	I st year	2nd year	3rd year
Small	8.4	7.3	5.6
Medium	10.4	9.01	7.8
All	9.4	8.2	6.7

Source: Primary data.

Table 6.2.10 depicts the average productivity of the sample farms.The medium farms have more productivity than small farms in all the three years of cultivation. This may be due to the high plant density among the medium farms than the small farms. Similarly the productivity and years of cultivation show an inverse relationship irrespective of farm size in the intercropped rubber plations. This may probably be due to the fact that as the rubber plants grow, their shade also increases, which may lead to reduction in size and quantity of pineapple fruit in the second and third year of production.

6.2.11 Average price received by sample farmers (Rs/kg).

Table 6.2.11: Average price received by sample farmers (Rs/kg).

Farm Size	I st year	2nd year	3rd year
Small	13.21	11.76	10.52
Medium	13.62	11.82	10.57
All	13.42	11.79	10.54

Source: Primary data.

Table 6.2.11 displays the average price per kilogram of the fruit fetched by the sample farmers. The table shows that the medium farmers fetch slightly higher price than small farmers in all years of cultivation. It may be due to the proportion of A grade fruit in medium farms are than that of small farms. Further investigation is needed to make any final conclusion regarding this slight high average price fetched by the medium farmers. There is also a need to find out whether any significant difference exists between the average price fetched by the small farmers and medium farmers. Similarly the average price of fruit shows an inverse relationship with the years of cultivation, and that is a clear indication of the share of A grade fruit decline over years irrespective of farm sizes.

Chapter

7 COST AND RETURN STRUCTURE OF PINEAPPLE CULTIVATION

Contents

The present chapter analyses the cost and return structure of intercrop pineapple cultivation in Kerala. The cost structure is analysed under the following heads.

7.1 Cost of Cultivation.

Cost of cultivation refers to the total expenses incurred in cultivating one hectare of pineapple. The cost of cultivation is worked out by input wise and operation wise together with their percentage to the total. A detailed cost of cultivation on ABC cost measures (Manual on Cost of Cultivation Survey, Ministry of Statistics and Programme Implimentation, Government of India) is also worked out. All types of appropriations and imputations of various costs are taken as per the guidelines given in the manual. The cost of cultivation for three years of cultivation is worked out for the two classes of farms as well as for the total sample farms.

7.1.1 ABC Cost Measures.

The ABC measures of costs and their components are: Cost A_1, Cost A_2, Cost B_1, Cost B_2, Cost C_1, Cost C_2 and Cost C_3.

a) **Cost A_1**

Cost A_1 consists of all actual expenses in cash and kind, incurred in cultivation by the farmers. In the present study, it includes the cost of hired human labour, cost of machine labour, cost of planting materials, cost of manures and fertilizers, cost of plant protection chemicals and weedicides, irrigation and hormone charges, interest on working capital and loan, land revenue, depreciation and other expenses.

Components of various costs in Cost A_1

1. Value of hired human labour.

Human labour was measured in terms of man-day equivalents .Eight hours of labour was considered to be one man-day equivalent. Both family labour and hired labour were treated alike. Value of hired labour used in various operations was evaluated on the basis of the actual wages paid during the period of study. The value of family labour is imputed on the same rate as in the case of hired labour.

2. Value of machine cost

The value of machine cost is computed as the actual rent (after adding the incidental expense) given per hour for the machine used during the period of study.

3. Value of manure

The value of manure is ascertained at the market rate prevailing in the locality. The actual cost of these items was calculated considering the transportation and other incidental charges paid by the sample farmer.

4. Value of planting material

The purchased planting materials were evaluated on the basis of their purchase price, and own produced materials were imputed at their market price.

5. Value of chemical fertilizers:

The value of chemical fertilizers used is calculated on the actual prices plus the transportation and other incidental charges paid by the sample farmer.

6. The value of plant protection chemicals and weedicides.

Expenditure on fungicides, insecticides and weedicides is ascertained at the actual price paid by the sample farmers plus the incidental charges.

7. Cost of irrigation

The cost of irrigation consists of the rent of the hired pump set, price of kerosene, lubricant and petrol, electricity charges and transportation charges but it excludes the labour used for irrigating the crop. The amount of rent is imputed for owned pump sets.

8. Cost of Hormone .

The hormone charge consist of the cost of hormone at market price plus the other incidental charges such as water charges, rent of equipments, if any, used by the farmer. If own equipment is used, the value is imputed at market price.

9. Depreciation

In the present study, straight-line method was employed for working out the depreciation. The depreciation is charged on a proportionate basis to the entire pineapple cultivation .The average economic life of the depreciable items was taken as follows.

Temporary farm building	-	3 years
Pump sets and spares	-	10 years
Light implements	-	3 years
Vehicles	-	15 years

10. Interest on loan

Interest on loan was calculated at 7% of interest which was the interest rate charged by public sector banks for agricultural loans. The interest on loan is charged on a proportionate basis to the entire pineapple cultivation.

11. Land revenue

Land revenue was taken as the actual rent paid to the revenue department by the owned farms.

12. Interest on working capital.

Interest on working capital was charged at the rate of 3.5 per cent per annum, which the interest rate is charged by the public sector banks for savings deposit.

13. Other expenses

Other expenses include all expenses which are incidental to the cultivation such as, food and transportation facilities to labour and rent paid for the assets which are not mentioned earlier

14. Interest on fixed Assets

Interest on fixed assets is estimated @ 10% per annum on the book value of the fixed assets purchased by the farmer on a proportionate basis of the entire pineapple cultivation.

15. Land rent

Rent for leased land is computed as the actual rent paid by the farmer and the rent for owned land is imputed on the market rate on the locality.

b) **Cost A_2** = Cost A_1 + Rent paid for leased in-land

c). **Cost B_1** = Cost A_1 + Interest on value of owned fixed capital assets (excluding land)

d). **Cost B_2** = Cost B_1 + Rental value of owned land (net of land revenue) and rent paid for leased-in land

e). **Cost C_1** = Cost B_1 + Imputed value of family labour

f) **Cost C_2** = Cost B_2 + Imputed value of family labour

g) **Cost C_3** = Cost C_2 + 10 per cent of cost C_2 to account for managerial input of the farmer.

Table 7.1.1: Cost of cultivation of pineapple under ABC cost measures-First Year.

Cost of cultivation -First Year			
Cost measures	**Small (Rs/ha)**	**Medium (Rs/ha)**	**All (Rs/ha)**
Cost A_1	199,491	221,588	214,623
Cost A_2	223,640	250,574	242,084
Cost B_1	201,725	223,993	216,974
Cost B_2	238,682	265,396	256,970
Cost C_1	203,346	224,977	218,159
Cost C_2	240,304	266,380	258,161
Cost C_3	264,334	293,018	283,977

Source: Computed from primary data.

Table 7.1.1 presents the ABC cost analysis of inter crop pineapple cultivation for the first year for all farm sizes .Cost A_1 is computed at 76 per cent of Cost C_3 in small and medium farms and 73 per cent of C_3 in all farms. All cost measures are more in medium farms when compared with small farms. This may be due to the high plant density per hectare in medium farms as compared with small farms .About 12 to 13 per cent difference is displayed between Cost A_1 and Cost A_2 which reveals the fact that the cultivation is mainly in leased land and the difference which is more in medium farms indicates that share of leased land is more among medium farms. The small change between Cost B and Cost C (0.8 per cent in small farms and 0.4 per cent in medium farms) is an indication of low or even negligible use of family labour in the cultivation .However small farms uses more family labour in farming than medium farms in the first year.

Table 7.1.2: Cost of cultivation of pineapple under ABC cost measures-Second Year.

Cost of cultivation - Second Year			
Cost measures	**Small (Rs/ha)**	**Medium (Rs/ha)**	**All (Rs/ha)**
Cost A_1	122,053	131,816	128,739
Cost A_2	146,202	160,802	156,200
Cost B_1	124,991	134,074	131,211
Cost B_2	161,949	175,478	171,213
Cost C_1	126,264	134,946	132,204
Cost C_2	163,221	176,350	172,212
Cost C_3	179,544	193,985	189,433

Source: Computed from primary data.

Table 7.1.2 gives the detailed picture regarding the ABC cost measures of intercrop pineapple cultivation for the second year. In the second year also all cost measures show the same pattern as in the first year in all class of farms. But the per cent of Cost A_1 to C_3 reduces to about 67 per cent in all classes of farms which indicate that the share of direct cost reduces in the second year due to the absence of land preparation and planting of suckers. The difference between Cost A_1 and Cost A_2 increases to 20 per cent and 22 per cent in small and medium farms and it indicates that lease rent plays a significant element of cost in the second year. Any change (increase or decrease) in lease rent will have a great impact on the cost of cultivation. The employment of family labour has the same pattern as in the first year, but its share increases to 1 per cent and 0.6 per cent respectively in small and medium farms.

Table 7.1.3: Cost of cultivation of pineapple under ABC cost measures -Third Year.

Cost of cultivation -Third Year			
Cost measures	**Small (Rs/ha)**	**Medium (Rs/ha)**	**All (Rs/ha)**
Cost A_1	87,433	97,863	94,575
Cost A_2	111,582	126,848	122,036
Cost B_1	90,970	100,125	97,239
Cost B_2	127,927	141,528	137,241
Cost C_1	92,009	100,642	97,921
Cost C_2	128,966	142,025	137,923
Cost C_3	141,863	156,250	151,715

Source: Computed from primary data.

Table 7.1.3 presents the detailed structure of various elements of cost in the ABC cost measures of the intercrop pineapple cultivation for the third year.

In the third year, the Cost A_1 is about 62 per cent of the Cost C_3.The share of direct cost reduces slightly in the third year of cultivation as compared with the second year. The difference between the Cost A_1 and Cost A_2 is increases to 28 per cent and 29 per cent respectively in small and medium farms. Lease rent continues to be the major element in the cost of cultivation in the third year too. The shares of family labour increase slightly to 1.14 per cent in small farms and slightly decrease to 0.5 per cent in medium farms indicating that small farms employ family labour more than medium farms in pineapple farming.

A detailed computation of ABC cost measures is given in appendix III. The ABC cost analysis reveals that on an average about 60-80 per cent of the total cost constitute the direct cost i.e. Cost A_1, in all the three categories and in three years of cultivation. The share of Cost A_1 shows a decreasing trend in all farm sizes from the first year to the third year of cultivation. The sample farmers cultivate more in the lease land than owned land and its proportion is more in medium scale farmers than in small scale. Similarly, the use of family labour is low as compared to hired labour and the use of family labour is more in small scale farmers than in medium scale farmers. This establishes the potential of the crop as a means of livelihood among the marginal and small farmers. The result of an earlier study conducted by Padmini 2002, has depicted almost the same picture that the cost of cultivation was the highest in the first year due to the initial land preparation and planting costs incurred which are no longer needed in the second and third year of cultivation.

Table 7.1.4: Per cent variation of cost among farm sizes (1st, IInd and IIIrd years).

Farm Size \ Cost	Cost A_1	Cost C_3	Cost A_1	Cost C_3	Cost A_1	Cost C_3
Small	199491	264334	122053	179544	87433	141863
Medium	221588	293018	131816	193985	97863	156250
% of variation over small farms	11.07	10.85	7.4	8.04	11.92	10.14

Source: Computed from primary data.

Table 7.1.4 depicts the per cent variation of Cost A_1 and Cost C_3 among the small farms and medium farms for the first, second and third year of pineapple cultivation. Both Cost A_1 and Cost C_3 is more in medium farms as compared with the small farms in all the three years. This increase in per cent variation in medium farms may due to high plant density per hectare in medium farms as compared with small farm size .But the per cent variation in Cost A_1 is slight more as compared with Cost C_3 in the first year. The low per cent variation in Cost C_3 as compared with Cost A_1 may be considered an indication of savings in cost item lease rent made by the medium farms. The per cent variation of Cost A_1 and Cost C_3 in second year shows that variation is slightly more in Cost C_3 than in Cost A_1 in the second year. This indicates that all costs move almost in the same pattern, both in the small and medium sized farms. The per cent variation of cost C_3 is slightly less than the per cent variation of Cost A_1 in the third year of cultivation.

7.1.2 Input wise Cost of Cultivation

Input wise cost of cultivation is computed for the three years of cultivation. The major inputs, cost incurred in the first year are labour cost, machine cost, planting material cost, manure cost, chemical fertilizer cost ,cost of insecticides, cost of weedicides, hormone cost, irrigation cost, rent and other expenses .

Table 7.1.5: Input wise cost of cultivation of pineapple-First year (Rs/ha).

Inputs	Small	Per cent	Medium	Per cent	All	Per cent
Labour	73,097	27.7	87643	29.91	83058	29.25
Machine	19,743	7.5	16097	5.49	17246	6.07
Sucker	57,210	21.6	63246	21.58	61344	21.6
Manure	5,332	2.0	4061	1.39	4461	1.57
Chemical fertilizer	17,091	6.5	16971	5.79	17009	5.99
Insecticides	2,305	0.9	2356	0.80	2340	0.82
Weedicides	5,050	1.9	6276	2.14	5890	2.07
Growth regulatory hormone	673	0.3	688	0.23	683	0.24
Irrigation	2,436	0.9	2298	0.78	2341	0.82
Lease rent	36,992	14.0	41404	14.14	40012	14.1
Other expenses	44,405	16.7	51978	17.75	49593	17.47
Cost/hectare	264,334	100	293018	100	283977	100

Source: Computed from primary data.

Table 7.1.5 presents the input wise cost of pineapple cultivation for the first year for the two classes of pineapple farmers along with the all sample.

Among the various inputs costs, labour cost is the major share of cost in all farm sizes. Almost 30 per cent of the total cost is contributed by the labour alone. The other major inputs costs are planting material cost (21.6 per cent), Lease rent (14.1 per cent), other expenses (17.46 per cent) and chemical fertilizer cost (6 per cent). The least contributing input cost is hormone cost (0.2 per cent) in the total cost.

The input cost incurred in the second year is same as that in first year except the machine cost, planting material cost and manure cost. After the first year the plant is the ratoon of the original plant and hence there is no need for new planting. So is the case of manure and machine cost.

Table 7.1.6: Input wise cost of cultivation of pineapple-Second year (Rs/ha).

Inputs	Small	Per cent	Medium	Per cent	All	Per cent
Labour	79,899	44.5	90553	46.68	87195	46.03
Chemical fertilizer	18,366	10.2	14323	7.38	15597	8.23
Insecticides	184	0.1	973	0.50	724	0.38
Weedicides	1,722	1.0	2963	1.53	2571	1.36
Growth regulatory hormone	912	0.5	848	0.44	868	0.46
Irrigation	1,740	1.0	1630	0.84	1665	0.88
Lease rent	36,992	20.6	41404	21.34	40013	21.12
Other expenses	39,729	22.1	41291	21.29	40800	21.54
Cost/hectare	179,544	100	193985	100	189433	100

Source: Computed from primary data

Table 7.1.7 presents the detailed input wise cost in the second year cultivation of pineapple (first ratoon) among the two classes of farmers along with the aggregate level.

In the second year the share of labour cost increases sharply among all classes, it is amounted to about 46 per cent of the total cost .Since from second year onwards, the garden becomes more thick due to new suckers that arise from the stem of the parent plant, the labour required to perform various operations is more as compared to the first year plantation .Again ratooning and earthing up of the plant is done from the second year onwards. This may be the probable reason for the sharp rise in labour cost. The major other inputs are chemical fertilizers (8.23 per cent), lease rent (21 per cent) and other expenses (21.6 per cent).One notable factor is that, the inputs insecticides and weedicides have more share in medium (1.6 per cent) than in small scale farms (1per cent).Similarly the chemical fertilizer is used more (10.2 per cent) by the small scale farms than the medium farms.

Table 7.1.8: Input wise cost of cultivation of pineapple-Third year (Rs/ha).

Inputs	Small	Per cent	Medium	Per cent	All	Per cent
Labour	55,174	38.9	58673	37.55	57570	37.95
Chemical fertilizer	12,595	8.9	18924	12.11	16929	11.16
Field clearing chemical	1,568	1.1	1685	1.08	1648	1.09
Weedicides	1,933	1.4	3038	1.94	2690	1.77
Growth regulatory hormone	775	0.5	1019	0.65	942	0.62
Lease rent	36,992	26.1	41404	26.5	40013	26.37
Other expenses	32,826	23.1	31507	20.16	31923	21.04
Cost/hectare	141,863	100	156250	100	151715	100

Source: Computed from primary data.

Table 7.1.8 presents the detailed input wise structure of cost of third year cultivation for the two classes along with the total sample. The inputs used in the third year of cultivation (second ratoon) comprised of the inputs used in the second year except of insecticides and irrigation. But a new input field clearing is appeared in the third year. Since after the second year, the spacing between the plants become narrow, and hence the insecticides and irrigation application is not possible. This may be the probable reason why the farmers dropping these two inputs during the third year.

In third year also the labour cost is the major input with about 38 per cent of the total cost .Other major inputs are rent (26.4 per cent), other expenses (21.2 per cent) and chemical fertilizer cost (11.16 per cent) in the total cost. One noticeable fact is that share of the input of chemical fertilizer cost is more in medium scale sector. This may be due to the fact that the medium scale farms use more chemical fertilizers, to produce more suckers.

From the above analysis, one can find that the major share in input cost is the cost of labour. These findings are in par with the results of other studies like (Padmini 2002) and (PFA 2007).The other major input costs are rent and chemical fertilizer cost, other than other expenses

7.1.3 Operation wise Cost of Cultivation

The operation wise cost is computed by adding the cost of material and the corresponding labour cost for that operation.

Table 7.1.9: Operation wise cost of pineapple cultivation -First Year (Rs/ha).

Operation	Small		Medium		All	
	Amount	Per cent	Amount	Per cent	Amount	Per cent
Land Preparation	24672	9.3	22103	7.54	22912	8.07
Planting	70916	26.8	81019	27.65	77835	27.41
Manures& Manuring	7997	3.0	7301	2.49	7520	2.65
Chemical fertilizer application	22879	8.7	23783	8.12	23498	8.27
Plant protection operation	4997	1.9	5959	2.03	5656	1.99
Weeding	26218	9.9	35563	12.14	32618	11.49
Application of growth hormone	3232	1.2	3671	1.25	3553	1.24
Irrigation	9752	3.7	9771	3.33	9765	3.44
Mulching	3167	1.2	3650	1.25	3497	1.23
Harvesting	9107	3.4	6816	2.33	7538	2.65
Miscellaneous expenses	81397	30.9	93382	31.87	89605	31.55
Operating cost/ha	264334	100	293018	100	283977	100

Source: Computed from primary data.

Table 7.1.9 gives the operation wise cost of pineapple cultivation for the first year along with a per cent of total cost. Of the various operations done during the first year, the cost miscellaneous expenses, which include the rent, depreciation, interest on working capital etc constitute 31 per cent in the total operating cost. The next major item of operation cost is planting cost, which amounts to 26.83 per cent, 28.16 per cent and 27.14 per cent respectively for the small, medium and all farms. Other major elements of operating cost are weeding cost (9.92 percent, 12.41 per cent and 11.49 per cent), chemical fertilizer application cost (8.66 per cent, 8.31per cent and 8.27 per cent), and land preparation cost (9.33 per cent, 7.54 per cent and 8.07 per cent) respectively for the small, medium and all farms.

Table 7.1.10: Operation wise cost of pineapple cultivation -Second Year (Rs/ha).

Operation	Small		Medium		All	
	Amount	Per cent	Amount	Per cent	Amount	Per cent
Ratooning	2671	1.5	3064	1.58	2941	1.55
Earthing Up	7150	4.0	7704	3.97	7530	3.97
Chemical fertilizer application	22881	12.7	19472	10.04	20547	10.85
Plant protection operation	673	0.4	2467	1.27	1902	1
Weeding	32954	18.4	47721	24.60	43067	22.73
Application of growth hormone	4489	2.5	4820	2.48	4716	2.49
Irrigation	9355	5.2	9180	4.73	9235	4.88
Mulching	5035	2.8	6958	3.59	6352	3.35
Harvesting	17616	9.8	9901	5.10	12333	6.51
Miscellaneous expenses	76721	42.7	82698	42.64	80816	42.66
Operating cost/ha	179544	100	193985	100	189433	100

Source: Computed from primary data.

Table 7.1.10 presents the operation wise cost of cultivation for the second year for the two classes and also at aggregate level. In the second year also, miscellaneous expenses is the major element in operating cost item in among the various categories of farms. On an average a 10 per cent increase in miscellaneous expenses is shown in the second year as compared to the first year. This pattern of increase can be witnessed in the individual class of farms also. About 42.73 per cent in small farms 42.64 per cent in medium farms and 42.67 per cent in aggregate farms, the total operating cost constitute the miscellaneous expenses. This may be due to the increase in other expenses and other fixed expenses during the second year. Weeding cost is the second major segment in operating cost in the second year which amounts to 18.35 per cent of the total operating cost of the small scale farms, 24.97 per cent in the medium farms and 22.73 per cent of all farms. Other major operations that contribute to the total operating cost are chemical fertilizer application cost (12.74 per cent, 10.85 per cent and 9.90 per cent) and harvesting cost (9.81per cent, 4.96 per cent and 6.5per cent) respectively for the small, medium and all farms.

Table 7.1.11: Operation wise cost of pineapple cultivation -Third Year (Rs/ha).

Operation	Small		Medium		All	
	Amount	Per cent	Amount	Per cent	Amount	Per cent
Ratooning	1876	1.3	2508	1.61	2309	1.52
Chemical fertilizer application	19052	13.4	24923	15.95	23072	15.21
Weeding	19239	13.6	24169	15.47	22615	14.91
Application of growth hormone	7468	5.3	7461	4.77	7805	5.14
Field clearing	11785	8.3	12140	7.77	12028	7.93
Harvesting	12625	8.9	11637	7.45	11948	7.87
Miscellaneous expenses	69818	49.2	73412	46.98	71938	47.42
Operating cost/ha	141863	100	156250	100	151715	100

Source: Computed from primary data.

Table 7.1.11 presents the operation wise pineapple cultivation for the third year. Miscellaneous expenses constitute 49.2 per cent of the total operating cost in small farms, 46.98 per cent in medium farms and 47.42 per cent in all farms. On an average a 5 per cent increase in miscellaneous expenses is shown in the third year as compared to the second year. The same pattern of increase can be witnessed in the small and medium farms also. The other major segments in the total operating cost are weeding cost and chemical fertilizer application cost of which weeding cost amounts to 13.6 per cent of the total operating cost in small farms, 15.47 per cent in medium farms and 14.91 per cent in all farms. Chemical fertilizer cost is computed as 13.43 per cent of the total operating cost in small farms, 15.95 per cent in medium farms and 15.21per cent in all farms.

Among the three years, the major segments of operating costs are miscellaneous expenses followed by weeding and chemical fertilizer application. The miscellaneous expenses show an increasing trend from the first year to the third year in all categories of farms. This may be due to the fact that during the second year and third year, there is a possibility of increase in other expenses, due to the introduction of some new operations like ratooning and earthing up from the second year and also field clearing in the third year.

7.1.4 Testing of Hypothesis:

To test whether there is any significant difference between the average cost/ha of pineapple cultivation among the two farm sizes in each year; a‘t’ test is carried out for each year. For this purpose Shapiro-Wilk test of normality is done for the cost of cultivation in the three years of cost of cultivation among the two farm sizes.

Table 7.1.12: Shapiro-Wilk test of normality for cost of cultivation of small farms.

Year	Statistic	df	P.value
First Year	0.982	149	0.054
Second Year	0.985	149	0.104
Third Year	0.984	149	0.087

Since the p-value is greater than (0.05) the cost of cultivation small farms follow a normal distribution in all the three years

Table 7.1.13: Shapiro-Wilk test of normality for cost of cultivation of medium farms.

Year	Statistic	df	P.Value
First Year	0.984	109	0.199
Second Year	0.982	109	0.156
Third Year	0.984	109	0.224

In case of medium farms also the p-value is greater than (0.05) the cost of cultivation follow a normal distribution in all the three years.

Hypothesis (Ho): There is no significant difference in the average cost of pineapple cultivation (per ha) between the farm sizes in all the three years.

Table 7.1.14: T-test for equality of means.

Year	t statistic	df	P.value
First Year	(-22.61)	256	0.00
Second Year	(-21.33)	256	0.00
Third Year	(-22.66)	256	0.00

Result:

Since the P value is less than ‘α’ at 5 % level of significance, the null hypothesis is strongly rejected, ie there is significant difference in the average cost/ha of pineapple cultivation between the small farms and medium farms in all the three years of cultivation.

7.1.5 Labour use Pattern of Cultivation

Table 7.1.15: Labour use pattern of pineapple cultivation (Man days/hectare)-First Year.

Operations	Small		Medium		All	
	Man days/ ha	Per cent	Man days/ ha	Per cent	Man days/ ha	Per cent
Land Preparation	23	8.4	27	8.3	26	7.3
Planting	32	11.7	49	14.1	43	14.2
Manuring	10	3.7	13	3.7	12	3.6
Plant Protection	10	3.7	14	4.3	13	3.7
Chemical fertilizer application	22	8.0	28	8.4	26	7.6
Weeding	99	36.1	131	39.4	121	36.7
Hormone application	10	3.6	12	3.7	11	3.4
Irrigation	28	10.2	31	6.4	30	11.6
Mulching	17	6.2	17	5.3	17	4.7
Harvesting	23	8.4	22	6.4	23	7.2
Total	274	100	344	100	322	100

Source: Computed from primary data.

Table 7.1.15 presents the labour use pattern of pineapple cultivation (man days per hectare) for the first year for each class of farms with their per cent to the total labour in each class. The major component of labour use is the weeding operation. Weeding has a share of 36.1 per cent in small farms, 39.4 per cent in medium farms and 36.7 per cent for all farms. Labour used for planting comes to the second position. Planting labour amounts to 11.7 per cent for the small farms, 14.1 per cent for the medium farms and 14.2 per cent for all farms. Other major segments of labour uses are for operations like irrigation (10.2 per cent, 6.4 per cent and 11.6 per cent), chemical fertilizer application (8.0 per cent, 8.4 per cent and 7.6 per cent) and harvesting (8.4 per cent, 6.4 per cent and 7.2 per cent) respectively for small, medium and all farms.

Table 7.1.16: Labour use pattern of pineapple cultivation (Man days/hectare)-Second Year.

Operations	Small		Medium		All	
	Man days/ ha	Per cent	Man days/ ha	Per cent	Man days/ ha	Per cent
Ratooning	9	3.1	10	2.9	10	2.6
Earthing Up	24	8.4	26	7.5	25	7.4
Plant protection	2	0.6	5	1.5	4	1.6
Chemical fertilizer application	17	5.8	19	5.5	18	5.2
Weeding	137	47.2	186	53.7	171	53.2
Hormone application	12	4.2	15	4.3	14	4.1
Irrigation	25	8.6	28	8.1	27	9.7
Mulching	25	8.6	29	8.4	28	8.2
Harvesting	40	13.5	28	8.1	31	8
Total	291	100	346	100	328	100

Source: Computed from primary data.

Table 7.1.16 presents the labour use pattern of the second year pineapple cultivation for the two classes of farmers along with total sample. As in the first year, the labour used for weeding is the major segment in the second year operation also. 47.2 per cent in small farms, 54.4 per cent in medium farms and 53.2 per cent in all farms are the labour used for weeding. On an average more than 50 per cent of the labour used in the second year is used for weeding alone. The second major area of labour use is in harvesting .13.5 per cent of the total labour in small farms, 8.1 per cent of the total labour in medium farms and 8 per cent of the total labour in all farms is used for harvesting. Other major labour intensive operations are mulching (8.6 per cent, 8.4 per cent and 8.2 per cent), irrigation (8.7 per cent, 8.1 per cent and 9.7 per cent) and earthing up (8.4 per cent, 7.5 per cent and 7.4 per cent) in small, medium and all farms respectively. The rise in share of labour days in various operations may be due to the difficulty that arises due to high plant density from the second year onwards due to the emergence of new suckers from the stems.

Table 7.1.17: Labour use pattern of pineapple cultivation (Man days /hectare)-Third Year.

Operations	Small		Medium		All	
	Man days/ ha	Per cent	Man days/ ha	Per cent	Man days/ ha	Per cent
Ratooning	6	3.4	8	4.1	7	3.7
Chemical fertilizer application	20	12.0	21	10.3	21	10.6
Weeding	67	39.2	83	41.8	78	41.2
Hormone application	21	12.1	24	12.1	23	11.7
Field clearing	32	18.5	36	18.3	34	17.4
Harvesting	25	14.8	28	13.4	27	15.4
Total	171	100	200	100	190	100

Source: Computed from primary data.

Table 7.1.17 presents the labour use pattern of pineapple cultivation for the third year. The labour used for weeding constitutes the major share in the total labour use in the third year also. 39.2 per cent of labour use in small farms, 41.8 per cent of labour use in medium farms and 41.2 per cent of labour use in all farms comes from weeding alone. The next major item of labour is labour for field clearing. 18.5 per cent in small farms, 18.2 per cent in medium farms and 17.4 per cent in all farms constitute the labour used for field clearing. Other major areas of labour use are harvesting; 14.8 per cent in small farms, 13.4 per cent in medium farms and 15.4 per cent in all farms. For hormone application it is 12.1 per cent in small farms 12.1 per cent in medium farms and 11.7 per cent in all farms. The labour use pattern of chemical fertilizer is 12 per cent in small farms, 10.3 per cent in medium farms and 10.6 per cent in all farmers.

The labour use pattern reveals that in all farm categories and in all years, the labour used for weeding constitutes the major segment in total labour use.

For all classes of farms, about 37 per cent in the first year, about 51 per cent in the second year and about 41 per cent in the third year, weed control (which includes the labour for both chemical application and manual control) constitute the major element of labour use. Other major constituents are labour employed for planting, chemical fertilizer application and harvesting .

7.2 Return Structure of Cultivation

The profitability of pineapple cultivation can be ascertained by means of various income measures such as gross income, farm business income, own farm business income, family labour income and net income.(Kahlon and Singh 1980, Raju and Rao 1990).

i) Gross Income

Gross income represents the total value of the produce (both main product and by- product) which is valued at the prevailing market price.

ii) Farm Business Income

The farm business income is computed by deducting cost A_1 from gross income. This income provides profitability of the farm activity before considering the rent and other imputed values of expenses.

iii) Own Farm Business Income

Own farm business income is obtained by deducting cost A_2 from gross income. This measure of income depicts the profitability of firm after considering the lease rent paid by the farmer if any, but before the imputation of rent in case of own farm.

iv) Family Labour Income :It was arrived by deducting Cost B_2 from gross income. This measure provides the profitability of the farm after the imputation of lease rent but before the imputation of family labour.

v) Net Income

Net income was computed by deducting cost C_3 from gross income. This measure of income is obtained after the imputation of all expenses including the allowances for managerial expenses

Table 7.2.1: Income measures of pineapple cultivation (Rs/ha)-First Year.

Income measures	Small (Rs/ha)	Medium (Rs/ha)	All (Rs/ha)
Gross income	275716	355515	328496
Farm business income	76225	133927	113873
Own farm business income	52076	104941	86410
Family labour income	37034	90119	71526
Net income	11382	62997	44519

Source: Computed from primary data.

Table 7.2.1 presents the various income measures computed for the first year on per hectare basis for the two classes of farms and for the total samples of intercrop pineapple cultivation in Kerala.

In the first year, the gross income is worked out at Rs 275716/ha for small farms, Rs355515/ha for the medium farms and Rs 328496/ha on aggregate level. The net income is about 4 per cent of gross income in small farms and 18 per cent in medium farms. This difference in net income of medium farms over small farms may be from the increased output obtained by medium farms through high plant density and high proportion of A grade fruit which fetches higher price to medium farms. The various income measures of the first year pineapple cultivation show that the medium farms receive more return than small farms .This may be because of two reasons, firstly from the proper use of available resources and secondly due to the large scale operation and the resultant economies of scale.

Table 7.2.2: Income measures of pineapple cultivation (Rs/ha)-Second Year.

Income measures	Small (Rs/ha)	Medium (Rs/ha)	All (Rs/ha)
Gross income	216038	280291	260038
Farm business income	93985	148475	131299
Own farm business income	69836	119489	103838
Family labour income	54089	104813	88825
Net income	36494	86306	70605

Source: Computed from primary data.

Table 7.2.2 presents the various income measures computed for the second year for the two classes of farms as well as on the all samples of intercrop pineapple cultivation in Kerala.

In the second year the gross income for the small farms is computed at Rs 216038/ha, Rs 280291/ha for medium farms and Rs 260038/ha for all farms. The net income is about 17 per cent of the gross income of small farms and 31 per cent of the gross income of the medium farms. The reason for the hike in income of medium farms over the small farms may be the same reason as in the first year. Similarly the difference between various income measures between the two farm sizes shows almost the same pattern as in the first year. The various income measures show an upward trend among all classes with respect to first year income measures .This is due to the reduction in cost due to the absence of the operations like land preparation and planting in the second year.

Table 7.2.3: Income measures of pineapple cultivation (Rs/ha)-Third Year.

Income measures	Small (Rs/ha)	Medium (Rs/ha)	All (Rs/ha)
Gross income	166045	228353	204696
Farm business income	77581	130440	110123
Own farm business income	53432	101455	82662
Family labour income	37086	86825	67457
Net income	24182	72103	52983

Source: Computed from primary data.

Table 7.2.3 presents the various income measures computed for the third year of intercrop pineapple cultivation in Kerala.

In the third year, gross income is worked out at Rs166045/ha for small scale, Rs 228353/ha for medium scale and Rs 204696/ha for all farms. The net income is about 15 per cent of the gross income of small farms and 32 per cent of the gross income of medium farms. In the third year the net income of the pineapple farmers is lower as compared to second year may due the two reasons .Firstly the proportion of A grade fruits become less and secondly, as the proportion of A grade fruits become less the farmers are forced to sell them with lower average price. But the net income is higher when compared with the first year net income of all classes of farms.

Table 7.2.4: Percentage variation of farm business income & net income among farm sizes- First, Second and Third Year (Rs/ha).

Income / Farm size	Farm business income	Net income	Farm business income	Net income	Farm business income	Net income
Small	76225	11382	93985	36494	77581	24182
Medium	133927	62997	148475	86306	130440	72103
% of variation over Small farms	75.69	453	57.97	136	68.13	198

Source: Computed from primary data.

Table 7.2.4 depicts the per cent variation of farm business income and net income among the medium farms and small farms for the first, second and third year of cultivation. The table reveals that, both farm business income and net income are more in medium farms than in small farms in all the three years of cultivation. The net income of medium farms is about 4.5 times more in the first year, 1.36 times more in the second year and 2 times more in the third year than that of the small farms. There exists a huge variation in the net income of medium farms over small farms and this may be probably due to the economies associated with the large scale production of medium farms. Another reason may be the increased 'A' grade fruit, that may be achieved by the medium size farms and the resultant higher average price for their produce. This result reflects to some extent, the outcome of the earlier study conducted by Padmini(2002).

Table 7.2.5: Cost & Return of pineapple cultivation (Three years.)

Farm Size	Plant density/ ha	Cost A_1 (Rs/ha)	Cost C_3(Rs/ha)	Output (Kg/ha)	Gross return (Rs/ha)	Cost of production (Rs/Kg)
Small	19720	136326	195247	52964	219266	10.9
Medium	22453	150422	214418	63197	288053	9.18
All	21591	145979	211708	59971	264410	9.68

Source: Computed from primary data.

Table 7.2.5 shows the cost and return structure of pineapple cultivation aggregated for the three years The table shows that average plant density per hectare is more in medium farms and probably this results in an increased Cost A_1 and Cost C_3 .The output per hectare and gross return per hectare is also more in medium farms as compared with small farmers. But the cost of producing one kilogram of fruit is less in medium farms as compared with small farms indicating the utilization of economies of large scale production by medium farmers.

7.2.1 Sample Farms Incurred Loss in Pineapple Cultivation:

Table 7.2.6: Table of loss making farms.

Farm Size	No. of farms	Per cent	Total No. of farms	Per cent
Small	28	77	149	19
Medium	8	23	109	7
Total	36	100	258	14

Source: Computed from primary data.

Table 7.2.6 presents the number of farms which make a loss in pineapple cultivation. The table shows that 36 sample farms, out of the 258 samples make a loss in pineapple cultivation which is about 14 per cent. Nearly one fifth of small farms experience a loss, which is about 77 per cent of the total number of farms that experience a loss. Only less than 10 per cent of the medium sized farms make a loss which is about 23 per cent of the total loss making farms. The table reveals that the small farms are more severely affected by any set back in pineapple cultivation in Kerala than medium farms. This may be due to low yield and lower average price received by small farms which needs further focused study.

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Chapter

8 ESTIMATION OF TECHNICAL EFFICIENCY OF PINEAPPLE CULTIVATION

Contents

The present chapter deals with the estimation of technical efficiency of intercrop pineapple cultivation in Kerala. The technical efficiency (TE) is estimated for the small farms, medium farms and for aggregate farms using the stochastic production frontier technique. A generalized likelihood ratio test is carried out for all farm sizes to test the validity of the model.

Consider the following generalized stochastic production function that can be specified as

Yi = f(Xi; β)exp {Vi-Ui}, i = 1, …,N ………..(1).

Where

Yi = Production of the i-th firm.

Xi = k ×1 vector of (or transformation of) the input quantities of the i^{th} firm.

β = vector of unknown parameters.

Vi = random variables which are assumed to be independently and identically distributed (iid) as N(0, σ^2v) .

Ui = non-negative random variables that are assumed to account for technical inefficiency in production and are often assumed to be iid as N (0, σ^2u). It is assumed to be half normal, exponential and truncated from below at zero.

Let X = (X_1,.......X_N) $\geq$ 0 be an input vector used to produce scalar output Y $\geq$ 0 and let Z = (Z_1,......Z_Q) be a vector of exogenous variables that influences the structure of the production process by which inputs *X* are converted to output *Y*. The exogenous variables capture the features of the environment, treated as the conditional variables beyond the control of production agent. These variables are neither inputs to the production process nor outputs of it but they can exert influence on producer performance(Kumbhakar&Lovell 2000). Examples of such variables are age, level of education of the farmer, farm size, access to credit and utilization of extension services etc. The identification of those factors that influence the technical efficiency of farmers is significant, because the policy makers can attempt to formulate strategies to raise the average level of efficiency of the producer (Coelli and Battese 1996).

Following the Battese and Coelli (1995) model (single stage model), an extension of Huang and Liu model (1994), the log-linear Cobb-Douglas form of *equation* (1) can be written as:

$\ln Yi=\beta_0+\Sigma_n\beta_n \ln X_{ni} +Vi -Ui$.........(2)

Where *ln* denotes natural logarithms, Yi, β and Xi are as defined in *equation* (1).

Vi = random variables which are assumed to be independently and identically distributed (iid) as N(0, σ^2v) .

Ui = non-negative random variables that are assumed to account for technical inefficiency in production assumed to follow a truncated (at zero) normal distribution as N (μ_i, $\sigma^2 u$).

With these assumptions the mean of technical inefficiency effects μ_i is a function of the explanatory variables and can be specified as:

$\mu_i = Zi\delta + W_i$……….(3)

Where

Zi is a (p×1) vector of variables which may influence the efficiency of a firm; δ is an (1×p) vector of unknown parameters to be estimated. Where the random variable W_i is defined by the truncation of the normal distribution with zero mean and variance σ^2, such that the point of truncation is $-Zi\delta$ ie $W_i \geq -Zi\delta$ .These assumptions are consistent with U_i being a non -negative truncation of the N($Zi\delta$, σ^2) distribution.(Battese and Coelli 1995).

The technical efficiency of production for the i^{th} farm is defined as follows:

$TE_i = \exp(-U_i)$ …….(4).

The technical efficiency of a farmer is between zero and one and is inversely related to the inefficiency effect.

The parameters of the model defined by *equation* (2) and *equation* (3) may be estimated by the method of maximum likelihood.[1]

The parameters to be estimated are β ,δ, λ, $\sigma^2 v$ and $\sigma^2 u$

Using the Battese and Corra (1977), parameterisation, the above model is reparameterised [2] involving the parameters $\sigma^2 = \sigma^2 v + \sigma^2 u$ and $\gamma = \frac{\sigma^2 u}{\sigma^2}$.

[1] The detailed derivation of the likelihood function is obtained from "A Stochastic Frontier Production Function Incorporating a Model for Technical Inefficiency Effects"-Working paper No 69 ,Battese and Coelli (1993) .

The γ parameter lies between zero and one. If γ =0 then all deviations from the frontier are due to noise, while γ = 1 means all deviations are due to technical inefficiency. The maximum likelihood estimates of β, δ, σ^2 and γ are obtained by setting their first order partial derivatives with respect to the elements equal to zero and solving them simultaneously.

The log likelihood estimation of the parameters of both the stochastic frontier model and the inefficiency effects model is done through the software FRONTIER 4.1 was developed by Coelli (1996a). The software program carries out three steps of estimation. The first step is Ordinary Least Square (OLS) estimates of the production function. It provides unbiased estimators for all the β except the intercept. The OLS estimates are then used as starting values to estimate the final maximum likelihood model. The second step carries out a two-phase grid search of the value of the likelihood function which is estimated for different values of γ with the β parameters derived in the OLS. The third and final step calculates the final maximum likelihood estimates (MLE) with an iterative Davidon-Fletcher-Powell algorithm. This step uses the values of the β's from the OLS and the value of γ from the intermediate step as starting values (Coelli, 1996a).

The technical inefficiency model can be estimated only if the technical inefficiency effects U_i are stochastic. The Generalized likelihood Ratio tests are conducted to test the validity of the model. The following null hypotheses are used to test the validity of the model.

1) H_0: Inefficiency effects are not present.

$$H_0:\gamma = \delta_0 = \delta_1 \ldots\ldots \delta_k = 0$$

[2] The suitability of re parameterization of λ by γ is given by Battese and Corra (1977), G .E Battese, T.J Coelli, T.C Colby (1989), Guang H. Wan and George E. Battese(1992).

2) H_0: Inefficiency effects are not stochastic.

$$H_0{:}\gamma = 0$$

3) H_0: Variables in the Inefficiency effects model have no effect on level of technical inefficiency.

$$H_0: = \delta_0 = \delta_1 \ldots\ldots \delta_k = 0$$

These null hypotheses are tested using the generalized likelihood ratio statistics λ defined by: $\lambda = -2\ln[L(H_0)-L(H_1)]$, where $L(H_0)$ and $L(H_1)$ are the values of the likelihood function under the specifications of null and alternative hypothesis respectively. The λ has approximately a Chi square (or a mixed chi square distribution)with parameter equal to the number of parameters assumed to be zero in the null hypothesis,H_0,provided H_0 is true and with degrees of freedom equal to the number of independent constraints. (Judge et.al 1985). If the null hypothesis involves $\gamma = 0$, then the asymptotic distribution involves a mixed chi-square distribution (Coelli1995,Coelli and Battese 1996, Lehmann and Casella 1998,Young and Smith 2005)[3]

Empirical Model

The technical efficiency of intercrop pineapple cultivation in Kerala is estimated by stochastic production frontier fitted to the Cobb-Douglas production function. The following stochastic frontier production function of the Cobb-Douglas type is specified to estimate the technical efficiencies of the farmers.

$$LnYi=\alpha+ \beta_1 \ln X_1+\beta_2 \ln X_2+ \beta_3 \ln X_3+ \beta_4 \ln X_4+ \beta_5 \ln X_5+ \beta_6 \ln X_6+Vi-Ui$$

[3] The critical values for the tests involving γ =0 are obtained from Table 1 of Kodde and Palm (1986)where the degrees of freedom are q+1 ,where q is the number of parameters which are specified to be zero but which are not boundary values.

Where Y_i = Actual output of the i^{th} farm (kg /ha)

α = Constant term

X_1 = Plant density (per ha)

X_2 = Total labour (Man days /ha)

X_3 = Manure (kg/ha)

X_4 = Plant protection chemicals (kg /ha)

X_5 = Chemical fertilizer (kg /ha)

X_6 = Irrigation (dummy variable) ,1 for irrigated, 0 for otherwise.

β_i = Unknown parameters to be estimated.

V_i = Symmetric component of the error term and

U_i = One sided error component (Non negative random variables which are under the control of the firm).

The inefficiency model specified (Battese and Coelli 1995) was as follows:

$$U_i = \delta_0+\delta_1 Z_1+ \delta_2 Z_2+ \delta_3 Z_3+ \delta_4 Z_4+ W_i.$$

Where U_i = Mean technical inefficiency

δ_0 = Constant

Z_1 = Experience of farmer (No of years)

Z_2 = Mode of ownership of cultivation (dummy) 1 if lease &0 if otherwise

Z_3 = Education level (No of years of formal education)

Z_4 = Access to farm extension service (dummy), 1 if seek advice &0 otherwise.

δ_k = Unknown parameters to be estimated.

W_i = error term

8.1Technical Efficiency Estimates of Small Scale Farms.

Table 8.1.1: Descriptive Statistics of Small Scale Farms

Variables	N	Minimum	Maximum	Mean	Std. deviation
Output Y(kg/ha)	149	2180	80275	51478	13441
Plant density X_1(No/ha)	149	14500	25000	19528	2313
Total labour X_2(Man days/ha)	149	494	719	608	54
Manure X_3 (kg/ha)	149	3400	9386	6284	1427
Weedicide & Pesticide X_4(kg/ha)	149	12.50	48.99	31.57	7.43
Chemical Fertilizer X_5(kg/ha)	149	3582	10959	7335	1630
Irrigation X_6 (dummy variable)	149	0	1	0.64	0.48
Experience of farmer Z_1 ((No of years)	149	4	36	18	7
Mode of ownership of cultivation Z_2 (dummy variable)	149	0	1	0.41	0.49
Education level Z_3 (No of years of formal education)	149	5	17	10	3
Access to farm extension service Z_4 (dummy variable)	149	0	1	0.25	0.43

Source: Computed from primary data

Table 8.1.2: Maximum Likelihood Estimates of Small Scale Farmers.

Production function	Coefficient	Standard-error	t-ratio
β_0	0.361	1.119	
β_1	1.779	0.419	4.24*
β_2	0.744	0.214	0.347
β_3	-0.001	0.015	-0.078
β_4	0.208	0.103	2.019*
β_5	-0.135	0.063	-2.142*
β_6	-0.033	-0.041	- 0.803
Inefficiency effects	**Coefficient**	**Standard- error**	**t-ratio**
δ_0	0.045	0.198	
δ_1	0.192	0.095	2.021*
δ_2	0.021	0.063	0.333
δ_3	0.133	0.159	0.834
δ_4	-0.042	0.052	-0.816
Sigma-squared	0.062	0.005	10.94*
Gamma	0.99	0.143	6.92*

Source: Computed from primary data *Significant at 5% level.

Mean efficiency : 72%

Minimum efficiency : 43%

Maximum efficiency : 99%

Table 8.1.3: Deciles range frequency distribution of technical efficiency of Small Scale Farms.

Efficiency level (percentage)	Frequency	Percentage
≤ 50	15	10.07
51-60	36	24.16
61-70	27	18.12
71-80	14	9.4
81-90	35	23.49
91-100	22	14.77
Total	149	100

Source: Computed from primary data

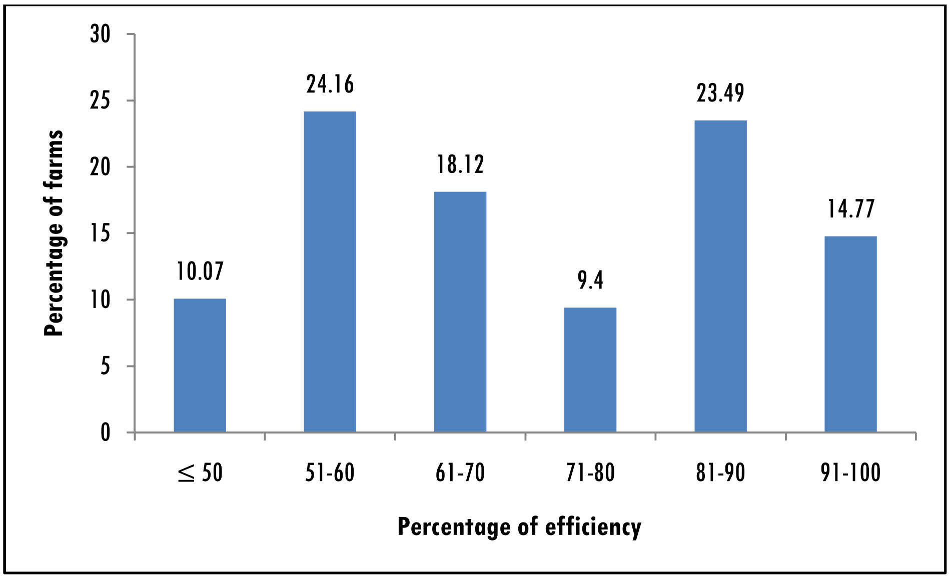

Figure 8.1: Frequency distribution of technical efficiency of Small Scale Farms (percentage wise)

The MLE estimates of production function of small scale farmers have an *a priori* positive sign for the coefficients of variables except for the variables manure, chemical fertilizer and irrigation (dummy variable) which shows a negative sign. The negative coefficient indicates the over use of the particular input and positive coefficient indicates under use of the particular input. The efficiency can be increased through the reduction of negative signed coefficient and can be increased by the additional use of positive signed coefficient. Among the elasticity of coefficient of various inputs, the coefficient of the input plant density is significant and the most prominent one. The elasticity is more than one which means increasing returns to scale and increase in pineapple output more than proportionately with one per cent increase in number of suckers. Other inputs in the model that increase efficiency by additional use are plant protection chemicals and total labour. Of these plants protection chemical is significant at 5 per cent level and the coefficient total labour is only indicative in nature and not significant. The negative signed coefficients of inputs are manure, chemical fertilizers and irrigation and of these, chemical fertilizer is significant at 5 per cent level and others are indicative in nature. The probable reason for the over use of chemical fertilizer may be due to application of chemical fertilizer to a lower number of suckers per hectare. The value of coefficients manure and dummy variable irrigation is small and the standard error of the coefficients seems to be higher as compared with the value of coefficient.

Among the inefficiency effects, the coefficients of the variables experience of the farmer and the dummy variable ownership of farm and level of education of farmers shows a positive relation with production function .The positive sign of coefficient of the inefficiency effects have a negative impact on the efficiency i.e., increase of these variables will reduce the efficiency. Among the inefficiency effects that increase inefficiency the coefficient of the variable experience of the farmer is significant at 5 per cent level. The experienced farmers may be reluctant to follow the scientific methods of cultivation and stick on their experience and probably this may lead to inefficiency in production. Similarly, the leased and educated small farmers are less efficient probably due to low plant density per hectare, even though the result is unexpected and only indicative in nature. The sign of the inefficiency variable access to farm extension services is negative and not significant which indicates that the more the farmers follows the practices advised by experts, the less the possibility of arising inefficiency in production.

The gamma (γ) parameter is 0.99 and is significant which shows that the onside error (inefficiency of the farmer) is the main source of total inefficiency and the random effect has no impact on the total inefficiency. The mean efficiency is 72 per cent which means on an average the farmers can improve efficiency by 28 per cent by the proper utilization of available resources.

Table 8.1.4: Generalized likelihood Ratio Test of Small Scale Farmers.

Null Hypothesis (H_0)	Test Statistic(λ)	Critical value($\chi^2_{0.95}$)	Decision
$H_0: \gamma = 0$	16.33	7.05	Reject(H_0)
$H_0 : \gamma = \delta_0 = \delta_1 \ldots\ldots \delta_4 = 0$	53.06	11.91	Reject(H_0)
$H_0 : \delta_1 \ldots\ldots \delta_4 = 0$	51.05	9.45	Reject(H_0)

The table 8.1.4 presents the result of generalized likelihood ratio test of small scale farmers. The rejection of the first null hypothesis H_0: $\gamma = 0$, implies the existence of a stochastic production frontier ie the traditional average response function is not suitable. The second null hypothesis, which implies inefficiency effects are absent from the model is also rejected. The third null hypothesis farm specific factors have no effect on the level of inefficiency which is also rejected, indicates that the joint effects of the explanatory variables on the inefficiencies of production are significant although the individual effects of one or more of the variables may not be statistically significant.

Thus, it can be concluded here that the proposed inefficiency stochastic frontier production is a significant improvement over the stochastic frontier which does not involve a model for the technical inefficiency effects.

8.2 Technical Efficiency Estimates of Medium Scale Farmers.

Table 8.2.1: Descriptive Statistics of Medium Scale Farmers.

Variables	N	Minimum	Maximum	Mean	Std. deviation
Output Y(kg/ha)	109	40508	81304	63042	9391
Plant density X_1(No/ha)	109	17290	25823	22254	1992
Total labour X_2(Man days/ha)	109	651	914	749.	52
Manure X_3 (kg/ha)	109	2964	7057	4815	958
Weedicide&Pesticide X_4(Kg/ha)	109	31	57	44.	7
Chemical Fertilizer X_5(Kg/ha)	109	5253	9831	7573	1326
Irrigation X_6 (dummy variable)	109	0	1	0.73	0.44
Experience of farmer Z_1 ((No of years)	109	6	30	15	6
Mode of ownership of cultivation Z_2 (dummy variable)	109	0	1	0.69	0.46
Education level Z_3 (No of years of formal education)	109	5	17	13	3
Access to farm extension service Z_4 (dummy variable)	109	0	1	0.55	0.50

Source: Computed from primary data

Table 8.2.2: Maximum Likelihood Estimates of Medium Scale Farmers.

Production Function	Coefficient	Standard error	t-ratio
β_0	0.361	1.161	0.311
β_1	0.706	0.136	5.19*
β_2	0.454	0.217	2.09*
β_3	0.104	0.052	1.99*
β_4	0.156	0.078	2.03*
β_5	-0.089	0.100	-0.89
β_6	0.011	0.018	0.65
Inefficiency effects	**Coefficient**	**Standard- error**	**t-ratio**
δ_0	0.062	0.969	0.064
δ_1	-0.259	0.629	-0.41
δ_2	-0.426	0.982	-0.43
δ_3	0.099	0.251	0.39
δ_4	-0.045	0.281	-0.16
Sigma-squared	0.073	0.160	0.45
Gamma	0.96	0.084	11.50*

Source: Computed from primary data *Significant at 5% level

Mean efficiency : 89%

Minimum efficiency : 70 %

Maximum efficiency : 98%

Table 8.2.3: Deciles range frequency distribution of technical efficiency of Medium Scale Farmers.

Efficiency level (Percentage)	Frequency	Percentage
≤ 50	0	0
51-60	0	0
61-70	12	11.01
71-80	8	7.34
81-90	16	14.68
91-100	73	66.97
Total	109	100

Source: Computed from primary data

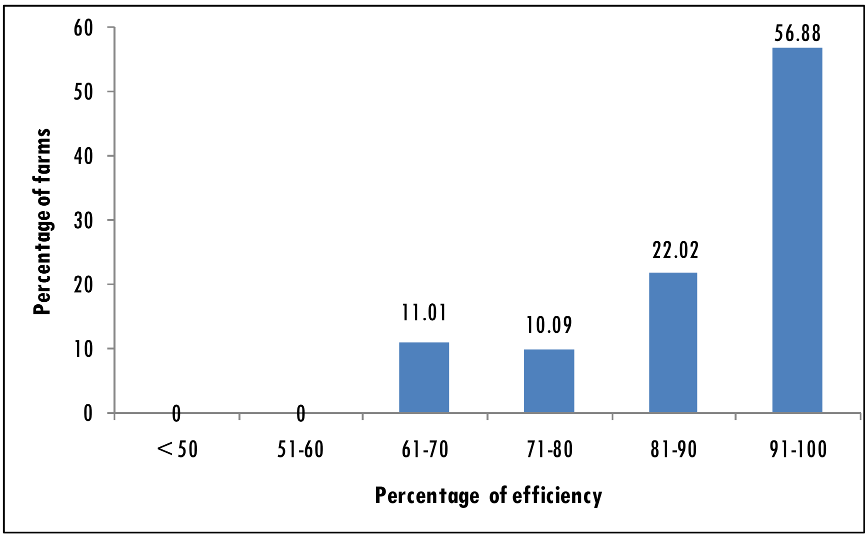

Figure 8.2: Frequency distribution of technical efficiency of Medium farmers (percentage wise).

The MLE estimates of production function of medium scale farmers shows that the coefficients have expected results except the coefficient of the variable chemical fertilizer which is negative and not significant. The value of the coefficients such as plant density, total labour, manure, and plant protection shows a positive and significant value. The positive and significant value of coefficients reinstates that adding these input will definitely lead to an increase in pineapple output. The coefficient of input irrigation (dummy variable) shows that irrigated farmers are more efficient than non irrigated farmers even though the value is only indicative in nature. The coefficient of the input chemical fertilizer has a negative sign as in the case of small farmers indicating the over use of the input though not significant.

Among the inefficiency effects, the coefficients of experience of the farmers, the dummy variable expert advice seeking and ownership of farmers show a negative relation with production function. Though the coefficient is not significant and indicative in nature, the negative sign of the inefficiency effects has a positive impact on the efficiency ie, increase of these variables will reduce the inefficiency. As per the model, farmers who seek expert advice from the agricultural experts, have more experience (in contrast to small scale farms)and doing the farming on leased land is more efficient than those farmers who are less experienced, doing farming on owned land and who do not seek any advice about the cultivation from agricultural experts.

The gamma (γ) parameter is 0.96 and is significant which shows that the onside error (inefficiency of the farmer) is the main source of inefficiency and the random effect has no impact on the total inefficiency as in the case of small farmers. The mean efficiency is 89 per cent which means on an average, the medium sized farmers can improve efficiency by 11 per cent by the proper utilization of available resources.

Table 8.2.4 Generalized likelihood Ratio Test of Medium scale farmers.

Null Hypothesis (H_0)	Test Statistic(λ)	Critical value($\chi^2_{0.95}$)	Decision
$H_0: \gamma = 0$	14.60	7.05	Reject(H_0)
$H_0: \gamma = \delta_0 = \delta_1 \ldots\ldots \delta_4 = 0$	12.62	11.91	Reject(H_0)
$H_0: \delta_1 \ldots\ldots \delta_4 = 0$	13.32	9.45	Reject(H_0)

Table 8.2.4 presents the result of generalized likelihood ratio test of medium scale farms. The rejection of the first null hypothesis H_0: $\gamma = 0$, means that the traditional OLS production function with no technical inefficiency effects is not an adequate representation of the medium farms. The second null hypothesis is also rejected in favour of the presence of inefficiency effects. The third null hypothesis farm specific factors have no effect on the level of inefficiency which is also rejected confirming that the joint effect of these factors on technical inefficiency is significant.

Thus it can be concluded that the inefficiency model presented here is better suited for estimating the efficiency of medium sized pineapple farms than the ordinary least square model (OLS).

8.3 Technical Efficiency Estimates of All Farms

Table 8.3.1 Descriptive Statistics of All Farms

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Output Y(kg/ha)	258	21800	81304	56364	13186
Plant density X_1(No/ha)	258	14500	25823	20679	2563
Total labour X_2(No/ha)	258	494	914	668	88
Manure X_3 (kg/ha)	258	2964	9386	5663	1444
Weedicide&Pesticide X_4(kg/ha)	258	13	57	37	10
Chemical Fertilizer X_5(kg/ha)	258	3582	10959	7436	1511
Irrigation X_6 (dummy variable)	258	0	1	0.68	0.46
Experience of farmer Z_1 ((No of years)	258	4	36	17	7
Mode of ownership of cultivation Z_2 (dummy variable)	258	0	1	0.53	0.50
Education level Z_3 (No of years of formal education)	258	5	17	12	3
Access to farm extension service Z_4 (dummy variable)	258	0	1	0.38	0.48

Source: Computed from primary data

Table 8.3.2 The Maximum Likelihood Estimates of All Farms.

Production function	Coefficient	Standard-error	t-ratio
β_0	6.193	0.811	7.63
β_1	0.038	0.007	5.3
β_2	0.392	0.143	2.74
β_3	0.021	0.007	2.74
β_4	0.216	0.074	2.89
β_5	0.196	0.065	3.02
β_6	0.006	0.017	0.36
Inefficiency effects	**Coefficient**	**Standard-error**	**t-ratio**
δ_0	0.791	0.098	8.03
δ_1	-0.465	0.106	-4.35
δ_2	-0.095	0.046	-2.06
δ_3	-0.041	0.113	-0.36
δ_4	-0.016	0.060	-0.27
Sigma- squared	0.1088	0.025	4.2
Gamma	0.97	0.009	103.6*

Source: Computed from primary data *Significant at 5% level.

Mean efficiency : 77%
Minimum efficiency : 37%
Maximum efficiency : 98%

Table 8.3.3: Deciles range frequency distribution of technical efficiency of All farms.

Efficiency level (percentage)	Frequency	Percentage
≤ 50	24	9.3
51-60	29	11.24
61-70	31	12.02
71-80	38	14.73
81-90	62	24.03
91-100	74	28.68
Total	258	100

Source: Computed from primary data

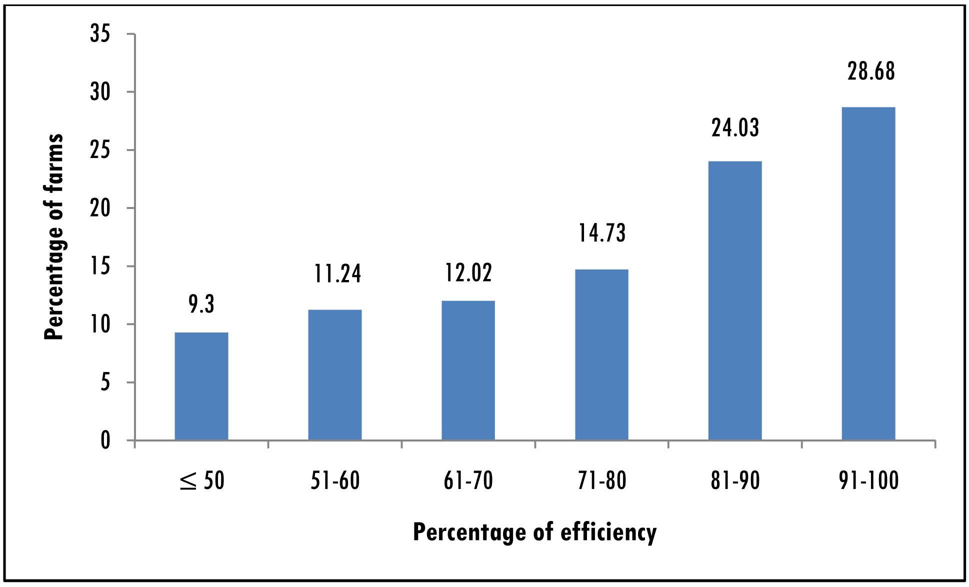

Figure 8.3: Frequency distribution of technical efficiency of All farms (percentage wise).

The MLE estimates of production function of all farms show an *a priori* expected result .Among the variables, except the coefficient of dummy variable irrigation is highly significant and positive. The coefficient of the variable irrigation is positive but not significant and so only indicative in nature. The various inputs seem to be underutilized but the elasticity with values less than one indicates the second stage of the law of variable proportion, ie law of diminishing returns. This indicates that there is a scope for further increase of efficiency at a decreasing rate by increased use of these inputs in production of pineapple.

Among the inefficiency effects, coefficient of all the variables shows a negative relation with production function .Of these variables, experience of farmer and ownership of farms are highly significant which means that more experienced farmers use their expertise in farming and are able to reap a higher efficiency than less experienced farmers. Similarly, the leased farmers have more efficiency than owned farmers as they do the cultivation with a view to fetch a higher profit rather than as a means of lively hood and may have many farms at a time, able to avoid inefficient utilization of resources by transferring the movable resources as and where needed. The coefficient of other inefficiency variables such as education level of farmers and access to farm extension service are looking impressive as they also reduce the inefficiency, though they are only indicative in nature.

The gamma (γ) parameter is 0.98 and is significant which shows that the onside error (inefficiency of the farmer) is the main source of inefficiency and the random effect has no or very little impact on the inefficiency. The mean technical efficiency is 77 per cent which means that on an average, the pineapple farmers can improve efficiency by 23 per cent by the proper utilization of available resources.

Table 8.3.4: Generalized likelihood Ratio test of Aggregate farmers.

Null Hypothesis (H_0)	Test Statistic(λ)	Critical value($\chi^2_{0.95}$)	Decision
$H_0: \gamma = 0$	77.48	7.05	Reject(H_0)
$H_0: \gamma = \delta_0 = \delta_1 \ldots\ldots \delta_4 = 0$	14.45	11.91	Reject(H_0)
$H_0: \delta_1 \ldots\ldots \delta_4 = 0$	15.61	9.45	Reject(H_0)

The table 8.3.4 presents the result of generalized likelihood ratio test of all farms. The first null hypothesis technical inefficiency effects are not stochastic and the second null hypothesis technical inefficiency effects are absent from the production function which is rejected .This shows the existence of the stochastic production function and the presence of inefficiency effects in the production model. The rejection of third hypothesis ensures the effect of explanatory variables on the level of technical inefficiency.

Thus it can be concluded here that the proposed inefficiency stochastic frontier production is more suitable to explain the technical inefficiency of pineapple farms in Kerala.

8.4 Testing of Hypothesis

H_0: There is no significant difference in the efficiency of pineapple cultivation between the farm sizes.

It is most apt that a non parametric test be used to test the significance between the two sample sizes, as the observations are derived from the data. So Mann-Whitney U test is used to test the hypothesis.

Table 8.4.1: Mann-Whitney U test.

Sample Size	N	Mean Rank
Small	149	85.72
Medium	109	189.34
Mann-Whitney U		1598
Z		11.02**

** Significant at 5 % level

Mann-Whitney U statistics are found to be significant, showing that there exists significant difference in technical efficiency between the samples ie, small and medium farms. The mean rank score reveals that technical efficiency is more in medium farms.

The efficiency analysis of the intercrop pineapple cultivation in Kerala shows that in all classes of farms, the gamma (γ) parameter is significant and so it can be concluded that the inefficiency in the cultivation occurs due to the inefficiency of the farmer and not due to the random factors. The major inputs that can be increased to gain efficiency in production are the plant density (though the coefficient is small), total labour, plant protection chemicals and manure in cultivation. But the elasticity of these variables depicts decreasing returns to scale (except plant density in small farms) that necessitates further studies such as allocative efficiency and cost efficiency before taking any decision relating to improvement of technical efficiency. Among the inefficiency variables, which reduce inefficiency, are the experience of the farmer and leased farming which are the significant ones. Similarly, the variables access to farm extension service and education of farmers can exert some influence on farmers to reduce inefficiency in production of pineapple in Kerala.

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Chapter

9 SUMMARY OF FINDINGS SUGGESTIONS & CONCLUSION

Contents

The present chapter deals with the summary of findings, suggestions, conclusions and scope for further research made on the basis of the study.

9.1 Summary of Findings

The major findings of the study are summarized under the following heads.

9.1.1 Growth rate in Area, Production and Productivity of pineapple cultivation in India.

9.1.1.1 The CAGR in area, production and productivity of pineapple cultivation in India under the study period (1961-2013) is not impressive even though they are significant at one per cent level. The CAGR of area, production and productivity of pineapple for the period 1961-2013 is abysmally low ie 0.3 per cent, 0.3 per cent and 0.4 per cent p.a respectively.

9.1.1.2 Similarly, both the CAGR and kinked exponential growth rate are showing a decreasing trend from the first period (1961-1991) to the second period (1992-2013) in area, production and productivity of pineapple cultivation in India. However the kinked exponential model shows a clearer picture than the compound model.

9.1.1.3 The trend break of area and production shows a significant negative trend break between the two sub-periods even though the co-efficient is small. The abysmally low growth in area, production and productivity probably, may be due to the difference in variety planted, difference in plant density per hectare and the difference in cultivation practice followed by the farmers across the nation. Again, the co-efficient of variation shows a higher inconsistency in area and production of pineapple cultivation in India.

9.1.2 Growth rate in Area, Production and Productivity of pineapple cultivation in Kerala.

9.1.2.1 The CAGR for the period (1983-2013) of area and production of pineapple cultivation in Kerala shows a positive significant growth and a negative significant growth for productivity.

9.1.2.2 Both CAGR and kinked exponential model for the sub-period growth rates show that a higher growth rate occurred in period II (1983-2013) than in period I (1983-1992) as regarding area and production of pineapple cultivation. The productivity of pineapple cultivation in Kerala shows a negative growth in both sub-periods but the value of co-efficient is low in period II as compared with period I. The low or negative growth rate in productivity may be due to the existence of inefficiency in resource use.

9.1.2.3. The trend break between two sub-periods is significant for area and production of pineapple cultivation and not significance for productivity. The coefficient of variation shows inconsistency more in case of area and production of pineapple cultivation in Kerala than in productivity as in the case of national level.

9.1.3. Direction and growth rates of pineapple export from India.

9.1.3.1 A snapshot of world pineapple export show that Costa Rica stands in the top position in fresh pineapple exporting (44.62 per cent of quantity and 32.03 per cent of value) and Thailand (43.04 per cent of quantity and 44.91 per cent of value) in processed pineapple export. USA stands in top of world pineapple import (both fresh and processed) with a share of 27.83 per cent and 30.16 per cent of fresh and processed quantity and 23.77 per cent of value of world pineapple import.

9.1.3.2 The direction of fresh pineapple export shows that during the first decade (1983-1992), European countries like USSR and Czechoslovakia are the major export destinations from India . Asian countries like Nepal, UAE, Sri Lanka and Saudi Arabia are the major export destinations during the second (1993-2002) and third decades (2003-2012). The direction of export of fresh pineapple shows a shift from European countries to Asian countries under the study period.

9.1.3.3 The processed pineapple export shows that European countries like Portugal, Germany and Netherland are the major export destination during the first, second and third decades in contrast to the fresh pineapple exports which are mainly to the Asian countries.

9.1.3.4 The pineapple juice export (Brix value >20 and Brix value ≤ 20) shows that European countries like Netherlands, Germany and Belgium as the major export destinations .

9.1.3.5 The CAGR of fresh pineapple export for the period 1983-2013 is not an impressive rate (only 0.9 per cent). The sub-period growth rate shows a negative growth in the sub-period I (1983-1994) i.e. 0.6 per cent and -6.6 per cent respectively under the compound and kinked exponential growth model.

But in the sub-period II, (1995-2013) both models show a positive growth rate and the kinked exponential model shows an impressive growth of 21.8 per cent p.a.

9.1.3.6 The CAGR of value of fresh pineapple export from India shows the same pattern i.e. growth rate is only 0.8 per cent. The sub-period I shows a negative growth rate while the sub-period II shows a positive growth rate for both compound and kinked exponential model.

9.1.3.7 The test of trend break for (both quantity and value) fresh pineapple exports is significant between the two sub-periods which establishes that there occurs a shift in exporting, from the negative growth rate to a positive growth rate. This shift in exporting is probably due to the impact of AOA and the subsequent initiatives to boost export trade activities that take place in India.

9.1.3.8 The CAGR of both quantity and value of processed pineapples export shows a negative significant rate (-4.1 per cent and -1.3 per cent) for the period 1983-2013. The sub-period I shows a negative growth and sub-period II shows a positive growth in both compound growth model and kinked exponential growth model. The probable reason for growth in sub-period II may be the same as in fresh pineapple export. The test of trend break between the two sub periods is significant at 1 per cent and 10 per cent for quantity and value of processed pineapple export.

9.1.3.9 The coefficient of variation for the fresh and processed pineapple (both for quantity and value) shows a huge variation depicting large inconsistency of export during the period 1983-2013.

9.1.4 Profile of Sample Farmers.

9.1.4.1 Out of 258 sample farmers, 149 farmers are small scale farmers (58 per cent) and 104 farmers are medium scale farmers (42 per cent). Of the 149 small scale farmers 61 farmers (41 per cent) cultivate in their own land and 88 farmers (59 per cent) cultivate in leased land. Out of 109 medium farmers, 31 farmers (28.44 per cent) cultivate in own land and 78 farmers (71.56 per cent) cultivate in leased land.

9.1.4.2 Out of the total sample farmers, more than one third (34.40 per cent) of farmers come under the age group of 40-50 years. About 36.91 per cent of small scale farmers come under the category of 50-60 years and about 42.20 per cent of medium scale farmers come under the age group of 40-50 years.

9.1.4.3 More than one third (39.92 per cent) of total sample farmers have experience of 10-20 years in pineapple cultivation. About 30.62 per cent of the farmers have the experience of 20-30 years in cultivation. The same pattern is seen in both the small size and medium size sample farmers.

9.1.4.5 Out of the total 258 samples, 45.35 per cent of farmers have the educational qualification of SSLC &below only. Majority of small scale farmers (55.03 per cent) and medium scale farmers (32.11 per cent) have only SSLC& below SSLC. But more medium scale farmers possess higher educational qualifications such as pre-degree and degree than the small scale farmers.

9.1.4.6 The irrigation status of sample farms shows that 176 farms in out of 258 farms (62.33 per cent) irrigated pineapple. About 65.43 per cent of small scale farms and 75.23 per cent of medium scale farms were get irrigated which shows that most of the farms are irrigated .

9.1.4.7 The status of accession to farm extension services reveals that only 31 per cent of (80 farmers) of the total 258 sample farmers sought any kind of formal extension services from the Local Krishi Bhavans and experts from Pineapple Research Station. Only 26 per cent of small scale farmers and 39 per cent of medium scale farmers sought any kind of extension service from agricultural experts.

9.1.4.8 The average plant density in a sample farm is 21590 suckers per hectare. For medium size farms it is 22453 suckers per hectare and for small size farms it is 19720 suckers per hectare. Medium size farms plant about 4 per cent more suckers than the average farms and 14 per cent more than the small size farm plant density.

9.1.4.9 36 farms (14 per cent) out of the total 258 farms incurred loss in pineapple cultivation. Of these 28 are small farms (78 per cent) and 8 are medium farms (22 per cent). Out of 149 small farms 19 per cent (28 nos) made a loss while out of 109 medium farms 7 per cent (8 nos) made a loss in cultivation under the period of study.

9.1.4.10 The mode of sale of produce shows that during the first year of cultivation about 90 per cent of both the small farms and medium farms sold their produce directly to the wholesaler / agent at the farm itself. During the second year and third year, the direct selling from the farm is less compared to the first year and the farmers take their produce to the market and sell to the wholesaler/ retailer.

9.1.5 Cost and Return Structure.

9.1.5.1 The cost C_3 for the entire sample for the first year is estimated at Rs. 293977/ha, for the second year at Rs. 189433/ha and for the third year Rs. 151715/ha. Cost C_3 per hectare for medium farmer is estimated at Rs. 283977 which is more than 7 per cent that of small farms (Rs. 264334) in the first year. For medium farmers in the second year it is more than 8.04 per cent that of small farms and in the third year it is more than 10.14 per cent that of small farms .This is in contrast to the usual conclusion that while, the size of the farm increases, the cost of cultivation tends to decrease. This may probably be due to the high plant density and the resultant proportionate increase in other input usage by medium farms.

9.1.5.2 The null hypothesis stating that there is no significant difference in the average cost of pineapple cultivation (per ha) between the farm sizes in all the three years is strongly rejected and it can be concluded that there exist significant differences between the average costs of pineapple cultivation in all three years among the two farm sizes.

9.1.5.3 The input wise cost of cultivation shows that labour cost has the major share (29.28 per cent) in the total cost during the first year of cultivation followed by planting material (21.6 per cent) and lease rent (14.09 per cent). In the second year, the share of labour cost increased to 46.03 per cent of the total input cost of cultivation followed by other expenses (21.54 per cent) and lease rent (21.12 per cent). In the third year also labour cost is the major input cost item (37.65 per cent) followed by lease rent (26.37 per cent) and other expenses (21.04 per cent). Besides the labour cost, the other inputs are chemical fertilizer (in all the three years) and machine cost for land preparation (first year) in pineapple cultivation. There is not much difference in share pattern of various between the small and medium size farms.

9.1.5.4 Operation wise cost of pineapple cultivation reveals that cost of planting has the major share (27.41 per cent) followed by weeding (11.49 per cent) and chemical fertilizer application (8.27 per cent) in the first year. In the second year weeding has the major share (27.73 per cent) followed by chemical fertilizer application (10.85 per cent) and harvesting cost (6.51 per cent). In the third year chemical fertilizer cost (15.25 per cent) is the major element in operation followed by weeding cost (14.91 per cent) and cost for clearing the field. (7.93 per cent). This pattern is also followed by the two farm sizes.

9.1.5.6 The labour use pattern (man days per hectare) of all sample farms shows that labour for weeding constitutes the largest segment of labour use (36 per cent) followed planting (14.2 per cent) and irrigation (11.6 per cent) in the first year of cultivation. In the second year and third year weeding constitutes the major operation of labour use (53.2per cent and 41.2 per cent respectively).

9.1.5.7 Harvesting (15.4 per cent) and hormone applications (11.7 per cent) are the other operations that demand labour use heavily. There is not much deviations in pattern of labour use among the two farm sizes ie small farms and medium farms. The analysis establishes the labour intensive nature of cultivation.

9.1.5.8 The net income of the pineapple cultivation for total sample farms is estimated as Rs.44519/ha, Rs.70605/ha and Rs. 52983/ha respectively for the first, second and third year of cultivation. The pineapple farms get the highest income in the second year irrespective of farm sizes. The medium sized farmers get about 4.5 times more net income in the first year, 1.4 times more net income in the second year, and about 2 times more net income in the third year than small farmers. This higher income generation may be due to the economics of large scale cultivation, higher plant density and resultant higher output lower cost of production and may the higher average price fetched by the medium farmers.

9.1.6 Technical efficiency.

9.1.6.1 Average technical efficiency of pineapple cultivation in Kerala is 77 per cent, which means that the efficiency can be improved by 23 per cent, more by proper utilization of available resources. The mean technical efficiency of small farms is 72 per cent and medium farms is 89 per cent indicating that there is room for further improvement in efficiency by proper utilization of resources by both the farm sizes.

9.1.6.2 The inefficiency parameter gamma has the value of 0.99 in small farms, 0.96 in medium farms and 0.97 in all sample farms and is significant at 5 percent level which indicates that the inefficiency that exists is not due to random factors but due to the factors which are under the control of farmers.

9.1.6.3 The rejection of various null establish that the traditional average response function is not suitable to estimate the efficiency, inefficiency effects are present in the model, and the inefficiency variables have an effect on the level of technical efficiency of pineapple cultivation.

9.1.6.4 The major inputs that can contribute to improve the level of technical efficiency are plant density, total labour (man days per hectare), manures weedicides and pesticide and chemical fertilizations. In the case of small farm sizes, the major inputs are plant density, weedicides and pesticides and chemical fertilizers (negative) and in the case of medium farm size, the major inputs are plant density , total labour (man days per hectare), manures per and weedcides and pesticides .

9.1.6.5 In the case of total sample farmers, all exogenous variables have a negative impact on inefficiency and the significant ones are experience of farmers and mode of ownership of cultivation. i.e. more experienced farmers manage farms efficiently and leased land cultivation reduces inefficiency in farming. But in small farms a different result is obtained ie more experienced farmers manage farms inefficiently and in the case of medium farms all exogenous variables are only indicative in nature.

9.2 Suggestions.

The following are some of the suggestions based on the findings.

9.2.1 Presently pineapple cultivation in India is confined to only a few states like Kerala, West Bengal, coastal regions of Karnataka and North Eastern States. As a prominent tropical fruit crop, it is necessary to increase the area and production of pineapple cultivation by identifying potential areas suitable for it and choosing the apt variety for cultivation in each area according to the geographical peculiarities, and by adopting appropriate cultivation practices suitable for each area.

9.2.2 The improvement in productivity can be achieved only through the harmonious effort of farmers, agricultural experts and government which is much needed in India for the sustainable growth of pineapple cultivation.

9.2.3 In Kerala, the possibility of increasing production and productivity by the expansion of area is limited due to high fragmentation of land as well as acute shortage in availability of agricultural land. The productivity can be improved by increasing the present plant density to the recommended level and extending the intercrop cultivation to coconut plantations as well as by cultivating the crop as a pure crop. Along with this, following a scientific practice of cultivation as recommended by Kerala Agricultural University may help to improve the yield per hectare in the state.

9.2.4 For continuing pineapple cultivation and obtaining a stable income to farmers it is inevitable to enhance export of pineapple from India. In order to utilize the export potential of the crop, Government of India must initiate and support various export market enhancement programmes and promotional measures especially to exploit the Geographical Indicator (GI) status of Vazhakkulam Pineapple abroad.

9.2.5 Apart from various supportive programmes for enhancing the export there should be adequate mechanism that ensures international quality standard (Codex Alimentarius Standards for pineapple) in the exporting of fresh pineapple / processed pineapple from India. The government should initiate programmes that intervene in the production, pre harvesting and post harvesting management to maintain the quality.

9.2.6 The working of AEZs (Agri Export Zone) for pineapple exporting is to be rejuvenated and there should be infrastructure development in the form of cold storage under public, private or co-operative sector. Providing incentives and financial assistance to exporters will surely boost up the export of pineapple from the present scenario to the unexploited markets like USA and European countries.

9.2.7 India has the potential to export the processed of pineapple. In order to exploit the markets of European countries and USA, suitable policy measures must be taken up by the government through industries department. Similarly there should be measures to monitor the processing technology in order to maintain the international quality standard of the products.

9.2.8. Efforts must be made by the government of Kerala, to set up small-scale pineapple processing units, to ensure stable price to the farmers.

9.2.9 The farmers need to be provided a better knowledge regarding the pineapple farming practices as most of the chemical inputs are applied more than the recommended dosage. The activities of extension agencies are to be more focused on cultivation practices which ensure that the farmers are cultivating the crop on par with the recommended practices.

9.2.10 Efforts are needed to conscientious the farmers and persuade them to alter the present usage of various chemicals (fertilizers, weedicides/pesticides) to bio chemicals /organic fertilizers, weedicides/ pesticides as the sustainable growth of pineapple cultivation in the state is largely depending upon organic farming.

9.2.11 It is imperative to formulate a policy and regulation regarding the leased land cultivation and related matters as more farming in pineapple cultivation is done in leased land than in owned lands. Lease rent is one of the major inputs that affects the cost of cultivation, especially among the small farmers.

9.2.12 Byproduct utilization in pineapple farming is an area that needs attention. The initiatives to produce fiber from pineapple leaves, cattle feed from waste after the extraction of juice should further be strengthened. Similarly the possibility of producing low cost bio fertilizers from pineapple leaves, waste, excess suckers and slip of pineapple should be examined seriously. These initiatives will definitely help the farmers to remain in this cultivation especially, the small farmers who face more loss in cultivation than the medium farmers.

9.2.13 The floor price mechanism to protect the cultivation from incurring loss due to unexpected fall in price should be revamped and adequate provisions should be made to intervene the market without any procedural delay when a steep fall in price occurs.

9.2.14 The major input components that incur a heavy cost are labour and sucker. In this context, the government should examine the possibility to deploy the labour under MGNREGA scheme for using various operations of pineapple cultivation. This will definitely alleviate some problems related to the non availability and high cost of labour.

9.2.15 There should be some mechanism to provide the suckers at reasonable rate either as pooling of suckers using the farmer's co-operative organizations or through providing low cost tissue culture suckers which is necessary to reduce the cost and ensure availability of good quality suckers in time, especially to small farmers.

9.2.16 Farm operations in general are not mechanized in pineapple cultivation. Efforts should be initiated to develop sophisticated tiny/small equipments that can be used in pineapple farming which is a much labour needed cultivation. This will definitely reduce the labour cost as well as ease strenuous work of labours.

9.2.17 Agricultural extension activities are usually provided to the farmers. In this context, it is imperative to give training to the labours engaged in pineapple cultivation, who have an equal role along with farmers, in cultivation regarding the scientific and accurate application of chemical fertilizer, weedicides and pesticides, growth promoter and harvesting which have an impact on the quality of the fruit.

9.2.18 Increasing the efficiency in utilization of inputs helps to for bring down the unit cost of pineapple farming. Efforts should be taken to improve the input efficiency, especially in small farmers who face loss in cultivation more often.

9.2.19 Overall, there should initiate a strong movement which inculcates awareness among the farmers that organic farming is the key to success and sustainability of the pineapple cultivation in the future, by the joint effort of the government, agricultural experts and farmer's organizations.

9.3 Conclusion.

The present study was undertaken with an objective to evaluate the cost and return structure and technical efficiency of intercrop pineapple cultivation in Kerala. The study also aimed to estimate the growth rates in area, production, productivity and export of pineapple crop, one of the prominent tropical fruit crop in India. The growth of area, production and productivity of the crop shows a grim picture, but it shows signs of good improvement after mid 1990's especially in Kerala. The export growth shows a dismal picture before 1990's but it shows a good growth rate after the mid 1990's. The cost and return analysis reveals comparatively a better picture towards big farm sizes, as they can avail more economies of scale than the small sized farms. Similarly there is a room for further improvement in technical efficiency by the proper utilzation of available resources. It can be concluded from the study that through a harmonious effort of the government, agricultural experts and farmers, the pineapple cultivation in Kerala can enhance the income level of farmers and can contribute towards the economic growth of the nation.

9.4 Scope for Further Research.

The present study gives a detailed description on various aspects of pineapple cultivation such as growth trends, export scenario, cost and return structure and prevailing technical efficiency. However some areas where future research on pineapple cultivation can be done are given below.

9.4.1 The cost efficiency of the cultivation will yield picture about cost optimization possibilities of pineapple cultivation in Kerala.

9.4.2 The marketing efficiency and other marketing aspects of pineapple cultivation are other areas that require further research which can improve the income level of farmers.

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REFERENCES

[1] Abdi, A.R, Halepoto, A.H., Shah, A.B., and Shaik, F. M.(2013).Time Series Analysis of Wheat flour Price Shocks in Pakistan: A Case Analysis: *Asian Journal of Agriculture and Rural Development,* 3(10) ,702-708.

[2] Achoja, F.O., Idoge, D.E., Ukwuaba, S.I, and Esowhode, A.E. (2012). Determinants of Export - Led Cassava Production Intensification Among Small Holder Farmers in Delta State, Nigeria. *Asian Journal of Agriculture and Rural Development,* 2(2) 142-148.

[3] Afriat, S.N.(1972).Efficiency Estimation of Production Functions. *International Economic Review,* 13(3), 568-598.

[4] Ahmad, M., and Bravo-Ureta, B.E. (1996). Technical Efficiency Measures for Dairy Farms Using Panel Data: A Comparison of Alternative Model Specifications. *Journal of Productivity Analysis.* 7(4): 399-415.

[5] Aigner,D.J;andChu,S.F.(1968). On Estimating the Industry Function. *American Economic Review,* 38(4), 826-839.

[6] Aigner, D.J., Lovell, C.A.K., and Schmidt, P. (1977). Formulation and Estimation of Stochastic Frontier Production Function Models. *Journal of Econometrics* 6(1) 21-37.

[7] Alagumani, T. (2005). Economic Analysis of Tissue- cultured Banana and Sucker- propagated Banana. *Agricultural Economics Research Review,* 18 (1), 81-89.

[8] Ali, F., Parikh, A. and Shah, M K.(1996). Measurement of Economic Efficiency using the Behavioural and Stochastic Frontier Approach. *Journal of Policy Modelling* 18(3), 271-287.

[9] Ali, M., and Flinn, J. C. (1989).Profit Efficiency among Basmati Rice Producers in Pakistan Punjab. *American Journal of Agricultural Economics,* 71(2), 303-310.

[10] Amor, T. B., and Muller, C.(2010).Application of Stochastic Production Frontier in the Estimation of Technical Efficiency of Irrigated Agriculture in Tunisia. *Agricultural Journal,* 5(2): 50-56.

[11] APEDA. (2015).*World trade Scenario of crops*. Retrieved from http://agriexchange.apeda.gov.in/Market%20Profile/Volume_IV/ World%20Trade%20Scenario%20of%20Crop.aspx. on 12/01/2015.

[12] Arsalanbod, M.(2005).The Efficiency of Farmers in North –West of Iran. *Indian Journal of Agricultural Economics*,60(1),103-109.

[13] Asokan**,** S.R., and Chokshi, S.N. (1997).Export of Floricultural Products: Problems and Prospects. *Indian Journal of Agricultural Economics*, 52 (3), 609-610.

[14] Awudu, A., and Huffman, W.(2000).Structural Adjustments and Economic Efficiency of Rice Farmers in Northern Ghana. *Economic Development and Cultural Change* , 48 (3),503-520.

[15] Balakrishnan, N. S. (2000). *Economics of Production and Marketing of Banana in Thrissur district*. (Unpublished M.Sc (Ag) dissertation), Kerala Agricultural University, Thrissur.

[16] Bamiro, O.M (2008).Technical Efficiency in Pig Production in Ogun State Nigeria. *Research Journal of Animal Sciences* 2(3), 78-88.

[17] Banik, A. (1994).Technical Efficiency of Irrigated Farms in a Village of Bangladesh. *Indian Journal of Agricultural Economics,* 49(1), 70-78.

[18] Barrett, C.B. (1997).How credible are estimates of peasant allocative, scale, or scope efficiency? A commentary. *Journal of International Development*, 9(2), 221-229.

[19] Bastine, C.L., and Radhakrishnan, V. (1988). Economics of Banana Cultivation in Irinjalakuda Block in Thrissur District of Kerala. *Indian Journal of Agricultural Economics,* 43(3), 514.

[20] Battese, G.E. (1992).Frontier Production Functions and Technical Efficiency. A Survey of Empirical Applications in Agricultural Economics. *Agricultural Economics,* 7(3-4), 185-208.

[21] Battese, G.E., and Coelli, T.J.(1988). Prediction of Firm-Level Technical Efficiencies with a Generalized Frontier Production Function and Panel Data. *Journal of Econometrics,* 38(3), 387-399.

[22] Battese, G.E., and Coelli, T.J.(1992).Frontier Production Functions, Technical Efficiency and Panel Data: With Application to Paddy Farmers in India. *Journal of Productivity Analysis,* 3(1/2), 152- 169.

[23] Battese, GE; and Coelli , T.J (1993). A Stochastic Frontier Production Function Incorporating a Model for Technical Inefficiency Effects. *Working Papers in Econometrics and Applied Statistics, No 69, Department of Econometrics, University of New England, Armidile.*

[24] Battese, G.E., and Coelli, T.J.(1995). A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data. *Empirical Economics,* 20(2), 325- 332.

[25] Battese, G .E., and Corra, G.S.(1977). Estimation of a Production Frontier Model: With Application to the pastoral Zone of Eastern Australia. *Australian Journal of Agricultural Economics*, 21(3), 169-179.

[26] Battese, G.E., Coelli, T.J., and Colby T.C. (1989**)** Estimation of Frontier Production Functions and the Efficiencies of Indian Farms using Panel Data from ICRISAT's Village Level Studies .*Journal of Quantitative Economics,* 5(2), 327 – 348.

[27] Bauer, P.W. (1990). Recent Developments in the Econometric Estimation of Frontiers. *Journal of Econometrics,* 46 (1/2) 39-56.

[28] Belbase, K., and Grabowski, R. (1985).Technical Efficiency in Nepalese Agriculture. *The Journal of Developing Areas,* 19(4), 515-526.

[29] Belloumi, M., and Matoussi, M. S.(2006).A Stochastic Frontier Approach of Measuring Technical Efficiency of date farms in Southern Tunisia. *Agricultural and Resource Economics Review,* 35(2), 285-298.

[30] Birthal, P.S., Joshi, P.K., Chauhan, S., and Singh, H.(2008).Can Horticulture Revitalise Agricultural Growth ?. *Indian journal of Agricultural Economics, 63*(3). 310-321.

[31] Bogetoft, P., and Otto, L. (2010). *Benchmarking with DEA, SFA and R.* New York, NY: Springer.

[32] Boyce, J.K.(1986). Kinked Exponential Model for Growth Rate Estimation. *Oxford Bulletin of Economics and Statistics,* 48(4), 385-391.

[33] Brahmaiah ,P; and Naidu, M.R. (1993). Economics of Chillies Production in Guntur district of Andhra Pradesh. *Indian Cocoa, Arecanut, Spices Journal*, 17(1&2) 22-28.

[34] Bravo-Ureta, B.E., and Evenson R.E. (1994). Efficiency in agricultural production the case of peasant farmers in eastern Paraguay. *Agricultural Economics,* (10), 27-37.

[35] Bravo – Ureta, B.E., and Pinheiro, A.E.(1993).Efficiency Analysis of Developing Country Agriculture: A Review of the Frontier Function Literature. *Agricultural and Resource Economic Review,* 22, 88 – 101.

[36] Bravo- Ureta, B.E., and Pinheiro, A.E.(1997).Technical, Economic and Allocative Efficiency in Peasant Farming : Evidence from the Dominican Republic. *The Developing Economics* 35(1), 48-67.

[37] Cebeco India Private Limited (2002).*AEZ Kerala*. Retrieved from www.kerala agriculture.gov.in/html/aez/Aez%20Kerala.pdf on 10/04/2012.

[38] Chand, R., Raju, S.S., and Panday, L.M.(2008).Progress and Potential of Horticulture in India. *Indian Journal of Agricultural Economics*, 63(3), 299-309.

[39] Charns, A., Cooper, W.W., and Rhodes, E. (1978).Measuring the Efficiency of Decision - Making Units. *European Journal of Operational Research,* 2(6), 429-444.

[40] Chennarayudu, K.C., Prasad, Y.E., Satyanarayana, G., and Rao, I.S.(1990). Land use Efficiency of Banana: An application of Frontier Production Function. *Agricultural Situation in India,* 65(1), 15-16.

[41] Choudary, S .K. (2013). Horticulture's Development: Prosperity and Constraint. *International Journal of Research in Economics and Social Science*, 3(5), 59-71.

[42] CMIE. (2014).*Area, Production and Productivity of pineapple cultivation in Kerala 01/01/1982 to 31/12/2013*. Retrieved on June.15, 2014, from CMIE database.

[43] Coelli, T.J.(1995). Recent Developments in Frontier Modeling and Efficiency Measurement. *Australian Journal of Agricultural Economics*, 39(3), 219 – 245.

[44] Coelli, T.J. (1996*). A Guide to FRONTIER Version 4.1: A Computer Program for Frontier Production Function Estimation. CEPA Working Paper 96/07, Department of Econometrics, University of New England, Armidale.*

[45] Coelli, T.J., and Battese, G.(1996).Identification of factors which influence the technical inefficiency of Indian farmers. *Australian Journal of Agricultural Economics*, 40(2), 103-128.

[46] Coelli, T.J., Prasada Rao, D.S., & Battese G.E. (1998). *An Introduction to Efficiency and Productivity Analysis*. Boston: Kluwer Academic Publishers.

[47] Dahiya, P. S., and Pandey, N.K. (1993). Economic Analysis of Potato Cultivation in Tribal and Hill Areas of Himachal Pradesh. *Journal of Indian Potato Association*, 20(3-4), 230- 238.

[48] Dattatreyulu, M (1997).*Export Potential of Fruits, Vegetables and Flowers from India*. (Occasional Paper-6). Mumbai: National Bank for Agriculture and Rural Development. Retrieved from

www.esocialsciences.org/Download/repecDownload.aspx?fname.pdf on12/03/2012.

[49] Debreu, G. (1951).The coefficient of Resource Utilization. *Econometrica*, 19(3), 273 - 292.

[50] Department of Agriculture and Cooperation. (2014).*Annual Report 2014*.Retrived from www.agricoop.nic.in/Annualreport2013-14/ artp13-14ENG.pdf.on 12/02/2015

[51] Department of Agriculture and Cooperation. (2014).*Hand Book on Horticulture Statistics*. New Delhi, Government of India.

[52] Deshmukh, M.S. (2008).Trade Liberalization and Export Performance of Horticultural Sector in India. *Indian Journal of Agricultural Economics,* 63(3), 359-360.

[53] Dhawan, K.C., Khattra, P.S., and Brar, S.S. (1997). Impact of Fruit Cultivation on General Crops and Milk Production in the Punjab. *Indian Journal of Agricultural Economics*, 52 (3), 615-616.

[54] Economics and Statistics Department. (2009). *Statistics for Planning*. Trivandrum, Government of Kerala.

[55] Economics and Statistics Department. (2005,2010, 2011, 2012, 2013).*Agricultural Statistics*. Trivandrum, Government of Kerala.

[56] FAO. (2014). *Area, Production and Productivity of pineapple cultivation in India 01/01/1961 to 31/12/2013*. Retrieved June.15, 2014, from FAO production statistics data base.

[57] Fare, R., and Lovell, C.A.K. (1978).Measuring the Technical Efficiency of Production. *Journal of Economic Theory*, 19(1), 150-162.

[58] Farrell, M.J. (1957). The Measurement of Productive Efficiency. *Journal of the Royal Statistical Society, Series A, General,* 120, Part 3, 253-81.

[59] Forsund, F.R., Lovell, C.A.K., and Schmidt, P.(1980).A Survey of Frontier Production Functions and their Relationship to Efficiency Measurement, *Journal of Econometrics,*13(1), 5-25.

[60] Fried, H.O., Lovell, C.A.K., & Schmidt. S.S. (1993*). The Measurement of Productive Efficiency: Techniques and Applications.* New York, NY: University of Oxford Press.

[61] Geetha, P. (2006). *Shifts in Cropping Pattern in Kerala*. (Unpublished Doctoral dissertation). Mahatma Gandhi University, Kottayam.

[62] Giri, A.K. (2008).Horticultural Prospect and Potential in India. *Indian Journal of Agricultural Economics,* 63(3), 367-368.

[63] Government of Kerala. (2014).*Kerala- Vision 2030.* Retrieved from kerala.gov.in/docs/reports/vision2030/5.pdf on 15/01/2015.

[64] Goyal, S.K., Suhag, K.S., and Pandey, U.K (2006). An Estimation of Technical Efficiency of Paddy Farmers in Haryana State of India. *Indian Journal of Agricultural Economics,* 61(1), 108-122.

[65] Greene, W.H. (1980a). Maximum likelihood Estimation of Econometric Frontier Functions. *Journal of Econometrics,* 13(1,) 27-56.

[66] Greene, W.H. (1980 b). On the Estimation of a Flexible Frontier Production Model. *Journal of Econometrics,* 13(1), 101-115.

[67] Greene, W.H.(1990). A Gamma - Distributed Stochastic Frontier Model. *Journal of Econometrics,* 46 (1/2), 141-164.

[68] Gujarati, D.N. (2004).*Basic Econometrics*. (4^{th}ed.). New York, NY: The Mc Graw-Hill Company.

[69] Gupta, S.C., & Kapoor, V .K. (1994). *Fundamentals of Applied Statistics*. (2^{nd} ed.). New Delhi: Sultan Chand & Sons.

[70] Gyan Research (2012). *Global Horticulture Market Outlook-2015*. Retrieved from www.marketresearch.com/Gyan-*Research* Analytics-Pvt-Ltd. /Global-Horticulture Market Outlook-2015, on 15/01/2015.

[71] Hazarika, C., Gogoi, H., and Hussain, A.(2006).Marketing of Pineapple in Assam-An Economic & Efficiency Analysis. *Productivity*, 46(1), 170-178.

[72] Huang, C.J., and Liu, J.T. (1994). Estimation of a Non-Neutral Stochastic Frontier Production Function. *Journal of Productivity Analysis*, 5(2), 171-180.

[73] IBIS World Industry Report (2014). *Global Fruit & Vegetables Processing*.Retrievedfrom*https://www.ibisworld.com/gosample.aspx?cid=0&rtid=1* on 15/01/2015.

[74] IndiraDevi, P., Thomas E.K., and Thomas, J.K. (1990). Growth and Supply Response of Banana in Kerala. *Agricultural Situation in India*, 45 (7), 239-242.

[75] IndiraDevi. P., Thomas, E.K.,and Thomas, J.K.(1992). Growth and Performance of Co-operative agricultural credit in Kerala. *Indian Co-operative Review*, 327-336.

[76] Iraizoz, B., Rapun, M., and Zabaleta, I. (2003).Assessing the technical efficiency of horticultural production in Navarra, Spain. *Agricultural Systems*, 78(3), 387-403.

[77] Jiang, N., and Sharp, B. (2014). Cost Efficiency of Dairy Farming in New Zealand, A Stochastic Frontier Analysis. *Agricultural and Resources Economics Review,* 43(3), 406-418.

[78] Job, E., and George, M.V. (2002). Technical efficiency in rice production - A frontier production function approach - Agricultural Economic Research Review, 15(1), 50-55.

[79] Jocob, C., and Soman, M (2006). *Pineapples.* IFMR Working Paper Series, Chennai, Institute for Financial Management and Research.

[80] Jondrow, J., Lovell, CAK., Meterov, I.S., and Schmidt, P .(1982) On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model, *Journal of Econometrics,* 19(2/3), 233-238.

[81] Jose, V.C (1993). *Feasibility of Pineapple as an Intercrop in Small holdings of Rubber in Muvattupuzha Taluk*. Thrissur, Kerala Agricultural University.

[82] Joy,P.P (2010).*Production Technology for Vazhakulam Pineapple(Mauritius).*Retrieved from http://www.kau.in/document-subject/production-technology-vazhakulam-pineapple-mauritius on 15/01/2015.

[83] Judge, G.G., Griffiths, W.E., Hill, R.C., Lutkepohl, H.,& Lee. T.C. (1985). *The Theory and Practice of Econometrics*. New York, NY: John Wiley & Sons.

[84] Kachroo, J., Sharma, A., and Kachroo, D.(2010).Technical Efficiency of Dry land and Irrigated Wheat Based on Stochastic Model. *Agricultural Economics Research Review,* 23(2), 383-390.

[85] Kadiri F.A., Eze, C.C., Orebiyi, J.S., and Henre – Ukoha, A. (2014) Economic Analysis of Paddy Rice Production in Niger Delta Region of Nigeria. *Asian Journal of Agriculture and Rural Development,* 4 (12), 541-550.

[86] Kahlon,A.S., and Singh, K. (1980). *Economics of Farm Management in India: Theory and Practice.* (2 nd ed.).New Delhi: Allied Publishers Limited.

[87] Kalirajan, K.P., and Flinn., J.C. (1983). The Measurement of farm - specific Technical efficiency**.** *Pakistan Journal of Applied Economics,* 2(2), 167-180

[88] Kalirajan, K.P, and Shand, R.T. (1986).Estimating Location- Specific and Firm- Specific Technical Efficiency: An Analysis of Malaysian Agriculture. Journal of Economic Development, 11(2), 147-160.

[89] Kalirajan, K.P., and Shand, R.T. (1994). Modelling and Measuring Economic Efficiency under risk. *Indian Journal of Agricultural Economics* .49(4), 579-590.

[90] Kalirajan, K. P., and Shand, R.T. (1999), Frontier Production Functions and Technical Efficiency Measures, *Journal of Economic Surveys*, 13(2), 149-172.

[91] Karthikeyan,N. (2001). *Economic Analysis of Production and Marketing of Cool Season Vegetables in Devikulam Block of Idukki District*. (Unpublished M.Sc(Ag) dissertation).Kerala Agricultural University ,Thrissur.

[92] Kaur, M., Kaur, A M., Sekhon, M.K., and Kingra, H.S (2010). Technical Efficiency of Wheat Production in Punjab: A Regional Analysis. *Agricultural Economics Research Review,* 23(1), 173-179.

[93] Kodde, D.A., and Palm, F.C. (1986). Wald Criteria for Jointly Testing Equality and Inequality Restrictions. *Econometrica*, 54(5), 1243-1248.

[94] Koop, G.(2005). *Analysis of Economic Data*. New York, NY: John Wiley & Sons.

[95] Koopmans, T.C. (1951). An Analysis of Production as an efficient Combination of Activities in T.C Koopmans , ed, *Activity of Production and Allocation, Cowles Commission for Research in Economics*, Monograph No 13, New York : Wiley.

[96] Koop, R.J., and Smith, V.K. (1980). Frontier Production Function Estimates for steam Electric Generation**.** A Comparative Analysis. *Southern Economic Journal*, 47(4), 1049 - 1059.

[97] Koshta, A.K., and Chandrakar, M.R. (1997).Profitability of Vegetable Crops in Chattisgarh Region of Durg District. *Indian Journal of Agricultural Economics*, 52 (3), 633-634.

[98] Kothari, C.R. (1990). *Research Methodology: Methods and Techniques*. (2^{nd}ed.). New Delhi: Wishwa Prakashan.

[99] Krishna, K.L., and Sahota. G.S. (1991). *Technical Efficiency in Bangladesh Manufacturing Industries*. The Bangladesh Development Studies. 19 (1&2), 89-106.

[100] Krishnan, M. Vasisht, A.K., and Sharma, B.M. (1991). Growth and Instability in Kerala Agriculture. *Agricultural Situation in India*, 45(1), 21-26.

[101] Kumaresan,P., Geetha Devi, R.G., Rajadurai,S., Selvaraju,N.G., and Jayaram, H.(2008). Performance of Large Scale Farming in

Sericulture- An Economic Analysis. *Indian Journal of Agricultural Economics,* 63(4) 641 – 657.

[102] Kumbakar, S.C., Lovell, C.A.K. (2000). *Stochastic Frontier Analysis.* New York, NY: University of Cambridge Press.

[103] Kumbhakar, S.C., Ghosh,S., and McGuckin, J.T. (1991). A Generalized Production Frontier for Estimating Determinants of Inefficiency in US Dairy Farms. *Journal of Business and Economic Statistics*, 9(3), 279-286.

[104] Kumbhakar, S.C., Biswas, B., Bailey, D.(1989).A Study of Economic Efficiency of Utah Dairy Farmers: A System Approach. *The Review of Economics and Statistics.*71 (4), 595-604.

[105] Lehmann, E.L., & Casella, G. (1998). *Theory of Point Estimation*. New York, NY: Springer.

[106] Leibenstein, H. (1966). Allocative Efficiency Vs X-Efficiency. *American Economic Review,* 56(3), 392-415.

[107] Madan,M.S ; Singh, R.V; and Singh, M.L. (1999). Economics of Production and Marketing of Cauliflower in Ranchi District of Bihar. *Bihar Journal of Marketing* .7(1) 28-35.

[108] Maurya, O.P., Singh, G.N., and Kushwash, R.K.S. (1996). Profitability of Banana plantation in District Hajipur (Bihar). *The Bihar Journal of Marketing.* 25(4), 20-24.

[109] Meena,LK.,ChandraSen.C.,andBairwa,S.,Jhajharia,A.,andRaghuwanshi,N.K. (2013).Economics of Garlic Production in Baran District of Rajasthan: Break Even Analysis. *Asian Journal of Agriculture and Rural Development,* 3(10), 697-701.

[110] Meeunsen, W., and van den Broeck, J. (1977). Efficiency Estimation from Cobb - Douglas Production Functions with Composed Error. *International Economic Review*, 18(2), 435-444.

[111] Ministry of Statistics and Programme Implementation (2014). *Manual* on *Cost of Cultivation Surveys*. Retrieved from mospi.nic.in/mospi/ manual_cost_cultivation_surveys_23july08.pdf on 20/5/2013.

[112] Mruthyanjaya, S., Rajeshekharappa., Pandey , L.M., Ramanarao , S.V., and Narayan, P. (2005). Efficiency in Indian Edible Oilseed Sector. Analyisis and Implication. *Agricultural Economics Research Review*,18(2),153-166.

[113] Murillo–Zamorano, L. R. (2004) Economic Efficiency and Frontier Techniques .*Journal of Economic Surveys* ,18(1), 33-77.

[114] Mythili, G., and Shanmugam, K.R. (2000). Technical efficiency of Rice Growers in Tamil Nadu: A Study Based on Panel Data: *Indian Journal of Agricultural Economics*, 55(1), 15-25.

[115] Narala, A., and Zala, Y.C. (2010).Technical efficiency of Rice Farms under Irrigated conditions in Central Gujarat. *Agricultural Economics Research Review*, 23(2), 375-381.

[116] National Horticulture Board (2010, 2011, 2012, 2013). Indian *Horticultural Data Base* .New Delhi, Ministry of Agriculture, Government of India.

[117] National Horticulture Board (2005) *National Horticultural Mission (2005) Action Plan*. New Delhi, Ministry of Agriculture, Government of India.

[118] Ogundari, K., Ojo, S.O., and Ajibefun, I.A. (2006). Economies of Scale and Cost Efficiency in Small Scale Maize Production. Empirical Evidence from Nigeria. *Journal of Social Science*, 13(2) 131-136.

[119] Ogundari, K. (2014, June).*A meta-regression analysis of frontier efficiency estimates from Africa.* Paper presented at the annual meeting of the Agricultural & Applied Economics Association (AAEA), Minneapolis, Minnesota.

[120] Oyewo, I.O., Rauf, M.O., Ogunwole, F., and Balogun, S.O. (2009). Determinant of Maize Production among Maize Farmers in Ogbomoso South Local Government in Oyo State. *Agricultural Journal*, 4(3), 144-149.

[121] Padmini,T.S.(2002). *Problems and Prospects of Pineapple Cultivation in Kerala.* (Unpublished Doctoral dissertation). University of Kerala, Trivandrum.

[122] Pandit, A., Pandey, N.K., Rana, Rajesh K., and Barsati Lal.(2009). An Empirical Study of Gains from Potato Contract Farming. *Indian Journal of Agricultural Economics,* 64(3), 497 – 507.

[123] Parikh, A;and Shah,K .(1994) .Measurement of Technical Efficiency in the North – West Frontier Province of Pakistan, Journal of Agricultural Economics, 45(1),132-138.

[124] Patil, G.R. (1997). Area, Production and Productivity of Vegetables and Fruits in India. *Indian Journal of Agricultural Economics*, 52 (3), 629-630.

[125] Pingali, Venugopal., and Premarajan, RK.(1999). *Impact Assessment Study of Kerala Horticultural Development Programme.* Jamshedpur: XLRI.

[126] Pitt. M., and Lee, L.F.(1981). The Measurement and Sources of Technical Inefficiency in the Indonesian Weaving Industry. *Journal of Development Economics*, 9(1), 43-64.

[127] Prakash, B., Sharma, D.K., and Tyagi, V.P.(2008). Fruits and Vegetables Processing in India: Current Trends, Constraints and Prospects. *Indian Journal of Agricultural Economics*, 63(3), 371-372.

[128] Prasad, R.M; and Bonny, B.P. (1996). Constraints in Commercial Production of Vegetables. *Journal of Tropical Agriculture*, 34(2), 159 -160.

[129] Rahman, K.M.M., Mia, M.I., and Alam, M .A.(2012). Farm Size Specific Technical Efficiency: A Stochastic Frontier Analysis for Rice Growers in Bangladesh. *Bangladesh Journal of Agricultural Economics*, 35(1&2), 131-142.

[130] Rai,J., and Rai, R.(2008).Economics of Guava Production in Kanpur Nagar District of Uttar Pradesh. *Indian Journal of Agricultural Economics*, 63(3), 375-376.

[131] Raju, V.T., & Rao, D.V.S. (1990). *Economics of Farm Production and Management*. New Delhi: Oxford & IBH Publishing Company Pvt. Ltd.

[132] Rama Rao, C.A., Chowdary, K.R., Reddy, Y.C.R., and Krishna Rao, G.V. (2003).Measuring and Explaining Technical Efficiency in Crop Production in Andhra Pradesh. *Indian Journal of Agriculture Economics*, 58(4) 768-779.

[133] Ramaswamy, K., and Kailasam, C. (2000).Sugarcane production: Estimation of Economic Efficiency. *Productivity*, 41(2), 338-341.

[134] Rao, N. A. (1997). Higher Employment and Income Potential of Horticultural crops. *Indian Journal of Agricultural Economics*, 52 (3), 584-591.

[135] Reddy, A.R., and Sen, C. (2004). Technical inefficiency in Rice production and Its Relationship with Farmers Specific Socio-Economic Characteristics. *Indian Journal of Agricultural Economics,* 59 (2), 259-267.

[136] Richmond, J. (1974). Estimating the Efficiency of Production. *International Economic Review,* 15(2), 515 – 521.

[137] Rifin,A., and Nauly, D.(2013,February).*The Effect of Export Tax on Indonesia's Cocoa Export Competitiveness*. Paper presented at the 57thAARES Annual conference, Sydney, New South Wales.

[138] Schmidt,P., and Lovell, C.A.K.(1979). Estimating Technical and Allocative Inefficiency Relative to Stochastic Production and Cost Frontiers. *Journal of Econometrics,* 9, 343 – 346.

[139] Schmidt. P., and Sickles R.C. (1984). Production Frontiers and Panel Data. *Journal of Business and Economic Statistics,* 2(4), 367-374.

[140] Sebastian, S. (2001).*Economic Analysis of Production and Marketing of Cashew nut in Kerala*. (Unpublished M.Sc (Ag) dissertation). Kerala Agricultural University, Thrissur.

[141] Sekhon, M.K., Mahal, A. K., Kaur, M., and Sidhu, M.S. (2010). Technical Efficiency in Crop Production: Region - wise Analysis. *Agricultural Economics Research Review,* 23(2)367-374.

[142] Senthilnathan, S; and Srinivasan, R. (1992). Economics of Substitution between Poovan banana and Paddy in wetlands of Trichirappilly district, *Artha Vikas* ,28, 47-57.

[143] Sha,D.(1998).Production Potentialities of Export Oriented Horticulture Crops of Maharashtra. *Productivity*. 38 (4), 653-659.

[144] Shanmugam, K.R.(2003). Technical Efficiency of Rice, Groundnut and Cotton Farms in Tamil Nadu. *Indian Journal of Agricultural Economics*, 58(1), 101-113.

[145] Shanmugam, K.R., and Venkataramani, A.(2006).Technical Efficiency in Agricultural Production and Its Determinants: An Exploratory Study at the District Level. *Indian Journal of Agricultural Economics*, 61(2), 169-184.

[146] Sharif, N R., and Dar, A. A. (1996). Stochastic frontiers and Technical Efficiency Distributions. An Analysis Based on Rice Farming Data for Bangladesh. *The Canadian Journal of Economics*, 29(2), S582-S586.

[147] Sharma, AK; Moorthi,T.V; and Oberoi, R.C.(1992). Economics of Vegetable farming in Mid hills of Himachal Pradesh. *Agricultural Situation in India*. 47(1) 11-14.

[148] Sharma, K. R., and Leung, P. (1998). Technical Efficiency of Carp Production in Nepal: An Application of Stochastic Frontier Production Function Approach. *Aquaculture Economics & Management*, 2(3), 129-140.

[149] Sharma, R.K. Chauhan, S.K., and Gupta, S.(2008). Technical Efficiency in North Western Himalayan Region: A Study of Himachal Pradesh Agriculture. *Agricultural Economics Research Review*, 21(1), 82-90.

[150] Sharma, S.K., Gauraha, A.K., and Jain, B.C. (1997).Comparative Economics of Vegetables and Non-Vegetable Farms: A Case Study. *Indian Journal of Agricultural Economics*, 52 (3), 638 -639.

[151] Singh, K. (2008).Farm Specific Economic Efficiency of Fish Production South Tripura District. A Stochastic Frontier Approach. *Indian Journal of Agriculture Economics*, 63 (4).

[152] Singh, R. (2011). Impact of WTO on Indian Agriculture System. *International Journal of Research in IT & Management,* 1 (1) 117-127, available at www.ijrcm.org.

[153] Singh, S. (2007).A Study on Technical Efficiency of Wheat Cultivation in Haryana. *Agricultural Economics Research Review*, 20(1), 127-136.

[154] Singh, M., and Joshi, AS. (2008). Economic Analysis of Crop Production and Dairy Farming on Marginal and Small Farmers in Punjab. *Agricultural Economic Research Review*, 21(2), 251-257.

[155] Singh, M; and Mathur, V.C. (2008). Structural Changes in Horticulture Sector in India: Retrospect and Prospect for XIth Five Year Plan. *Indian Journal of Agricultural Economics*, 63 (3), 332-343.

[156] Singh, R.K., and Singh, D.S. (1997). Diversification of Indian Agriculture through tropical Fruits: Potential and Challenges. *Indian Journal of Agricultural Economics*, 52 (3), 618-619.

[157] Singh, K., and Singh, V.(2001).Economics of Cultivation and Distillation of Damask Rose: A Case Study in Palampur (Himachal Pradesh). *Indian Journal of Agricultural Economics,* 56(4), 696-707.

[158] Singh, B., Prasad, V., and Yadav, S.R. (1997).Cost Structure and Economic Potentials of Horticultural Crops in District Farrukhabad, Uttar Pradesh. *Indian Journal of Agricultural Economics*, 52 (3), 631-632.

[159] Sreela, P. (2005).*Economic Analysis of Production and Marketing of Vegetables of Palakkad.* District. (Unpublished M.Sc(Ag) dissertation). Kerala Agricultural University, Thrissur**.**

[160] Srinivas, T., and Ramanathan, S.(2005) A Study on Economic Analysis of Elephant Foot Yam Production in India. *Agricultural Economics Research Review,* 18(2), 241-252.

[161] Srinivasan, J.T. (2012) An Economic Analysis of Paddy Cultivation in the Kole Land of Kerala. *Indian Journal of Agricultural Economics.* 67(2), 213-224.

[162] Stevenson, R.E. (1980). Likelihood Functions for Generalized Stochastic Frontier Estimation. *Journal of Econometrics,* 13(1), 57-66.

[163] Suresh, A. (2013).Technical Change and Efficiency of Rice Production in India: A Malamquist Total Factor Productivity Approach. *Agricultural Economics Research Review* .Vol 26 (Conference Number) 109-118.

[164] SureshKumar., Karol, A., Singh, R., and Vaidya, C.S.(2007). Cost and Return from Apple Cultivation: A Study in Himachal Pradesh. *Agricultural Situation in India*. October 2007, 307-313.

[165] Tadesse, B., and Krishnamoorthy, S. (1997). Technical efficiency in paddy farms of Tamil Nadu: an analysis based on farm size and ecological zone. *Agricultural Economics*, 16, 188-192.

[166] Thorve, P.V., Dhope, A.M., and Choube, N. (1997) Economics of Cultivation of Horticulture Crops vis-a vis Other Crops. *Indian Journal of Agricultural Economics*, 52 (3), 646-647.

[167] Timmer, C.P.(1971).Using a Probabilistic Frontier Production Function to Measure Technical Efficiency. *Journal of Political Economy*, 79(4), 776-794.

[168] UmaDevi, K., and Prasad, E. Y.(2004). A study on Technical Efficiency of Shrimp Farms in Coastal Andhra Pradesh. *Agricultural Economics Research Review,* 17 (2), 175-186.

[169] UNCOMTRADE. (2014).*Export of Pineapple from India 01/01/1983 to 31/12/2013*. Retrieved June.15, 2014, from UNCOMTRADE database.

[170] Vasisht, A.K., Bathla, S., Sigh, D.R., Bhardwaj, S.P., and Arya, P. (2008) Price Behaviour in Fruits and Vegetables Markets: Cointegration and Error Correction Analysis. .*Indian Journal of Agricultural Economics*, 63(3), 357-358.

[171] Verma, A.R. (2008) Marketing of Onion in Indore District of Madhya Pradesh. *Indian Journal of Agricultural Economics,* 63(3), 365-366.

[172] Wadud , M.A. (2003).Technical , Allocative and Economic Efficiency of Farms in Bangladesh: A Stochastic Frontier and DEA approach. *The Journal of Developing Areas*, 37(1), 109-126.

[173] Watto, M. (2013 February) Measuring Groundwater Irrigation Efficiency in Pakistan: A DEA Approach Using the Sub -vector and Slack based Models. – 57th AARES Annual conference, Sydney, New South Wales.

[174] Wan, G.H; and Battese, G.E .(1992) .A Stochastic Frontier Production Function Incorporating flexible risk properties. *Working Papers in Econometrics and Applied Statistics, No 66 Department of Econometrics, University of New England, Armidile.*

[175] Wilson, P., Hadely, D., Ramsden, S., and Kaltsas, I. (1998). Measuring and Explaining Technical Efficiency in UK Potato Production. *Journal of Agricultural Economics*, 49(3), 294-305.

[176] Wilson, P., Hadley, D., and Asby, C. (2001).The influence of management characteristics on the technical efficiency of wheat farmers in eastern England**.** *Agricultural Economics,* 24(3), 329-338.

[177] Winsten, C.B. (1957). Discussion on Mr. Farrell's Paper. *Journal of the Royal Statistical Society, Series A, General*, 120 part 3, 282-284.

[178] Yao, S., and Liu, Z. (1998). Determinants of Grain Production and Technical efficiency in China. *Journal of Agricultural Economics,* 49(2), 171-184.

[179] Young, G.A., & Smith, R.L, (2005). Essentials of Statistical Inference. New York, NY: University of Cambridge Press.

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Appendix

I QUESTIONNAIRE

Dear Respondent,

This questionnaire is intended to collect data for the research work being carried out on the topic 'Return and Efficiency of Intercropped Pineapple Cultivation in Kerala' in School of Management Studies, CUSAT,Kochi. The data provided by you will be kept strictly confidential and will be used only for academic purpose.

1 Personal Information of the Farmer:

a. Name &Address:

b Household information:

Sl. No.	Sex	Age	Martial status	Educational Qualification	Family labour (Y/N)

2 Occupation :

☐ Agriculture Alone

☐ Agriculture + Business

☐ Agriculture + Service

3 Area of Pineapple Cultivation (In Acres):

Year of Cultivation	Own		Leased		Total
	Irrigated	Non Irrigated	Irrigated	Non Irrigated	
1st Year					
2nd Year					
3rd Year					

4 Area of Other Crops (In Acres):

S.no	Crops	Own		Leased		Total
		Irrigated	Non irrigated	Irrigated	Non irrigated	

5 Funds invested in fixed assets :

Item	Year of purchase	Purchase price.
a) i. Building : 1. Permanent 2. Temporary b) Equipment, Machinery c) Tools d) Construction of tube well / others e) Motor pump set f) Hose g) Springer / drip h) Others		

6 First year details:

(a) Land preparation:

(i) Machine Cost

Machine Hour	Rate/hour	Amount

(ii) Labour Cost

Type of labour		No. of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(b) Material

i. No. of Sucker Planted (Per acre)

Qty	Rate/No	Amount

(ii) Specify the sources of seedlings for your cultivation (in per cent).

Own pineapple farm	Out side	Total

ii Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(b) Organic manure :

i) Material cost

Name of material	Qty	Rate/kg	Amount

ii) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(d)Weedicides:

i) Material cost

Name of weedicide	Qty	Rate/kg	Amount

ii) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(e)Pesticides:

i) Material cost

Name of pesticide	Material cost	Qty	Rate/kg	Amount

ii) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(f)Chemical Fertilizer :

i) Material cost

Name of fertilizer	Qty	Rate/kg	Amount
Factomphos			
Urea			
Potash			
Rajphos			

ii) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(g) Weeding :(Manual)

i) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(h) Mulching:

i) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(I) Irrigation:

i) Material cost

No of times	Total cost

ii) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(j) Hormone application

i) Material cost

No of times	Cost

ii) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(k) Harvesting:

(L) Output &Receipts

Qty	Rate/kg	Amount

i) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

7 Second Year Details:

(a) Ratooning:

i)Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(b) Earthing up:

i) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(c) Weedicides:

i) Material cost

Name of weedicide	Qty	Rate/kg	Amount

ii) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(d)Pesticides:

i) Material cost

Name of Pesticide	Qty	Rate/kg	Amount

ii) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(e) Chemical fertilizer :

i) Material cost

Name of fertilizer	Qty	Rate/kg	Amount
Factomphos			
Urea			
Potash			

ii) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(f)Weeding (Manual):

i) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(h) Mulching:

i) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(g)Irrigation:

i) Material cost

No. of times	Total cost

i) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(g) Hormone application:

i) Material cost

No. of times	Total cost

ii) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(i) Harvesting:

i) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(j) Output &Receipts:

Fruits

Qty	Rate/kg	Amount

Suckers

Qty	Rate/No	Amount

8 Third Year Details:

(a) Ratooning:

i) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(b)Weedicides:

i) Material cost

Name of Weedicide	Qty	Rate/kg	Amount

ii) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(c) Chemical fertilizer:

i) Material cost

Name of fertilizer	Qty	Rate/kg	Amount
Factomphos			
Urea			
Potash			

ii) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(d) Weeding : (Manual)

i)Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(h) Field clearing:

i) Material cost

Qty	Rate/kg	Amount

ii) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(h) Hormone application:

i) Material cost

No of times	Cost

ii) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(i) Harvesting:

i) Labour

Type of labour		No.of man days	Rate/day	Amount
Inside Kerala	Male			
	Female			
Outside Kerala	Male			
	Female			
Own	Male			
	Female			

(j) Output &Receipts:

Fruits

Qty	Rate/kg	Amount

Suckers

Qty	Rate/No	Amount

9 Other Informations:

1 Number of years of experience in pineapple cultivation. ☐

2 Whether any subsidy received for the cultivation? If yes specify the amount. ☐

3 Whether any agricultural loan is availed for the cultivation? If yes specify the amount. ☐

4 Rental Value : (In Rs)/ year ☐

5 Land tax: (in Rs)/year ☐

6 Have you made any contact with agricultural experts during the period of cultivation? Yes/No. ☐

7 How do you market your produce .

Year	Own farm sale (per cent)	Wholesale (per cent)	Retail/Local sale (per cent)
First			
Second			
Third			

Survey conducted by Jomy M Thomas, Research Scholar, School of Management Studies, Cochin University of Science and Technology(CUSAT), Ernakulam.

Appendix

III PER CENT OF AREA AND PRODUCTION OF FRUITS IN LEADING FRUITS PRODUCING COUNTRIES DURING2012-13

Per cent of Area and Production of Fruits in Leading Fruits Producing Countries During2012-13			
SI.NO	COUNTRY	Per cent of Production	Per cent of Area
1	CHINA	21	21
2	INDIA	13	12
3	BRAZIL	6	4
4	USA	5	2
5	INDONASIA	3	1
6	PHILIPPINES	3	2
7	MEXICO	2	2
8	TURKEY	2	2
9	SPAIN	2	3
10	ITALY	2	2
11	OTHERS	41	49
13	WORLD+	100	100

Source: Compiled from (HBH 2014).

Appendix

III COST OF CULTIVATION OF PINEAPPLE UNDER ABC COST CONCEPTS

FIRST YEAR

Farm size	Small		Medium		Aggregate	
Cost item	Rs/ha	Per cent	Rs/ha	Per cent	Rs/ha	Per cent
Value of hired human labour	71475	27.04%	86659	29.57%	81873	28.83%
Value of machine labour	19743	7.47%	16097	5.49%	17246	6.07%
Value of sucker	57210	21.64%	63246	21.58%	61344	21.60%
Value of manure	5332	2.02%	4061	1.39%	4461	1.57%
Value of chemical fertilizers	17091	6.47%	16971	5.79%	17009	5.99%
Value of plant protection	2305	0.87%	2356	0.80%	2340	0.82%
Value of weedicides	5050	1.91%	6276	2.14%	2341	0.82%
Irrigation charges	2436	0.92%	2298	0.78%	2341	0.82%
Hormone charges	673	0.25%	688	0.23%	683	0.24%
Other expenses	8652	3.27%	13570	4.63%	12020	4.23%
Depreciation	1879	0.71%	1762	0.60%	1799	0.63%
Land revenue	34	0.01%	54	0.02%	48	0.02%
Interest on working Capital	6346	2.40%	6120	2.09%	6191	2.18%
Interest on loan	1264	0.48%	1431	0.49%	1378	0.49%
Cost A_1	**199491**	75.47%	**221588**	75.62%	**214623**	75.58%
Rent of leased in land	24149	9.14%	28985	9.89%	27461	9.67%
Cost A_2	**223640**	84.61%	**250574**	85.51%	**242084**	85.25%
Interest on fixed assets	2234	0.85%	2404	0.82%	2351	0.83%
Cost B_1	**201725**	76.31%	**223993**	76.44%	**216974**	76.41%
Rental value of owned land &leased land	36957	13.98%	41403	14.13%	40002	14.09%
Cost B_2	**238682**	90.30%	**265396**	90.57%	**256970**	90.49%
Family labour	1622	0.61%	984	0.34%	1185	0.42%
Cost C_1	**203346**	76.93%	**224977**	76.78%	**218159**	76.82%
Cost C_2	**240304**	90.91%	**266380**	90.91%	**258161**	90.91%
Management cost	24030	9.09%	26638	9.09%	25816	9.09%
Cost C_3	**264334**	100.00%	**293018**	100.00%	**283977**	100.00%

SECOND YEAR

Farm size	Small		Medium		Aggregate	
Cost item	Rs/ha	Per cent	Rs/ha	Per cent	Rs/ha	Per cent
Value of hired human labour	78627	43.79%	89681	46.23%	86197	45.50%
Value of chemical fertilizers	18366	10.23%	14323	7.38%	15597	8.23%
Value of plant protection	184	0.10%	973	0.50%	724	0.38%
Value of weedicides	1722	0.96%	2963	1.53%	2571	1.36%
Irrigation charges	1740	0.97%	1630	0.84%	1665	0.88%
Hormone charges	912	0.51%	848	0.44%	868	0.46%
other expenses	13426	7.48%	14428	7.44%	14112	7.45%
Depreciation	2184	1.22%	1790	0.92%	1914	1.01%
Land revenue	34	0.02%	54	0.03%	48	0.03%
Interest on working capital	3554	1.98%	3865	1.99%	3767	1.99%
Interest on loan	1304	0.73%	1262	0.65%	1275	0.67%
Cost A_1	**122053**	67.98%	**131816**	67.95%	**128739**	67.96%
Rent of leased in land	24149	13.45%	28985	14.94%	27462	14.50%
Cost A_2	**146202**	81.43%	**160802**	82.89%	**156200**	82.46%
Interest on fixed assets	2939	1.64%	2258	1.16%	2473	1.31%
Cost B_1	**124991**	69.62%	**134074**	69.12%	**131211**	69.27%
Rental value of owned land& leased land	36957	20.58%	41403	21.34%	40002	21.12%
Cost B_2	**161949**	90.20%	**175478**	90.46%	**171213**	90.38%
Family labour	1273	0.71%	872	0.45%	998	0.53%
Cost C_1	**126264**	70.32%	**134946**	69.57%	**132204**	69.79%
Cost C_2	**163221**	90.91%	**176350**	90.91%	**172212**	90.91%
Management cost	16322	9.09%	17635	9.09%	17221	9.09%
Cost C_3	**179544**	100.00%	**193985**	100.00%	**189433**	100.00%

THIRD YEAR

Farm size	Small		Medium		Aggregate	
Cost item	**Rs/ha**	**Per cent**	**Rs/ha**	**Per cent**	**Rs/ha**	**Per cent**
Value of hired human labour	54135	38.16%	58156	37.22%	56889	37.50%
Value of chemical fertilizers	12595	8.88%	18924	12.11%	16929	11.16%
Value of weedicides	1933	1.36%	3038	1.94%	2690	1.77%
Field clearing	1568	1.11%	1685	1.08%	1648	1.09%
Hormone charges	775	0.55%	1019	0.65%	942	0.62%
Other expenses	11067	7.80%	9071	5.81%	9700	6.39%
Depreciation	2329	1.64%	1680	1.08%	1885	1.24%
Land revenue	34	0.02%	54	0.03%	48	0.03%
Interest on working capital	2521	1.78%	2899	1.86%	2780	1.83%
Interest on loan	475	0.33%	1334	0.85%	1063	0.70%
Cost A_1	**87433**	61.63%	**97863**	62.63%	**94575**	62.34%
Rent of leased in land	24149	17.02%	28985	18.55%	27461	18.10%
Cost A_2	**111582**	78.65%	**126848**	81.18%	**122036**	80.44%
Interest on fixed assets	3537	2.49%	2262	1.45%	2664	1.76%
Cost B1	**90970**	64.13%	**100125**	64.08%	**97239**	64.09%
Rental value of owned land &leased land	36957	26.05%	41403	26.50%	40002	26.37%
Cost B_2	**127927**	90.18%	**141528**	90.58%	**137241**	90.46%
Family labour	1039	0.73%	517	0.33%	681	0.45%
Cost C_1	**92009**	64.86%	**100642**	64.41%	**97921**	64.54%
Cost C_2	**128966**	90.91%	**142025**	90.90%	**137923**	90.91%
Management cost	12897	9.09%	14205	9.09%	13792	9.09%
Cost C_3	**141863**	100.00%	**156250**	100.00%	**151715**	100.00%

Appendix

IV INCOME MEASURES OF PINEAPPLE CULTIVATION:

First Year	Small	Per cent	Medium	Per cent	Aggregate	Per cent
Gross Income	275716	100%	355515	100%	328496	100%
Farm Business Income	76225	28%	133927	35%	113873	41%
Own Farm Business Income	52076	19%	104941	26%	86410	33%
Family Labour Income	37034	13%	90119	22%	71526	29%
Net Income	11382	4%	62997	14%	44519	21%

Second Year	Small	Per cent	Medium	Per cent	Aggregate	Per cent
Gross Income	216038	100%	280291	100%	260038	100%
Farm Business Income	93985	44%	148475	53%	131299	53%
Own Farm Business Income	69836	32%	119489	42%	103838	43%
Family Labour Income	54089	25%	104813	38%	88825	37%
Net Income	36494	17%	86306	31%	70605	31%

Third Year	Small	Per cent	Medium	Per cent	Aggregate	Per cent
Gross Income	166045	100%	228353	100%	204696	100%
Farm Business Income	77581	47%	130440	52%	110123	57%
Own Farm Business Income	53432	32%	101455	37%	82662	45%
Family Labour Income	37086	22%	86825	31%	67457	38%
Net Income	24182	15%	72103	24%	52983	31%

Appendix

V DESCRIPTIVE STATISTICS

COST OF CULTIVATION OF SMALL FARMERS (IN RUPEES.)

	N	Minimum	Maximum	Mean	Std. Deviation
First Year	149	84477	477241	281349	103732
Second Year	149	61399	330932	191101	70478
Third Year	149	51825	264706	150995	57947

COST OF CULTIVATION OF MEDIUM FARMERS (IN RUPEES.)

Cost	N	Minimum	Maximum	Mean	Std. Deviation
First Year	109	422695	1584176	931470	329556
Second Year	109	285051	1092959	613690	227512
Third Year	109	229009	912113	493900	171907

Appendix

VI DETAILS OF SAMPLING PLAN

Name of Block	Small Farmers	Medium Frames	Total
Elemdesam	42	26	68
Kanjirappilly	20	39	59
Muvattupuzha	87	44	131
Total	149	109	258

Appendix

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LETTER OF APPRECIATION

Esteemed Author

Please accept my heartiest felicitations on very kindly sending your valuable article/research paper titled '*DIRECTION AND TRENDS OF INDIA'S PINEAPPLE EXPORTS: A STUDY IN THE FREE TRADE REGIME*' for publication in Volume No. 3 (2013), Issue No. 07 (July).

Our editorial board has highly appreciated your invaluable piece of research. The researchers and the academics have conveyed their views and its worth have been appreciated by one and all.

With sincerest regards and profuse thanks for your contribution.

Sincerely Yours

Authorised Signatory

I. J. R. C. M.

*Success
has two roots
merit & aggressiveness.
In theory, merit suffices, but
not in practice ...
Neither merit nor
aggressiveness alone avail.
They must be mixed in the
right proportion.
The Secret of success in life is
for a man to be ready for his
opportunity
when it comes.*

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