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Estimation of Pre-and Post-Harvest Losses in Paddy Crop in Tamil Nadu

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Preface

Agriculture is one of the major sectors in Indian economy and within which food production plays a critical role in ensuring our food security. India now is one of the leading countries in the world on food grain production. India's food grain production has increased to 241 million tonnes in 2010-11 form just 50 million tonnes in 1950-51. Modern technology has made profound influence in increasing the food grain production to meet our ever growing needs.

The growing demand for agricultural commodities needs to be met with by increasing the production on one hand and mitigating the crop losses on the other. Government has implemented many schemes and programmes to support farmers and production and has started working at micro level to for efficient way of cultivation.

But the problem of food losses is a challenge that needs to be tackled effectively. The losses occur both during the pre and post harvest periods. They together are the critical determinant of food production, food security and farmers' income. They also have deep impact on economic development and environment. The estimation of the extent of crop loss either physical or financial is rather difficult exercise but needs to be done to address them effectively by appropriate policy interventions. This study is one such attempt to estimate the physical and financial losses in paddy (rice) at farm level in Tamil Nadu and it was allotted to AERC, Chennai. Tiruvarur and Villupuram districts were selected for the study and it has also examined the ongoing measures of pest and disease management under different agro climatic conditions to identify factors responsible for such losses and suggest ways and means to reduce the extent of losses in different operations in order to increase overall productivity. The results of the study, we hope would be useful to policy makers for clear evaluation and better implementation of the schemes so as to achieve the desired objectives.

I take this opportunity to thank Dr. V. Loganathan , Former Tagore Professor, University of Madras for going through the draft and offering valuable suggestions. I thank Mr. Rajasimman, Ph.D. Scholar of the Department of Economics, University of Madras for his assistance. I also thank the officials of the Government of Tamil Nadu and the district officials under the Ministries of Agriculture and Rural Development for all the assistance and support extended by them to carry out the study successfully. Finally I thank Dr. Parmod Kumar, Agriculture Development & Rural Transformation Unit, ISEC, Bangalore for the coordination of this study.

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INTRODUCTION

Agriculture plays an important role in the Indian economy. Its share in the Gross Domestic Product (GDP) has exhibited a declining trend from 55.4 percent in 1950-51 to 14.3 percent in 2010-11. But, still about 38 percent of food items are exported to foreign countries and a sizable work force is depending on agriculture. There has been significant progress in agricultural production during past six decades in India. Foodgrain production increased from 50 MT in 1950-51 to 241 MT in 2010-11. The increased food production is mainly due to the use of high yielding varieties (HYV), fertilizers and modern technology. The Green Revolution has played a significant role in increasing agricultural productivity. The benefits of Green Revolution did not reach the marginal farmers. The important natural resources, land and water are becoming increasingly scarce due to multiple uses; it has become difficult to extend the intensive cultivation. And cultivated area is reduced due to the development of other sectors over a period of time. We have to explore alternatives to increase the agricultural production and to meet the growing demand for foodgrains. Food is essential for future generations. Therefore, there is need for increasing production of food items for solving the problems arising out of population growth, poverty, hunger, water scarcity, land degradation, migration and other health constraints still persist in agricultural sector (Ministry of Agriculture 2008-09, 2009-10).

In India, the main objective of Green Revolution was to increase the productivity in agriculture by adaptation of high yielding varieties (HYV) along with use of chemical fertilizers and pesticides during 1960s. After 1980s, the crop diversification and emergence of allied sectors have been given priority and new technology has been introduced in the oilseeds. After the implementation of economic reforms there is increase in demand for agriculture commodities in domestic and foreign markets. Food consumption pattern is slowly changing from cereals to fruits, vegetable and livestock products. Trade liberalization has led to production of such commodities which have export demand in the international market. These developments have changed multi-commodity production to a specialized system in different parts of the country. In the process, many traditionally cultivated crops have lost their area or out of cultivation. But these developments have resulted in increased pests and diseases and consequent use of

pesticides has also resulted in developing insects and diseases resistance, leading to reduction in crop yield.

1.1 Tamil Nadu Economy: An Overview

Tamil Nadu is one of the best performing states in many aspects of economic, social and political fronts. Its share is about 4 percent in geographical area; it has of 7 percent of population of the country. The total geographical area of Tamil Nadu increased from 130.04 lakh ha. in 1970-71 to 130.27 lakh ha. in 2010-11; the gross cropped area declined to 57.52 lakh ha. in 2010-11 against to 68.18 lakh ha. in 1970-71. The net area sown had witnessed a gradual decline from 61.69 lakh ha in 1970-71 to 49.53 lakh ha in 2010-11. The net area sown witnessed a marginal decline due to increase in fallow lands and land put to non-agricultural uses. Due to rise in population, urbanization and industrialization, the proportion of land put to non-agricultural uses has been on the increase and it has marginally increased. Of the total geographical area, forest account for 21.06 lakh ha. in 2010-11(16.2 percent) from 20.30 lakh ha in 1970-71. In the case of uncultivable land, there is decline from 5.06 lakh ha. in 1970-71 to 3.26 lakh ha. in 2009-10.

There was decline in cropping intensity from 119 percent in 1990-91 to 116 percent in 2010-11. This downtrend must be reversed to keep agriculture growing at a faster rate. With regard to size of holdings, marginal holdings account for 33.51 percent, followed by small farms (25.22 percent), semi-medium farms (21.51 percent), medium farms (14.03 percent) and large farm (5.73 percent) during 2005-06 (Department of Economics and Statistics, 2012). It may be noted that more than half of the landholdings belong to the category of marginal and small farms. The share of total land operated by small and marginal farmers has increased from 42 percent to 55.5 percent during the same period. The growth in number and extent of small and marginal farmers is a major hurdle in promoting capital investment in agricultural sector with the aim of modernizing it.

1.1.2 Agricultural Scenario in the State

Agriculture remains unprotected from monsoon and is a gamble in the hands of monsoon. Crop failure is occurring once in every three years regularly. The worst crop failure tends to spread over two years. The state is often subject to drought and natural calamities such as floods

and Tsunami. The agriculture sector in the State faces a number of problems such as nitrogen deficiency, low productivity, scarcity of cultivable land, shortage of labour force, majority of small farms and seasonal variations in the agriculture. Factors like power, seeds, chemical fertilizers, bio- fertilizers, organic manures, and marketing strategy plays crucial role in the agriculture development.

Power is an input provided by the Government free of cost to marginal farmers since 1984-85 and to small farmers from 1999-2000. Free power supply is provided to the farmers for lifting well water. This policy helps to boost area coverage, production and productivity. Second, hybrid varieties for achieving high yields have become crucial one after the Green Revolution. Hybrid varieties in various crops are given high priority after 1960s and this has led to increased production. Third, use of chemical fertilizers helps in improving the productivity of crops. The Green Revolution technologies and development of various irrigation sources had resulted in increasing the level of fertilizer consumption.

Fourth, the application of organic manure has promoted the cultivation of green manure crops, application of vermi composting blue green algae, azolla and biofertilizers. Further, the micro nutrients help in sustaining the fertility and health of the soil. Most of the soil in the State is deficit in micronutrient content and has a direct impact on the productivity of crops. To improve the productivity of the soil, the State is running a Micro Nutrient Production Centre at Kudumiyanmalai with an annual production capacity of 1400 MTs. for different crops. Azolla was produced and distributed to the farmers and 14 types of notified micronutrients mixture were produced for different crops. During 2008-09, 5000 kits were distributed for producing vermi compost. A total quantum of 525 MTs of blue green algae and 500 MTs of azolla were produced and distributed to the farmers.

Fifth, the application of bio-fertilizers leads to the fertility and health of the soil and that promotes plant growth. The existing six bio-fertilizer production units and 9 more units at a cost of Rs.814.50 lakhs to be established by the state would enhance the production of bio-fertilizers from the present level of 80 lakh packets to 192.50 lakh packets. Sixth, the State undertakes activities such as training, demonstration, group formation, capacity building and providing revolving funds for income generating activities through Agricultural Technology Management Agency (ATMA). ATMA is functioning in all the districts except Chennai and Nilgiris with fund

shared by the centre and state in the ratio of 90:10. During 2008-09, an amount of Rs.12.66 crores was funded by Government of India for the scheme.

Lastly, the State Government had established 153 *Uzhavar Sandhais* in the State. Of this, 141 *Uzhavar Sandhais* are functioning well in the State. In these *Uzhavar Sandhais*, on an average, 1609 MT of fruits and vegetables sold every day by 7524 farmers' were worth of Rs.191.77 lakhs. This had benefited 2.72 lakh consumers per day during 2008-09. To facilitate marketing of agricultural produce, 21 Market Committees, 277 Regulated Markets and 144 rural godowns are functioning in the State.

1.1.3 Performance of State Income in Tamil Nadu

Tamil Nadu is the seventh state in the overall economic growth of the Indian Union. It is politically, socially and economically an advanced state in India. When we look at the economic conditions, we notice that structural changes have taking place in the state economy over a period of time. State's income is disbursed according to the performance of different sectors of the economy like agriculture, industry and services sector. The share of primary sector in Gross State Domestic Product (GSDP) has experienced a declining trend in Tamil Nadu during the economic reforms period. Sectoral distribution of GSDP at constant prices (2004-05) is presented in Table 1.1. It is observed that GSDP of Tamil Nadu at constant prices (2004-05) has increased from Rs 28752968 lakhs in 2006-07 to Rs 41654941 lakhs in 2011-12.

The overall economy of the state has witnessed an increase in growth rate by 1.24 percent; it increases from 6.13 percent in 2006-07 to 7.37 percent during 2011-12. The contribution of primary sector consisting of agricultural and allied activities towards GSDP at constant prices has declined from 11.43 percent during 2006-07 to 8.77 percent in 2011-12. The share of secondary sectors mainly manufacturing and construction have slightly increased. But, the share of secondary sector as a whole in the state income declined marginally from 30.63 percent in 2006-07 to 30.24 percent in 2011-12. The contribution of tertiary sector of the state comprising trade, transport, banking, insurance, public administration and communication towards GSDP had increased sharply from 57.94 in 2006-07 to 60.99 percent in 2011-12. Within the tertiary sector, the services like banking, finance, insurance, real-estate and communication have recorded an increased share.

Table 1.1: Gross State Domestic Product at Constant Prices 2004-05 Series (Percent)

Sectors	2006-07	2007-08	2008-09	2009-10 (RE)	2010-11 (QE)	2011-12 (AE)
I Primary Sector (1+2)	11.43	10.33	9.62	9.27	8.81	8.77
1 Agriculture, Forestry &Fishing	10.87	9.79	9.12	8.77	8.35	8.32
1.1 Agriculture& Allied Activities	9.41	8.45	7.84	0.76	7.17	7.21
1.2 Forestry& Logging	0.61	0.59	0.56	0.52	0.50	0.47
1.3 Fishing	0.85	0.75	0.72	0.70	0.69	0.64
2 Mining& Quarrying	0.56	0.54	0.50	0.50	0.46	0.44
II Secondary Sector (3+4+5)	30.63	29.99	28.00	30.74	30.58	30.24
3 Manufacturing	20.65	19.57	18.41	21.55	21.52	20.74
3.1 Registered	13.88	12.82	11.92	15.27	15.34	14.78
3.2 Un Registered	6.77	6.75	6.49	6.29	6.18	5.96
4 Electricity	1.69	1.15	0.28	0.31	0.57	0.87
5 Construction	8.30	9.27	9.31	8.87	8.49	8.63
III Tertiary Sector (6+7+8+9)	57.94	59.68	62.38	60.00	60.61	60.99
6 Trade, Hotels	18.22	17.91	17.70	16.76	16.46	15.90
7 Transport Storage	9.01	9.29	9.69	9.61	9.53	9.66
7.1 Railways	0.72	0.76	0.85	0.88	0.85	0.88
7.2 Transport by other means	5.79	5.84	5.99	5.88	5.74	5.67
7.3 Storage	0.03	0.03	0.03	0.04	0.04	0.04
7.4 Communication	2.47	2.65	2.81	2.81	2.90	3.08
8 Financing, Insurance	18.45	20.32	21.71	20.70	21.44	22.63
8.1 Banking	7.72	8.52	8.95	8.35	9.01	9.52
8.2 Real Estate	10.73	11.80	12.76	12.35	12.44	13.10
9 Community services	12.26	12.17	13.28	12.93	13.17	12.80
9.1 Public Administration	37.55	3.57	4.24	3.86	3.84	3.76
9.2 Others	8.50	8.60	9.04	9.07	93.31	9.04
IV Gross State Domestic Product	**100**	**100**	**100**	**100**	**100**	**100**

Source: Director of Statistics and Economics, Government of Tamil Nadu, Chennai-18.

RE: Revised Estimates, QE: Quick Estimates, AE: Advanced Estimates

During 2006-07 and 2011-12, the share of overall primary sector in the GSDP declined from 11.43 percent to 8.77 percent; On the other hand, the share of secondary sector in GSDP remained almost constant at 30.63 percent and 30.24 percent; the share of tertiary sector increased from 57.94 percent to 60.99 percent. It may be noted that the service sector is growing after economic reforms period, but agricultural sector has shown declining trend due to constraints in the farm activities.

Table 1.2: Gross State Domestic Product at Current Prices (2004-05 Series) (Percent)

Sectors	**2006-07**	**2007-08**	**2008-09**	**200910 (RE)**	**2010-11 (QE)**	**2011-12 (AE)**
I Primary Sector (1+2)	12.62	12.51	12.49	13.73	13.65	12.76
1 Agriculture, Forestry &Fishing	11.97	11.91	11.83	13.13	13.06	12.15
1.1 Agriculture& Allied Activities	10.10	10.19	9.95	11.32	11.27	10.53
1.2 Forestry& Logging	0.97	0.90	1.05	0.96	1.04	0.95
1.3 Fishing	0.90	0.81	0.83	0.85	0.75	0.67
2 Mining& Quarrying	0.64	0.61	0.66	0.60	0.59	0.60
II Secondary Sector (3+4+5)	31.16	30.53	28.19	29.56	29.07	29.47
3 Manufacturing	20.79	19.48	17.86	19.77	19.41	19.08
3.1 Registered	13.97	12.76	11.57	14.00	13.83	13.60
3.2 Un Registered	6.82	6.72	6.30	5.77	5.57	5.48
4 Electricity	1.68	1.15	0.28	0.32	0.60	0.93
5 Construction	8.69	9.91	10.04	9.47	9.07	9.46
III Tertiary Sector (6+7+8+9)	56.23	56.96	59.33	56.71	57.28	57.77
6 Trade, Hotels	18.44	18.16	17.98	16.61	16.23	15.92
7 Transport Storage	8.30	8.31	8.49	8.39	8.07	8.10
7.1 Railways	0.72	0.75	0.78	0.84	0.72	0.74
7.2 Transport by other means	5.82	5.89	6.08	5.97	5.87	5.88
7.3 Storage	0.03	0.03	0.03	0.04	0.04	0.04
7.4 Communication	1.74	1.64	1.60	1.54	1.45	1.44
8 Financing, Insurance	17.28	18.35	19.35	18.24	19.06	19.99
8.1 Banking	6.50	6.67	6.71	5.76	6.27	6.43
8.2 Real Estate	10.78	11.68	12.64	12.48	12.79	13.56
9 Community services	12.20	12.15	13.50	13.46	13.91	13.76
9.1 Public Administration	3.73	3.54	4.26	3.95	3.98	3.96
9.2 Others	8.47	8.60	9.25	9.51	9.93	9.80
IVGross State Domestic Product	**100**	**100**	**100**	**100**	**100**	**100**

Source: Director of Statistics and Economics, Government of Tamil Nadu, Chennai-18.
RE: Revised Estimates, QE: Quick Estimates, AE: Advanced Estimates.

The percentage of sector-wise Gross State Domestic Product at current prices (2004-05 series) is given in Table 1.2. The income originated from the primary sector to GSDP at current prices decline from 12.62 percent in 2006-07 in the first two subsequent years, and then it slightly increased to 12.76 percent in 2011-12. The share of secondary sector in GSDP at current prices declined to 29.47 percent in 2011-12 from 31.16 percent in 2006-07. The manufacturing sector contribution to GSDP at current prices has declined from 20.79 percent in 2006-07 to 19.08 percent in 2011-12. The share of territory sector increased from 56.23 percent in 2006-07 to 57.77 percent of GSDP at current prices in 2011-12.

The per capita income of the State at constant prices had increased from Rs.43, 941 in 2006-07 to Rs.61, 531 in 2011-12. The per capita income at current prices had increased from Rs.47, 456 in 2006-07 to Rs.94, 393 in 2011-12.

Table 1.3: Per Capita Income in Tamil Nadu (in Rs.)

Year	At Constant Prices (Base Year 2004-05)	At Current Prices
2006-07	43941	47456
2007-08	46293	53220
2008-09	48216	60455
2009-10(RE)	52851	71776
2010-11(QE)	57671	84197
2011-12(AE)	61531	94393

Source: Director of Statistics and Economics, Government of Tamil Nadu, Chennai-18.
RE: Revised Estimates, QE: Quick Estimates, AE: Advanced Estimates

1.2 Importance of Selected Crops in Tamil Nadu

The production of foodgrains averaging 74.11 percent during 1985-86 had declined to 73.55 percent in 2009-10. Out of that, paddy accounts for half of the foodgrains in Tamil Nadu almost during the last 30 years. Paddy production declined from 33.21 percent in 1985-86 to 33.12 percent in 2009-10. These declining trends were due to water shortage, adverse weather conditions, declining fertility of the soil. The gross cropped area of paddy and the area irrigated remained static over the period. The increasing exploitation of ground water for irrigation, activisation of the seed-fertilizer technology and effective extension services had notably

contributed to the significant step up in the productivity of paddy crop in Tamil Nadu. But for the substantial increase in crop yield, the quantum of production could not have been at this increased level. Foodgrains production dominates the agricultural sector with coverage of over 75 percent of the total gross cropped area. Among the commercial crops, sugarcane, groundnut and cotton are having significant share.

Table 1.4: Cropping Pattern in Tamil Nadu (1985-86 to 2009-10) (Percent)

Crops	1985-86	1990-91	2000-01	2006-07	2007-08	2008-09	2009-10
Paddy	33.21	27.98	32.82	33.06	30.77	33.16	33.12
Maize	0.23	0.41	1.29	3.39	3.84	4.92	4.38
A: Total Cereals	55.38	45.81	44.38	45.01	42.78	45.59	44.84
B: Total Pulses	8.54	12.77	10.85	9.18	10.48	9.20	9.62
Turmeric	0.31	0.13	0.52	0.52	0.47	0.51	0.60
Banana	0.87	0.91	1.31	1.80	1.94	1.99	2.04
Mango	0.58	0.83	1.70	2.15	2.20	2.23	2.38
Potato	0.11	0.08	0.09	0.09	0.07	0.07	0.08
Tapioca	0.69	1.15	1.65	2.39	2.41	2.13	2.13
Sweet Potato	0.05	0.03	0.02	0.02	0.02	0.01	0.01
Onion	0.29	0.33	0.49	0.51	0.51	0.52	0.56
Sugarcane	2.80	3.51	4.97	6.70	6.09	5.30	5.26
Total Food crops	74.11	69.87	71.56	74.18	72.80	73.29	73.55
Groundnut	13.67	14.52	11.03	8.70	9.20	8.41	7.41
Coconut	2.19	2.71	5.10	6.41	6.59	6.69	7.19
Sunflower	0.20	0.31	0.10	0.45	0.76	0.44	0.26
Cotton	3.73	3.61	2.68	1.72	1.71	1.97	1.87
Tobacco	0.19	0.16	0.13	0.09	0.10	0.09	0.13
Non-food crops	25.89	30.13	28.44	25.82	27.20	26.71	26.45
Food, Non-food crops	100	100	100	100	100	100	100

Source: Director of Statistics and Economics, Government of Tamil Nadu, Chennai-18.

Tamil Nadu is one of the highest paddy producing states in India; the paddy growing districts of Thanjavur, Thiruvarur, Villupuram and Nagapattinam accounted for about one fourth of the gross cropped area under paddy in the State. The area almost remained stagnant in the recent years while the growth in yield rate had shown an increase in the production at the State and all India level. The yield rate of paddy had come down from 2817 kgs. / ha in 2007-08 to 2682 kgs. / ha during 2008-09, but, the total production of paddy had improved from 50.40 lakh tonnes to 51.83 lakh tonnes between 2007-08 to 2008-09.

1.3 Background of Pre-and Post-Harvest Losses

The problem of food losses is not given much importance in world's poorest countries to improve food security and to increase farmers' income. These losses have deep impact on food security, economic development and environment. It influences crop production choices, patterns, internal infrastructure, marketing chains and consumer behavior in the economy. On the other hand, food losses have direct and negative impact on the income of farmers and consumers. Generally, there are two kinds of losses pre-harvest and post-harvest losses.

1.3.1 Pre-Harvest Losses

The crop damage occurs due to pest and disease, rat menace, weed etc. The loss due to pest and diseases is estimated at around 20 percent. The major pests like stem borer, leaf folder, in paddy, boll worm, white fly, red hairy caterpillar, leaf miner and prodenia in groundnut, pod borer in pulses cause several damages in the farm.

The estimation of crop loss due to pests and disease is rather difficult exercise. The extent of crop loss either physical or financial depends on stages of crop growth, pests, and weather conditions. The worldwide crop loss due to various types of pests was estimated at 37.4 percent in rice, 28.2 percent in wheat, 31.2 percent in maize and 26.3 percent in soybean (Oerke, 2007). In India, crop loss estimate due to insect pests has been provided by Dhaliwal et al. (2010). According to their study, crop loss was estimated at 25 percent in rice and maize, 5 percent in wheat, 15 percent in pulses and 50 percent in cotton. The crop loss has increased during post-Green Revolution period than pre-Green Revolution period. The severity of pest problems has been changing with the developments in agriculture technology. Many studies have revealed that there is strong relationship between pest infestation and yield loss in various crops in India (Nair,

1975, Dhaliwal and Arora, 1994, Muralidharan, 2003, Rajeswari etal. 2004, Muralidharan and Pasalu, 2006, Muralidharan and Rajeswari).

Another problem is plant disease. It is a major cause for change in agricultural patterns and even food habits in many parts of the world. In India, the brown spot of paddy (Cochliobolus miyabeanus) caused the great Bengal famine in 1943; red rot of sugarcane caused severe ephiphytotics in Uttar Pradesh and Bihar in 1938-42; wheat rust in Uttar Pradesh and Madhya Pradesh in 1946-47; Helminthosporium blight of wheat and barley in Uttar Pradesh, Bihar and Maharashtra in 1932 and 1974; grey mould (Botrytis cinerea) of chickpea in Bihar in 1979-81, Andhra Pradesh, Himachal Pradesh and Tamil Nadu leaf curl of cotton in Punjab and Rajasthan in 1994-95; tungro disease of paddy in Punjab in 1998-99; and necrosis disease of sunflower in Karnataka in 1997-2000 are serious problems caused by plant diseases. Ironically most of these diseases have caused destruction in crops grown under rainfed agriculture, indicating vulnerability of such cropping systems.

1.3.2 Post-Harvest Loss

Post-production operations play an important role in providing food supply chain. In United States, Canada, and Europe, 40 percent of food is wasted. Americans waste $ 165 billion worth of food every year, which could meet the entire requirement of Sub-Saharan Africa. The food wasted in Italy can feed the entire population of the hungry Ethiopia. According to the United Kingdom Institution of Mechanical Engineers, almost half of the food produced globally is wasted (Devinder Sharma, The Times of India, 2013).

Several studies have reported post-harvest losses of cereal grains such paddy, wheat and maize (Bala, 1978, Singaravadivel, 1992, Saxena et al. 2000, Singh et al., 2002 and Basappa, et al., 2007). Bala (1978) reported the estimate of quantitative losses of paddy in Bangladesh at each stage starting from harvesting to retailing. The loss was estimated to be about 8 percent to as high as 22 percent counting all the processes between the harvest and retailing. The important stages of losses are threshing, drying, distribution and storage. The highest loss is reported to have occurred during storage.

Post-harvest losses especially in vegetables and fruits are presently in the range of 20 to 30 percent. It contributes directly to higher costs and reduces availability of these commodities (Tenth Five Year Plan 2002-07, Government of India). Fruits are highly perishable products and

their quality can be affected by post-harvest practices such as handling, transportation, storage and marketing (Naureen et al., 2009). Decrease in post-harvest losses can minimize cost of production, improve trade and distribution, enhance food security especially in developing countries and increase farmers' income. There will be great challenges in paddy crop due to mismatch between supply and demand in future. Increasing paddy production is a major challenge to the economy because of climatic change (plant hopper outbreaks induced by rising temperatures) in Asia region; In addition, intensive cropping systems are affected because of plant hopper and overuse of fertilizers and pesticides. Paddy supply can also be increased by reducing grain losses at the post-harvest stage. About 5-6 percent of paddy is lost due to poor cutting, handling, threshing, and cleaning. Another 5-21 percent is lost because of inadequate drying, storage, milling, and processing facilities. The total estimated losses are 10-37 percent of paddy grown (Asian Development Bank, 2009).

1.4 Need for the Present Study

As per the available data, the crop losses caused by pests and diseases are huge. But, the knowledge on the crop loss at the farm level is very much limited. In addition to losses that occur during the growth period of the crop, there is a huge quantity of grains lost during the process of harvesting, threshing, transportation and storage. Therefore, the present study makes a comprehensive attempt to estimate the dimension of losses occurring during the pre-and post-harvest stages of paddy crop in Tamil Nadu. For the pre-harvest losses, generally animal pests (insects, mites, rodents, snails and birds), plant pathogens (bacteria, fungi, virus and nematodes) and weeds are collectively called as pests, which cause economic damage to crops. This broader definition of pests and diseases is followed in the present study. For estimating post-harvest losses, there is a need to establish the extent of losses during storage under different agro-climatic conditions. Causes of storage losses include sprouting, transpiration, respiration, rot due to mould and bacteria and attack by insects. Sprouting, transpiration and respiration are physiological activities that depend on the storage environment (mainly temperature and relative humidity). These physiological changes affect the internal composition of the grains and result in destruction of edible material and cause changes in nutritional quality. But it would be difficult to measure the loss due to physiological changes at the farm level. Nevertheless, an attempt has

been made to estimate such losses based on the visual observations and according to farmers' estimates.

1.5 Objectives of the Study

The objectives of the present study are:

- To estimate the physical and financial losses caused by pests and diseases in paddy (rice) at farm level in Tamil Nadu.
- To examine the measures of pest and disease management to reduce the pre-harvest crop loss due to pests and diseases at farm level.
- To arrive at pre-and post-harvest losses in paddy (rice) under different agro climatic conditions.
- To identify factors responsible for such losses and suggest ways and means to reduce the extent of losses in different operations in order to increase national productivity.

1.6 Data base and Methodology

The study is based on the farm level data collected from the two major paddy growing districts namely Tiruvarur and Villupuram of Tamil Nadu. The crop production faces various constraints particularly infestation by pests and diseases. Losses caused by them were worked out based on the estimates provided by the farmers. As not only pests and diseases cause crop damage when their population reach beyond a threshold level, there are also other bio-economic factors like soil fertility, water scarcity, poor seed quality, high input costs and low output price resulting in considerable financial loss to farmers. So, data on these bio-economic variables were also collected from the farmers. The post-harvest losses during the process of harvesting, collection and threshing, transportation and storage were also quantified based on the estimates provided by the farmers. As storage material used by the farmers was not scientific, it was essential to identify the structure of storage at the farmers' level and enumerate the losses occurring in the process of storage at the farm level.

To collect the primary data, a sample survey was conducted in Tiruvarur and Villupuram districts of Tamil Nadu for the reference period for rabi 2010-11 (November to May) and kharif 2011-12 (June to October) for paddy crop. Tiruvarur district is located in the southern part of Tamil Nadu region while Villupuram district is in the northern part of Tamil Nadu region. From

each district, two villages with one nearby the market/mandi centre and one far off from the market centre were selected for canvassing the questionnaire. Random samples of 40 paddy growing farmers are selected from each block. This constituted a total sample of 160 farmers for each crop in the state. To ensure proportionate representation to various farm size categories in the study sample, standard national level definition of operational holdings viz., marginal (< 2.50 acres), small (2.51 to 5.00 acres), medium (5.01 to 10.00 acres) and large (> 10.01 acres) was applied. In addition to the primary data collected from the farmers, concerned district agriculture offices and State Commissioner, Agriculture Office (Chennai) and Tamil Nadu Agricultural University were also consulted to compile the crop loss estimates (if any) for pre- and post-harvest losses. Simple statistical tools were used to interpret the sample survey results.

The random sample procedure adopted at the district, taluk and village level for the primary survey is given in Table 1.5. It can be observed that the majority of the farmers fall in the marginal (33.5 percent) and small farmers (27.5 percent) category. The percentage of farmers in medium category is 17.5 percent. About 160 households have been selected from 8 villages in 4 blocks of Tiruvarur and Villupuram districts at the rate of two villages in a block and two blocks from each district on random basis.

Table 1.5: Sample Farmers of Tiruvarur and Villupuram Districts of Tamil Nadu

Districts	**Tiruvarur**				**Villupuram**				
Blocks	**Nananilam**		**Manargudi**		**Thiruvennainallur**		**Koliyanur**		
Farm Size	Salipery	Peralam	Thirupalakudi	Velakudi	Eruvelpattu	TV Nallur	Bedagam	Kutchipalayam	**Total**
Marginal	4	10	5	8	6	5	9	6	53
Small	6	3	5	6	8	6	3	8	45
Medium	2	4	3	4	3	4	5	2	27
Large	8	3	6	3	4	4	3	4	35
Total	20	20	19	21	21	19	20	20	160

Source: Field Survey Data

1.7 Organization of the Report

The report has been organized into six chapters. The first chapter being introductory in nature, discusses the background of the report covering status of agricultural economy of the state, significance of the selected crops, backdrop of pre-and post-harvest losses, the need for the study, objectives, data base and methodology. The second chapter deals with the trends and growth in the area and production of paddy crop in Tamil Nadu. Further, it deals with the cost of

cultivation of paddy in Tamil Nadu. The third chapter gives the socio-economic conditions of the household, cropping pattern and production structure of sample holdings. The fourth chapter focuses on assessment of pre-harvest losses of paddy crop in Tamil Nadu. It deals with the constraints faced in cultivation of paddy, assessment of incidences of pests and diseases attacks and crop losses, methods of pest and disease control adopted and source of information received by the sample households. The estimation of post-harvest losses of paddy crop including production loss during harvest, threshing/winnowing, transportation/handling and storage is presented in chapter Five. The last chapter concludes with the summary and relevant policy suggestions.

CHAPTER II

AREA, PRODUCTION AND PRODUCTIVITY OF PADDY CROP IN TAMIL NADU

2.1 Introduction

Agricultural production in India has increased considerably during last three decades due to cultivation of new high yielding varieties, increase in area under the crops from early sixties. The increase in food production has made us self-sufficient in food production and helps to ensure food security. Particularly paddy cultivation has increased and rice is consumed by more number of people in India during the post Green Revolution period.

Paddy is a major food crop as well as cash crop for the rural population in the world. The production has gradually increased from 200 MT in 1960 to 678 MT in 2009, and that means more than a threefold increase. The major paddy producing countries are China, India, Indonesia, U.S.A and Nigeria. Its production and consumption in China has increased from 1, 26,414 thousand MT in 2006 to 1, 37,500 thousand MT in 2011, and that shows an increase of 0.36 percent. Paddy production in India increased from 91,790 thousand MT in 2006 to 99,000 thousand MT in 2011 and that means an increase of 13.14 percent. Production in Indonesia has increased from 34,959 thousand MT in 2006 to 40,000 thousand MT in 2011. It increased nearly by 3.09 percent. In USA, the production of paddy increased by 10.18 percent; it increased from 6,912 thousand MT in 2006 to 7,621 thousand MT in 2011 (World Market & Trade, USDA 2012).

2.2 Trends of Paddy Production in India

Paddy cultivation is the most important agricultural operation in the country, not only in terms of food security but also in creating more livelihoods, opportunities for rural population. It plays a major part in the people's diet, economy and employment. Nearly 90 percent of paddy produced is consumed within the country. It contributes nearly 15 percent of India's annual gross domestic product (GDP) and provides 31 percent of the total calorie supply. The area under paddy has increased from 31.29 million ha in 1953-54 to 42.56 million ha.(125.73 million ha. of food grains) in 2010-11, while productivity increased from 902 kg/ha to 2240 kg/ha during the

period. The area under paddy accounts for 33.85 percent of India's food crops and 42.79 percent of its cereal crops area during 2010-11.

Table 2.1: Production of Paddy Crop in Major States of India (Annual Compound Growth Rate)

Major States	**1980-90**	**1990-2000**	**2000-12**
Andhra Pradesh	3.57	0.98	0.34
Assam	1.03	1.67	0.03
Bihar	1.20	1.00	2.84
Gujarat	3.92	2.22	14.08
Haryana	3.29	3.48	3.38
Karnataka	0.74	4.40	0.49
Kerala	-1.68	-3.38	-2.98
Madhya Pradesh	1.03	1.06	6.47
Maharashtra	-0.18	1.01	3.82
Orissa	3.86	-0.17	2.34
Punjab	7.59	2.92	1.42
Rajasthan	0.09	5.92	4.99
Tamil Nadu	3.84	2.68	-0.66
Uttar Pradesh	5.46	2.58	1.85
West Bengal	3.88	2.80	1.80
All States	3.22	1.90	1.04
Union Territory	-0.08	0.32	37.31
All India	**3.21**	**1.92**	**2.05**

Source: Ministry of Agriculture, Government of India

Table 2.1 presents state-wise production of paddy crop in major states of India during 1980-90 to 2000-12. The estimated figure shows that there is a considerable annual growth in the production of the crop in major states during the past three decades. The production of paddy at all-India level has declined from the annual compound growth rate of 3.21 percent during 1980-90 to 2.05 percent during 2000-12. Thus, the annual compound growth rate in production has declined by 1.16 percent during the last thirty years. Among the major states of India, Gujarat registered highest annual compound growth rate (ACGR) of 14.08 percent in 2000-12 against to 3.92 percent in 1980-90, though the ACGR declined to 2.22 percent during 1990-2000. Gujarat is followed by Madhya Pradesh with ACGR rate of 6.47 percent during 2000-12 against 1.03 percent during 1980-90. Rajasthan's ACGR increased from 0.09 percent in 1980-90 to 5.92

percent in 1990-2000, but it declined to 4.99 percent in 2000-12. Maharashtra registered an ACGR of 3.82 percent during 2000-12 against -0.18 ACGR during 1980-90. On the other hand, the growth rate of production in Kerala declined to -2.98 percent during 2000-12, Assam growth rate during 2000-12 was 0.03 percent and 1.03 percent during 1980-90 and 1.67 percent during 1990-2000. This implies that the hilly tracts of the state could not produce more paddy crop during these years. But states such as Gujarat, Madhya Pradesh, Maharashtra, Punjab, Rajasthan and Tamil Nadu performed well in paddy production among major states of India, even though the farmers faced various constraints in those states such as monsoon failure, bad weather conditions, high cost of inputs, and reduction of employment opportunities.

2.3 Trends in Production of Paddy Crop in Tamil Nadu

Tamil Nadu is one of the most important paddy producing states in India with the area accounting for 32.8 percent in 2000-01and it has slightly increased to 33.1 percent in 2009-10. The state has about 4.25 percent of total area of the country and accounts for 5.23 percent of the total production of the country during 2008-09. Paddy productivity in Tamil Nadu has always been above the national average. The average yield in the State was 2510 Kg/Ha during 2008-09 which is 3241 Kg/Ha higher than the national averages of 2186 Kg/Ha. Over the last decade, average productivity increased from 2308 Kg/Ha to 3541 KG/Ha.

State-wise area, production and yield of paddy crop in Tamil Nadu are shown in Table 2.2. It is observed that Tamil Nadu is one of the best producing states; paddy production in the state increased from 5370490 tonnes with an area of 2264293 ha. in 1985-86 to 6063400 tonnes with an area of 1963228 ha has declined in 1989-90. The area has grown by 4.37 percent and production increased by 6.31 percent. The total area of cultivation increased from 1855741 ha. in 1990-91 to 2228524 ha. during 1994-95 and production increased from 5782440 tonnes to 7558710 tonnes. That means an increase in production of 1776270 tonnes and the area increased by 372783 ha. within five year period. There are remarkable changes in production. It was 8141300 tonnes in 1998-99 against 5290030 tonnes in 1995-96 and the area increased to 2274961 ha. from 1950593. The production is estimated to increase to 2851270 tonnes with area of 324368 ha. during five year period. Paddy production registered the highest record due to the use of impact of high yielding varieties.

Table 2.2: State-wise Area, Production and Yield of Paddy Crop in Tamil Nadu

Year	Area (Hectares)	Production(Tonnes)	Yield (Kg/Ha.)
1985-86	2264293	5370490	2372
1986-87	1955155 (-13.65)	5332700 (-0.70)	2728 (15.0)
1987-88	1954836 (-0.02)	5613530 (5.27)	2872 (5.28)
1988-89	1880953 (-3.78)	5703600 (1.60)	3032 (5.60)
1989-90	1963228 (4.37)	6063400 (6.31)	3088 (1.85)
1990-91	1855741 (-5.48)	5782440 (-4.63)	3116 (0.89)
1991-92	2117875 (14.13)	6596260 (14.07)	3115 (-0.03)
1992-93	2184400 (3.14)	6805720 (3.18)	3116 (0.03)
1993-94	2306260 (5.58)	6749810 (-0.82)	2927 (-6.07)
1994-95	2228524 (-3.37)	7558710 (11.98)	3392 (15.89)
1995-96	1950593 (-12.47)	5290030 (-30.01)	2712 (-20.05)
1996-97	2173696 (11.44)	5805300 (9.74)	2671 (-1.51)
1997-98	2260544 (4.0)	6893730 (18.75)	3050 (14.19)
1998-99	2274961 (0.64)	8141300 (18.1)	3579 (17.34)
1999-2000	2163558 (-4.90)	7532100 (-7.48)	3481 (-2.74)
2000-01	2080010 (-3.86)	7366320 (-2.20)	3541 (1.72)
2001-02	2059878 (-0.97)	6583630 (-10.6)	3196 (-9.74)
2002-03	1516537 (-26.38)	3577108 (-45.67)	2359 (-26.20)
2003-04	1396651 (-7.91)	3222776 (-9.91)	2308 (-2.17)
2004-05	1872822 (34.09)	5061622 (57.06)	2703 (17.14)
2005-06	2050455 (9.48)	5209433 (2.92)	2541 (-6.01)
2006-07	1931397 (-5.81)	6610607 (26.9)	3423 (34.72)
2007-08	1789170 (-7.36)	5039954 (-23.76)	2817 (-17.7)
2008-09	1931603 (7.96)	5183385 (2.85)	2682 (-4.78)
2009-10	**1845553 (-4.45)**	**5665258 (9.30)**	**3070 (14.45)**

Source: Directorate of Economics and Statistics, Government of Tamil Nadu, Chennai-05
Note: Figures in parenthesis are the percentage of respective area, production and yield of paddy crop

The area and production declined from 2163558 ha. with production of 7532100 tonnes in 1999-2000 to 1396651 ha. with production of 3222776 tonnes in 2003-04. During the period as 1999-2003, there was steep decline in area and production of paddy crop in Tamil Nadu. The production and area are declined to 4309324 tonnes and 767907 ha. respectively, within a few years due to tsunami during 2004; the sea shore area was affected and in the following years conditions prevailed drought. On the other hand, the period 1991 to 2001, state witnessed boom

conditions in the cultivation of paddy and in area and production of the paddy crop during that period.

There was a declining trend from 1931397 ha. of area with production of 6610607 tonnes in 2006-07 to 1845553 ha. in 2009-10 with production of 5665258 tonnes. The paddy production increased from 5332700 tonnes to 5665258 tonnes during the 25 year period. But there was tremendous increase in the production of paddy in Tamil Nadu, in the following years: 6063400 tonnes in 1989-90, 6805720 tonnes in 1992-93, 7558710 tonnes in 1994-95, 8141300 tonnes in 1998-99, 7532100 tonnes in 1999-2000, 7366320 tonnes in 2000-01, 6583630 tonnes in 2001-02, and 6610607 tonnes in 2006-07.

2.3.1 District-wise Area and Production of Paddy in Tamil Nadu

Paddy is a major crop cultivated in many districts of Tamil Nadu. Farmers cultivate paddy during three seasons: Kar/Kuruvai/Sornavari (April to July), Samba/ Thaladi/Pishanam (August to November) and Navarai/ Kodai (December to March). The total area under paddy crop declined from 2264293 ha. in 1985-86 to 1845553 ha. during 2009-10. The total area declined to 418740 ha. over the 25 year period, out of which, during 12 years the area declined due to monsoon failure, agro climatic conditions of the state and natural calamities.

The area, production and productivity under paddy cultivation in the districts of Tamil Nadu are given in Table 2.3. The table shows that in Thanjavur, Tiruvarur, Villupuram, Nagapattinam, Ramanathapuram, Cuddalore, Vellore, Tirunelvei, Kancheepuram. There was an increase in the area under cultivation of paddy during 1985-86. Among those districts, Thanjavur the highest area under cultivation of paddy but exhibited declining trend from 535354 ha. in 1985-86 to 162938 ha. in 2009-10, it further declined to 372416 ha. during the 25 year period. Production of paddy also declined from 1090670 tonnes in 1985-86 to 427142 tonnes in 2009-10; it declined to 663528 tonnes over the 25 year period. The ACG rate of production declined at -3.68 percent over the two decades. Tiruvarur is second highest paddy producing district. But its production declined from 661460 tonnes in 2000-01 to 483125 tonnes in 2009-10 and area also declined from 174261 ha. to 166252 ha.

Villupuram is the third highest paddy producing district. It produced 467831 tonnes in 2009-10 against 510620 tonnes in 2000-01. The area under paddy cultivation declined from 153505 ha. to 148454 ha. with annual growth rate of -0.87 percent. Nagapattinam produced

432029 tonnes of paddy with an area of 157855 ha. in 2009-10 against to 547630 tonnes with area of 167317 ha. in 2000-01. Kanchipuram paddy production declined to 331434 tonnes from an area of 91020 ha. in 2009-10 against 766710 tonnes with an area of 307520 ha. in 1985-86. Production (435276 tonnes) and area (216500 ha) declined due to urbanization of the district and large size of agricultural land has been converted into real estates in the area. It may be noted that paddy is grown in 31 districts of Tamil Nadu except Chennai.

The production level of paddy is lower in Nilgiris, Coimbatore, Namakkal districts. Specifically, Nilgiris was producing of 1783 tonnes with area of 509 ha. in 2009-10 due to hilly tracts in the state. Coimbatore produced 9884 tonnes in an area of 2817 ha. in 2009-10 against 87710 tonnes in an area of 21684 ha. in 1985-86 due to the urbanization. In many districts of Tamil Nadu the area under the cultivation and production of paddy declined due to urbanization, real estates; most of the cultivable lands become uncultivable and farmers feel agriculture is becoming unprofitable occupation. In Thiruvannamalai (2.55 percent), Erode (1.11 percent) and Ramanathapuram (0.08 percent) districts, the area under paddy cultivation increased moderately. The annual growth rate of paddy production is Sivagangai (3.94 percent), Thiruvannamalai (3.46 percent), Ramanathapuram (3.31 percent), Erode (2.19 percent), Dindugal (1.11 percent), Virudhunagar (0.42 percent) and Salem (0.26 percent) during the three decades.

The highest yield rate of 5056kg/ha was recorded in Theni district during 2009-10 followed by Thoothukudi (4945 kg/ha), Dindugal (4737kg/ha) and Kanyakumari (4405 kg/ha). The highest annual growth rate of yield was recorded in Sivagangai (4.11 percent) followed by Nilgiris (3.59 percent) and Ramanathapuram (3.23 percent), Dindugal (2.36 percent), Kanniyakumari (2.21 percent), Salem (1.97 percent), Tiruchy (1.92 percent), Kancheepuram (1.59 percent), Dharmapuri (1.42 percent), Vellore (1.39 percent), Madurai (1.34 percent), Theni (1.31 percent), Tirunelvei (1.28 percent), Erode (1.07 percent) Thanjavur (1.01 percent), Perambalur (0.91 percent), Virudhunagar (0.61 percent) Thoodhukudi (0.23 percent) over a period of 25 years.

Table 2.3: District wise Area, Production and Yield of Paddy Crop in Tamil Nadu

Districts	Area in Hectares					Production in Tonnes					Yield (Kg./Ha.)				
	1985-86	1990-91	2000-01	2009-10	ACGR	1985-86	1990-91	2000-01	2009-10	ACGR	1985-86	1990-91	2000-01	2009-10	ACGR
Kancheepuram	307520	231960	132855	91020	**-4.75**	766710	743650	435500	331434	**-3.30**	2493	3206	3278	3641	**1.53**
Thiruvallur	-	-	93061	80942	**-1.39**	-	-	329300	256294	**-2.48**	-	-	3538	3166	**-1.10**
Cuddallore	305308	179942	114315	111517	**-3.95**	921880	611610	419740	322962	**-4.11**	3020	3399	3671	2896	**-0.17**
Villupuram	-	-	153505	148454	**-0.33**	-	-	510620	467831	**-0.87**	-	-	3326	3151	**-0.54**
Vellore	249011	34567	52332	39765	**-7.08**	602890	100850	211440	135834	**-5.79**	2421	2918	4040	3416	**1.39**
Thiruvannamalai	-	53316	81753	105177	**2.55**	-	164540	247220	324984	**3.46**	-	3086	3023	3090	**0.01**
Salem	37199	30375	45960	24382	**-1.68**	99830	101040	201220	106464	**0.26**	2684	3326	4378	4366	**1.97**
Namakkal	-	-	21456	10687	**-6.73**	-	-	93600	45946	**-6.87**	-	-	4361	4299	**-0.14**
Dharmapuri	36350	29927	55912	20310	**-2.30**	100130	96180	190830	79675	**-0.91**	2755	3214	3413	3923	**1.42**
Krishnagiri	-	-	-	16490	**0.00**	-	-	-	64976	**0.00**	-	-	-	3940	**0.00**
Coimbatore	21684	18156	14110	2817	**-7.84**	87710	62750	50030	9884	**-8.36**	4045	3456	3545	3509	**-0.57**
Thiruppur	-	-	-	11958	**0.00**	-	-	-	50179	**0.00**	-	-	-	4196	**0.00**
Erode	28916	64255	58024	38114	**1.11**	91040	277260	260660	156419	**2.19**	3148	4315	4492	4104	**1.07**
Tiruchirapalli	102077	92682	81177	64296	**-1.83**	262620	299420	316770	266272	**0.06**	2573	3231	3902	4141	**1.92**
Karur	-	-	17954	15013	**-1.77**	-	-	81110	64087	**-2.33**	-	-	4517	4269	**-0.56**
Perambalur	-	-	54605	12089	**-14.00**	-	-	174820	42372	**-13.21**	-	-	3201	3505	**0.91**
Ariyalur	-	-	-	25978	**0.00**	-	-	-	80462	**0.00**	-	-	-	3097	**0.00**
Pudukkottai	102825	68443	94786	95302	**-0.30**	282310	172550	323090	188449	**-1.60**	2746	2521	3408	1977	**-1.30**
Thanjavur	535354	459422	191800	162938	**-4.65**	1090670	1403460	719000	427142	**-3.68**	2037	3055	3748	2622	**1.01**
Thiruvarur	-	-	174261	166252	**-0.47**	-	-	661460	483125	**-3.09**	-	-	3795	2906	**-2.63**
Nagapatinam	-	-	167317	157855	**-0.58**	-	-	547630	432029	**-2.34**	-	-	3272	2737	**-1.77**
Madurai	97460	119149	76905	50986	**-2.56**	279220	409550	325000	203616	**-1.26**	2865	3437	4225	3994	**1.34**
Theni	-	-	18214	15371	**-1.68**	-	-	80820	77710	**-0.39**	-	-	4437	5056	**1.31**
Dindigul	22638	21954	22937	16647	**-1.22**	59780	80560	107760	78849	**1.11**	2641	3669	4697	4737	**2.36**
Ramanathapuram	131269	151265	124277	133885	**0.08**	103990	263440	237080	234880	**3.31**	792	1742	1907	1754	**3.23**
Virudhunagar	27892	36782	26014	26617	**-0.19**	58240	123490	73060	64716	**0.42**	2088	3357	2808	2431	**0.61**
Sivagangai	80578	89343	83947	77332	**-0.16**	52560	203120	218280	138095	**3.94**	652	2274	2600	1786	**4.11**
Thirunelveli	130136	101402	76285	85994	**-1.64**	391970	398260	338960	355877	**-0.39**	3012	3928	4443	4138	**1.28**
Thoothukudi	-	28789	15620	19549	**-1.92**	-	136000	67970	96675	**-1.69**	-	4724	4351	4945	**0.23**
The Nilgiris	3453	2784	2034	509	**-7.37**	5010	6890	8350	1783	**-4.05**	1451	2476	4105	3503	**3.59**
Kanniyakumari	44623	41228	28594	17307	**-3.72**	113930	127820	135000	76237	**-1.59**	2553	3100	4721	4405	**2.21**
Tamil Nadu	**2264293**	**1855741**	**2080010**	**1845553**	**-0.81**	**5370490**	**5782440**	**7366320**	**5665258**	**0.21**	**2372**	**3116**	**3541**	**3070**	**1.04**

Source: Directorate of Economics and Statistics, Government of Tamil Nadu, Chennai-05, Note: GR refers Growth Rate

Table 2.4: Districts wise Area, Production and Yield of Paddy Crop in Tamil Nadu: 1985-86 to 2009-10 (Annual Compound Growth Rate)

Districts	Area			Production			Yields		
	1985-86 to 1989-90	1990-91 to 1999-2000	2000-01 to 2009-10	1985-86 to 1989-90	1990-91 to 1999-2000	2000-01 to 2009-10	1985-86 to 1989-90	1990-91 to 1999-2000	2000-01 to 2009-10
Kancheepuram	-7.23	-4.60	-3.71	-3.84	-4.23	-2.69	3.65	0.38	1.06
Thiruvallur	-	0.90	-1.39	-	7.72	-2.48	-	6.77	-1.10
Cuddallore	-6.85	-4.48	-0.25	-4.17	-3.24	-2.59	2.87	1.29	-2.34
Villupuram	-	3.07	-0.33	-	3.56	-0.87	-	0.48	-0.54
Vellore	-30.14	3.73	-2.71	-25.73	7.97	-4.33	6.43	4.09	-1.66
Thiruvannamalai	-	6.21	2.55	-	6.30	2.77	-	0.08	0.22
Salem	10.72	4.47	-6.14	15.74	7.04	-6.17	4.50	2.46	-0.03
Namakkal	-	-2.71	-6.73	-	3.54	-6.87	-	6.43	-0.14
Dharmapuri	2.73	6.25	-9.63	5.61	7.63	-8.36	2.78	1.29	1.40
Krishnagiri	-	-	5.27	-	-	6.21	-	-	7.39
Coimbatore	3.69	-0.16	-14.88	-1.12	1.01	-14.97	-4.69	1.16	-0.10
Thiruppur	-	-	3.98	-	-	-	-	-	-
Erode	19.92	-0.63	-4.12	21.70	0.03	-4.98	1.48	0.66	-0.90
Tiruchirapalli	1.20	-1.35	-2.30	8.85	1.71	-1.72	7.56	3.10	0.60
Karur	-	5.91	-1.77	-	9.50	-2.33	-	3.39	-0.56
Perambalur	-	2.47	-14.00	-	6.27	-13.21	-	3.88	0.91
Ariyalur	-	-	2.82	-	-	-	-	-	-
Pudukkottai	-4.16	3.77	0.05	-3.88	7.50	-5.25	0.29	3.59	-5.30
Thanjavur	-2.33	-8.50	-1.62	6.68	-7.35	-5.07	9.23	1.26	-3.51
Thiruvarur	-	1.30	-0.47	-	19.73	-3.09	-	18.19	-2.63
Nagapatinam	-	-7.53	-0.58	-	-7.58	-2.34	-	-0.05	-1.77
Madurai	6.34	-3.63	-4.03	13.00	-1.14	-4.57	6.26	2.58	-0.56
Theni	-	-0.73	-1.68	-	1.84	-0.39	-	2.59	1.31
Dindigul	5.54	2.59	-3.15	14.89	5.44	-3.08	8.84	2.79	0.08
Ramanathapuram	0.70	-1.51	0.75	10.39	-10.67	-0.09	9.63	-9.30	-0.83
Virudhunagar	5.32	-1.21	0.23	13.82	0.60	-1.21	8.07	1.83	-1.43
Sivagangai	2.29	-0.14	-0.82	25.48	-1.83	-4.48	22.67	-1.69	-3.69
Thirunelveli	-8.66	-1.60	1.21	-7.30	-0.19	0.49	1.51	1.43	-0.71
Thoothukudi	8.91	-4.80	2.27	13.42	-5.28	3.59	4.14	-0.50	1.29
The Nilgiris	-7.82	-3.52	-12.94	0.44	1.48	-14.31	8.14	5.18	-1.57
Kanniyakumari	-0.32	-2.66	-4.90	5.33	1.58	-5.55	5.67	4.36	-0.69
Tamil Nadu	**-2.81**	**1.55**	**-1.19**	**2.46**	**2.68**	**-2.59**	**5.42**	**1.11**	**-1.42**

Source: Directorate of Economics and Statistics, Government of Tamil Nadu, Chennai-05

The annual compound growth rate of district-wise area, production and yield of paddy crop in Tamil Nadu during 1985-86 to 2009-10 is shown in Table 2.4. The area under paddy cultivation declines at an annual compound growth rate from -2.81 percent in 1985-86 to 1989-90 and -1.19 percent in 2000-01 to 2009-10. There was positive growth rate of 1.55 percent in Tamil Nadu during 1990-91 to 1999-2000. It may be noted that there is area expansion of paddy cropduring 1990-91 to 1999-2000 period due to adequate supply of water, good rainfall, and use of hybrid varieties of seeds.

The ACGR of production of paddy in Tamil Nadu increased to 2.68 percent during 1990-91 to 1999-2000 against to 2.46 percent during 1985-86 to 1989-90; in other words, the ACGR increased at 0.22 percent during 15 year period. Thereafter, the growth rate declined to -2.59 percent during 2000-01 to 2009-10 and there was some improvement to -0.09 percent during the past ten years. *Tsunami had a negative impact on the production level of paddy because of soil erosion in the sea shore areas of the districts; thana and neelam disasters also affected the production in the cultivated areas.*

Among the districts, Erode had highest ACGR of 19.92 percent during 1985-90, followed by Salem (10.72 percent). The average annual compound growth rate of Thoothukudi (8.91 percent), Madurai (6.34 percent), Dindugal (5.54 percent), Virudhunagar (5.32 percent), Coimbatore (3.69 percent), Dharmapuri (2.73 percent), Sivagangai (2.29 percent), Trichy (1.20 percent), Ramanathapuram (0.70 percent) was the result of the extension in the cultivated area during 1985-90. During 2000-01 and 2009-10, Krishnagiri (5.27 percent), Thiruppur (3.98 percent), Ariyalur (2.82 percent), Thiruvannamalai (2.55 percent), Thoothukudi (2.27 percent), Thirunelveli (1.21 percent), Ramanathapuram (0.75 percent), Pudukkottai (0.05 percent) had exhibited positive growth trend. There was also an extension in the cultivation of land area under paddy cultivation in Ramanathapuram from 0.70 percent in 1985-90 to 0.75 percent in 2000-10. In Thoothukudi, the area under cultivation declined from 8.91 percent to 2.27 percent and in Virudhunagar it declined to 0.23 percent from 5.32 percent.

During 1985-90, out of 19 districts, 13 districts exhibited increasing trend in production in Tamil Nadu. Sivagangai was highest producing district with an average annual compound growth rate at 25.48 percent, followed by Erode (21.70 percent), Salem (15.74 percent), and Dindugal (14.89 percent). The average annual compound growth rate of Virdhunagar (13.82 percent), Thoothukudi (13.42 percent), Madurai (13 percent), Ramanathapuram (10.39 percent),

Trichy (8.85 percent), Thanjavur (6.68 percent), Dharmapuri (5.61 percent), Kanniyakumari (5.33 percent), The Nilgiris (0.44 percent) have shown increasing trend in production.

Among the districts of Tamil Nadu, Krishnagiri was one of the leading districts in production with an ACGR of 6.21 percent during 2000-10, followed by Thoothukudi (3.59 percent) Thiruvannamalai (2.77 percent) and Thirunelveli (0.49 percent). On the other hand, out of 32 districts in four districts, the production of paddy had exhibited increasing trend during the last ten years (2000-10). The dynamics of cultivation of paddy crop in Tamil Nadu show that there are wide variations are in area, production of paddy among districts. Study of the period of 25 years shows that during the earlier period of 1985-90, because most of the districts in Tamil Nadu in terms of area and production in paddy cultivation had shown increasing trend than the latter period 2000-10, during which the average annual growth rate of production declined in majority of the districts in Tamil Nadu, except Krishnagiri, Thoothukudi, Thiruvannamalai and Trichy.

Among the districts, the average annual growth rate of yield in paddy crop in Tamil Nadu, Krishnagiri had highest yielding rate at 7.39 percent during 2000-10, followed by Dharmapuri at 1.40 percent and Theni (1.31 percent) and Thoothukudi (1.29 percent).

2.4 Changes in Cost and Profitability of Paddy Crop

The cost of cultivation in paddy crop in Tamil Nadu during 2007-08 to 2011-12 is given in Table 2.5. The cost of cultivation of paddy crop may be broadly divided into operational and fixed costs. Within operational cost, there are various costs like human, animal labour, machine, seed, fertilizers, plant protection, irrigation charges widely used in the agriculture. The different heads of cost of cultivation of paddy crop vary extensively from season to season. The total cost of cultivation of paddy crop varied from Rs. 37575 per ha. in 2007-08 to Rs. 59496 per ha in 2011-12, thus there was an increase in the cost of cultivation by Rs. 21922 per ha.

Operational cost accounts for the largest increase in the cost of cultivation of paddy over the last five year period. They increases from Rs.25024 per ha. in 2007-08 to Rs. 44952 per ha in 2011-12, that means an increase of 8.95 percent (Rs.19928). Within operational cost, labour cost accounts for a larger proportion of the total cost of cultivation. It is observed that the human labour cost more than doubled to Rs. 24395 per ha in 2011-12 against Rs.11754 per ha in 2007-08.

The cost of seeds increased to Rs.5268 per ha. in 2011-12 from Rs.2066 per ha in 2007-08. The managerial cost increased from Rs.3416 to Rs.5409. The cost of fertilizers increased from Rs.3767 to Rs.5493 per ha during the same period. Fixed cost and irrigation charges remained more or less stagnant one during the period.

Table 2.5: Cost of Cultivation of Paddy Crop in Tamil Nadu (2007-08 to 2011-12) (Rs. /Ha)

Particulars	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**
Operational Cost	25024.02	28339.97	34268	36328	44952
Human Labour	11754.79	14471.42	17137	18766	24395
Animal Labour	623.43	378.23	440	290	392
Machine Power	5690.2	5578.98	7368	6559	7300
Seed	2066.94	1584	3513	4811	5268
Fertilizers and Manures	3767.18	4950.76	4065	4394	5493
Plant protection Charges	413.8	668.62	464	951	1200
Irrigation Charges	137.11	61.77	498	79	132
Interest on Working Capital	570.58	646.19	783	478	772
Fixed Cost	9135	10048.5	9135	9135	9135
Sub Total (I + II)	34159.02	38388.47	43403	45463	54087
Managerial Cost @ 10 Percent	3415.9	3838.85	4340	4546	5409
Total Cost	**37574.92**	**42227.31**	**47743**	**50009**	**59496**
Percentage Share in Cost of Cultivation					
Operational Cost	66.60	67.11	71.78	72.64	75.55
Human Labour	31.28	34.27	35.89	37.53	41.00
Animal Labour	1.66	0.90	0.92	0.58	0.66
Machine Power	15.14	13.21	15.43	13.12	12.27
Seed	5.50	3.75	7.36	9.62	8.85
Fertilizers and Manures	10.03	11.72	8.51	8.79	9.23
Plant protection Charges	1.10	1.58	0.97	1.90	2.02
Irrigation Charges	0.36	0.15	1.04	0.16	0.22
Interest on Working Capital	1.52	1.53	1.64	0.96	1.30
Fixed Cost	24.31	23.80	19.13	18.27	15.35
Sub Total (I + II)	90.91	90.91	90.91	90.91	90.91
Managerial Cost @ 10Percent	9.09	9.09	9.09	9.09	9.09
Total Cost	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source: Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu

The operational cost accounts for a major share of the cost of cultivation of paddy in 2007-08, within operational costs, the cost of human labour accounts for (31.28 percent) followed by machine power (15.14 percent) and fertilizers accounts for 10.03 percent during the same year. The share of operational cost increased to 75.55 percent in 2011-12, out of which the cost of human labour accounts for 41 percent. On the other hand, costs of machine power, fertilizers, irrigation charges, fixed cost had shown declining trend in 2011-12. But the cost of seeds, fertilizers, human labour cost, animal labour cost and plant protection charges increased due to inflationary trend in the economy.

Table 2.6 Profitability Indicators of Paddy in Tamil Nadu (Rs/Ha)

Particulars	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**
Fixed Cost	9135	10048.5	9135	9135	9135
Variable Cost	28439.92	32178.81	38608	40874	50361
Total Cost	37574.92	42227.31	47743	50009	59496
Total Return (Value of Main and By Products)	38048.47	46897.79	55167	58462	65520
Total Profit	473.55	4670.48	7424	8453	6024
Yield (Quintals)	47.11	41.44	49	51	54
Price realized (Rs.per Quintal)		1034	1062	1084	1130
Cost of Production (Rs./Quintal)	797.6	1019	974	981	1102

Source: Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu

Table 2.6 explains the profitability indicators of paddy in Tamil Nadu (Rs/Ha) during 2007-08 to 2011-12. The total cost for paddy cultivation increased to Rs.59, 496 per ha. in 2011-12 against Rs.37, 575 in 2007-08. In other words, the cost of cultivation incurred by Rs.21, 921 per ha. over the five year period in Tamil Nadu. The total returns from paddy cultivation in Tamil Nadu also increased to Rs.65,520 per ha. in 2011-12 from Rs.38048 per ha. in 2007-08. The total return increased by Rs.27, 472 per ha. over the five year period. The total profit from paddy cultivation to the farmer increased to Rs.6024 per ha in 2011-12 against Rs. 474 per ha. in 2007-08. The amount of profit increased by Rs.5550 per ha. over the period. The profit to the farmer increased approximately 12 times over the five year period. The yield rate for paddy

cultivation in Tamil Nadu increased to 54 quintal per ha. in 2011-12 against 47 quintal in 2007-08. The price of paddy increased from Rs.1034 per quintal in 2007-08 to Rs.1130 per quintal in 2011-12. The table revealed that cost of production and price of paddy per quintal is almost same over the five year period in Tamil Nadu. This implies that there is no profit to the farmers who cultivate paddy.

2.5 Secondary Estimates of Losses caused by Pests and Diseases in Crops

The loss of foodgrains in the post-harvest system is not new; it has always been a problem for mankind. Various empirical studies estimated the pre-and post-harvest losses in India as well as in the World. Both the losses varied from region to region. In pre-harvest losses, pests and diseases play a major role. Assessment of losses at various stages of pre-and post-harvest losses of mango was conducted in India. Pre-harvest spray of fungicide is effective in controlling storage disease due to anthracnose and stem end rot in mango varieties. Alphonso fruits harvested with less than one specific gravity are free from spongy tissue and the incidence increased with increase in specific gravity. (Roy, Pal, 2013). A vast number of plant pathogens cause diseases in the crops. Plant pathogens are difficult to control because their populations are variable in time, space, and genotype. In order to combat the losses they cause, accurate estimates of the severity of disease and its effect on yield, and identification of its virulence mechanisms are necessary (Richard Strange and Peter Scott, 2005).

Grant Singleton (2003) examines rodents because chronic losses to production of rice are 5-10 percent per annum. In many areas, farmers actually withdraw from planting a second or third rice crop because of the expectation of severe rodent damage. The assessment of the impact of rodents on pre-and post harvest operations is influencing food security for the rural poor. In India, rodents have long been reported as having a substantial impact on rice crops (Rao and Joshi 1986). It is now, the main constraint to rice production, irrespective of production system (Parshad 1999, Rao 2003). Some 25 years ago, rodents are reported to consume between 10-15 percent of the national production of all grains in India (Barnett and Prakash 1975). Recently, Hart (2001) claimed that the overall losses of grain to rodents in India are approximately 25 percent and 25-30 percent during pre-and post-harvest seasons.

The chronic losses are economically more important but unrecognized (Sridhara 1992). Parshad (1999) has studied impact of rodents on rice production. His analysis indicates that pre-

harvest losses to rice are generally in the range of 5-15 percent. Added to the chronic annual losses caused by rodents are episodic outbreaks that cause famine-like conditions (Chauhan and Saxena 1983, Prakash and Mathur 1987). Two regions hard hit by these outbreaks are Mizoram and Arunachal Pradesh. Periodic outbreaks also occur in Andhra Pradesh following flash floods or cyclones in this deltaic region. The 1996 cyclone was followed by an outbreak of rodent populations in 1997, leading to damage upto 29 percent of the standing rice crop to early tiller. In West Godavari, 4.3 million farmers were affected by the rodent outbreak (Rao 1998).

Post-harvest loss is an important one in the production process. The losses occur from harvesting to marketing stage of the product. Various empirical studies point out that post-harvest losses happen during harvesting seasons. According to World Bank study (1999), post-harvest losses of food grains are 7-10 percent of the total production from farm to market level in India. Losses have been worked out to be 11-15 million Mt of foodgrains annually, which included 3-4 million Mt of wheat and 5-7 million MT of rice. These losses would be enough to feed about 70-100 million people, about one-third of poor in India or the entire populations of Bihar and Haryana together for about one year. Hence, it is evident that post-harvest losses have impact on micro and macro level of the economy.

The post-harvest losses were estimated for rice and wheat in Karnataka from 1982-83 to 2001-02. The study revealed that the post-harvest losses at the farm level were 3.82 kg/ q for rice and 3.28 kg/q for wheat. The losses are the highest during storage in both the crops. The factors that influence the post-harvest losses significantly are identified (Basavaraja, Mahajanashetti and Naveen Udagatti, 2007). Further, the study conducted estimating post-harvest loss in maize at farm level in Karnataka during 2003-04. The post-harvest loss at farm level is estimated to be 3.02 kg per quintal; 0.68 kg of maize is lost at the storage level and 0.49 kg per quintal is lost at the drayage level, whereas at transportation, threshing, packaging and cleaning 0.44 kg per quintal, 0.34 kg per quintal, 0.15 kg per quintal, and 0.10 kg per quintal respectively is lost. The improvement in storage facilities required immediate attention of the policy makers for reducing post-harvest loss in maize (Basappa, Deshmanya and Patil, 2007).

The study was conducted in Dharwad and Belgaum districts of Karnataka during 2008-09. A large number of farmers (48.33 percent) possessed knowledge about causes of post-harvest losses (Ravi Kumar, Modi, Bheemappa, Manjunath Hedge and Handigol, 2010). In Assam, post-harvest loss of horticulture produce varies between 5-39 percent of total production. In case of

brinjal, cauliflower, guava, chilly and papaya post-harvest loss is found to be at a lower level, because of lower level of production. On the contrary, in case of mango, onion, tomato and potato, loss is at a very high level due to lack of quality consciousness and this in turn leads to post-harvest losses (Planning Commission, 2012).

Ministry of Agriculture (2004) conducted a millennium study on post-harvest losses in the case of the Indian farmers. The study indicates that the highest average post-harvest losses are incurred by rice at 11 percent, followed by jowar (10 percent), gram (9 percent) and wheat (8 percent) in India. Another study revealed post-harvest losses of major agricultural commodities in India conducted during 2005-07. The results indicated that the highest average losses are reported in the case of wheat at 6 percent, followed by pulses (5.67 percent), rice (5.2 percent), bajra (4.80 percent), gram (4.30 percent) during post-harvest seasons in India (Indian Council of Agricultural Research (2010).The comparative commodity-wise study of post-harvest losses of major foodgrains indicate that there has been reduction in quantum of losses indicated and there are wide variations between two periods.

The study aims at providing estimates of post-harvest losses at producer's level in state and at national level in India. Total post-harvest losses of paddy at producers' level (in transport from field to threshing floor, threshing and winnowing, transportation and farm storage) are estimated at 2.72 percent of the total production (Government of India, Ministry of Agriculture, 2002). Gupta, Jagbir Singh and Kathuria (2000) observed that considerable losses of agricultural produce occurred due to various causes at various post-harvest stages in Bulandshahr district of Uttar Pradesh during 1985-88.

2. 6 Post-Harvest Losses in India: Current Scenario

At current level, post-harvest losses in India are a challenging task to the country. The post-harvest losses not only affect the farmer, but also economy as whole. India's post-harvest fruit and vegetable losses are over Rs 2 lakh crore annually due to inadequate cold storage and lack of proper food processing units. About 30 percent of Fruits and vegetables produced in the country (ASSOCHAM study). Among the states, West Bengal tops the list with losses worth Rs 13,600 crore each year, followed by Gujarat with losses of Rs 11,400 crore, Bihar Rs 10,700 crore, Uttar Pradesh Rs 10,300 crore and Maharashtra Rs 10,100 crore. The magnitude of post-harvest losses in fruits and vegetables can be minimized by proper cultural operations,

harvesting, transportation, storage, pre-and post-harvest treatments. The study focused that there is an additional requirement of cold storage of about 370 lakh tonnes for fruits and vegetables. At present, the country's total storage capacity is over 300 lakh tonnes (Economic Times 2013).

Effective steps to reduce pre-and post-harvest losses will help in solving the food production to a considerable level. In Twelfth Five Year Plan (2012-17); special attention has been given for curbing pre-and post-harvest losses foodgrains, vegetables and fruits in India. The post-harvest loss stands around 4 to 6 percent in food grains. These are estimated to be as high as 16 to 18 percent in fruits and vegetables. These losses occur at various stages from harvesting, storage to processing. In India, processing is as low as 10 to 12 percent, while developed countries process up to 70 percent of their food (The Hindu, Ludhiana, 2011).

2.7 Summary

Tamil Nadu is one of the major paddy producing states in India. Production of paddy has increased from 5370490 tonnes in 1985-86 to 5665258 tonnes in 2009-10 due to High Yielding Varieties (HYV). But the area under cultivation of paddy has marginally declined over the years from 2264293 ha in 1985-86 to 1845553 ha in 2009-10. Districts like Thanjavur, Tiruvarur, Villupuram, Nagapattinam, Ramanathapuram, Cuddalore, Vellore, Tirunelveli and Kancheepuram has shown an extension in the area in paddy cultivation but still production has declined in these areas. It is noted that due to urbanization, a majority of cultivated land was converted into real estates.

Paddy is produced in almost all 31 districts of Tamil Nadu except Chennai. Districts like Nilgiris, Coimbatore, Namakkal are the lowest producing districts in Tamil Nadu. In almost all districts in the Tamil Nadu, the area and production of paddy generally exhibited a declining trend owing to urbanization, industrial development, real estates; most of the cultivable land has become uncultivable and farmers feel agriculture has become an unprofitable occupation.

The highest yield rate of 5056 kg/ha was recorded in Theni district during 2009-10 followed by Thoothukudi district (4945 kg/ha), Dindugal district (4737 kg/ha) and Kanyakumari district (4405 kg/ha). The highest annual growth rate was recorded of Sivagangai (4.11 percent) followed by Nilgiris (3.59 percent) and Ramanathapuram (3.23 percent), Dindugal (2.36 percent), Kanniyakumari (2.21 percent), Salem (1.97 percent), Trichy (1.92 percent), Kanchipuram (1.59 percent), Dharmapuri (1.42 percent), Vellore (1.39 percent), Madurai (1.34

percent), Theni (1.31 percent), Tirunelvei (1.28 percent), Erode (1.07 percent) Thanjavur (1.01 percent), Perambalur (0.91 percent), Virudhunagar (0.61 percent) Thoodhukudi (0.23 percent).

In Tamil Nadu the Annual Compound Growth Rate(ACGR) has declined by -2.81 percent during 1985-86 to 1989-90 and -1.19 percent during 2000-01 to 2009-10 whereas, during 1990-91 to 1999-2000, there was positive growth rate of 1.55 percent in Tamil Nadu. It is noted that there is an extension in the area of paddy crop during that period due to availability of water sources, good rainfall and use of hybrid variety seeds in the farm field. Krishnagiri was a leading district in production with 6.21 percent of ACGR during 2000-10, followed by Thoothukudi (3.59 percent), Thiruvannamalai (2.77 percent) and Thirunelveli (0.49 percent). On the other hand, out of 32 districts only four districts increased the production during the ten years (2000-10). It is observed that there are wide variations in area, production of paddy among the districts of Tamil Nadu.

The period of 1985-90 is the most significant one, because most of the districts in Tamil Nadu in terms of area and production in paddy cultivation exhibited an increasing trend than the later period of 2000-10. The average annual growth rate of paddy production has declined in majority of the districts of Tamil Nadu, except Krishnagiri, Thoothukudi, Thiruvannamalai and Trichy.

Production cost plays an important role in determining the agricultural growth in the state. Different parts of states realize different cost variations in their production process. Operational cost has also increased from Rs.25024 per ha. in 2007-08 to Rs. 44952 per ha. in 2011-12. It shows an increase of 8.95 percent (Rs.19928) during the five year period. Within operational cost, the human labour cost has also increased to Rs. 24395 in 2011-12 against to Rs. 11754 per ha. in 2007-08, which shows a 10 percent increase (Rs.12644). This implies that the human labour cost increased to above 50 percent between 2007 and 2012. The cost of seeds increased to Rs.5268 per ha. in 2011-12 from Rs.2066 and 3.35 percent increased (Rs. 3202). The managerial cost increased from Rs.3416 to Rs.5409, which increased to Rs. 1994 per ha. On the whole, in Tamil Nadu total cost of paddy crop cultivation has increased from Rs. 37575 per ha. in 2007-08 to Rs. 59496 per ha. in 2011-12.

CHAPTER III

HOUSEHOLD CONDITIONS, CROPPING PATTERN AND PRODUCTION SCHEME

The present chapter discusses the household conditions of farmers, cropping pattern and production scheme. After the advent of Green Revolution, the farmers' conditions have changed due to adoption of modern technology in agriculture. Nowadays even uneducated farmers in the rural area are using modern technologies in agriculture. This kind of rural transformation of technology not only increased agriculture production, but also brought about improvements in the living condition of households. This chapter deals with the socio-economic conditions of the selected respondents, further it discusses about their operational land holdings, tenancy system, irrigation method, cropping pattern, productivity, marketed surplus and output of agriculture product of the farmers.

3.1 Socio-economic Conditions of Sample Farmers

An attempt is made to highlight the existing situation in the study area with regard to socio-economic conditions of the farmers. It covers the number of households, size, and proportion of male/female/children, average age of respondents, educational status and caste status of the farmers. The distribution of selected farmers and their socio-economic conditions observed in the study area are presented in Table 3.1. The table gives the demographic profile for different socio-economic characteristics of the selected farmers of the two districts in Tamil Nadu (Tiruvarur and Villupuram). Large and medium farmers earn more money than small farmers. A significant difference exists in the number of households among the different size of farmers. There are 53 marginal farmers (33.13 percent), 44 small farmers (27.5 percent), 28 medium farmers (17.5 percent) and 35 large farmers (22 percent). The farmers have to carry their produce to the main market which is at a distance of 7 to 10 Kms.

Most of the interviewed households are male members of the family in all the farm sizes, because the female members have hesitated to attend the interview. The data shown below depicts the age group of selected farmers in two districts of Tamil Nadu. It is seen that more than 55 to 80 percent of the farmers are in the age group of above 40. About 20 to 48 percent of the farmers are in the age group of 25 to 40 years. This is followed by 5 to 8 percent of the farmers

who are below 25 years. In both the districts, 62.2 percent of the average sample farmers are above 35 years of age. In general, it is seen that most of the farmers belonged to the middle level age group. This implies that the younger generation is not interested to take up farming as a profession.

Table 3.1: Demographic Profile of the Selected Sample Size of Paddy Growing Farmers in Tiruvarur and Villupuram Districts of Tamil Nadu (Percent of Households)

Characteristics		**Marginal**	**Small**	**Medium**	**Large**	**Overall**
Number of Households		53	44	28	35	160
Household Size (Numbers)		5	5	6	7	6
Average Number of Earners		1.00	1.00	2.00	2.00	1.50
Proportion of Male/ Female/ Children (Percent)	Male >15	47.17	55.56	40.74	40.00	45.87
	Female >15	39.62	37.78	44.44	37.14	39.75
	Children<15	13.21	6.67	14.81	22.86	14.39
Identity of Respondents (%)	Head	100	100	100	100	100
	Others	0	0	0	0	0
Average Age of the Respondent (Percent)	Less than 25	5.66	8.89	0.00	0.00	3.64
	Between 25 to 40	39.62	28.89	48.15	20.00	34.16
	Above 40	54.72	62.22	51.85	80.00	62.20
Educational Status of a Family Member (Percent Households)	Illiterate	20.75	13.33	14.81	8.57	14.37
	Up to Primary	22.64	11.11	11.11	2.86	11.93
	Up to Secondary	11.32	6.67	11.11	8.57	9.42
	Higher Secondary	33.96	37.78	37.04	42.86	37.91
	Graduate & above	11.32	24.44	22.22	25.71	20.93
	Post-Graduate	0	6.67	3.70	11.43	5.45
Caste Status (Percent Households)	SC	35.85	20.00	7.41	5.71	17.24
	ST	0	0	0	0	0
	OBC	56.60	80.00	88.89	82.86	77.09
	General	7.55	0	3.70	11.43	5.67
Distance from Market (KM)		8.92	10.04	8.26	7.06	8.57
Annual Income (Rs.)		105123	200113	373928	971557	412680

Source: Field Survey

When we take all the respondents (marginal, small, medium and large farmers) as a whole, we find that roughly 14 percent of the farmers are illiterate, 12 percent of farmers had primary education, 47 percent had secondary and higher secondary education. And 26 percent of the farmers were either graduates or post graduates. But 43 percent of marginal farmers were

either illiterate or had only primary education. Among those who had secondary and higher secondary education there is not much difference in percentages among different categories of farmers. Nearly half of the graduates and post-graduates (48 percent) are from the medium and large categories of farmers. This helps them to easily adapt new technology in agriculture. There is enough empirical evidence in standard literatures to show that higher the level of education, greater the response to innovations in agricultural methods.

When we look at the social background, we find that nearly 36 percent of marginal farmers and 20 percent of small farmers belonged to the Scheduled Caste (SC). Very small percentage of SC farmers had medium and large holdings. On the other hand, among other backward class (OBCs) more than half of the farmers (57 percent) belonged to the marginal farmer category but roughly 80 percent of them belonged to small, medium and large farm categories.

3.2 Pattern of Operational Holdings

In Tamil Nadu, net sown area in the land use pattern has been declining gradually over the past six decades. It is evident that the net sown area has declined from 60.26 lakh ha during 1960s to 49.53 lakh ha 2010-11. Nearly 10.73 lakh ha went out of cultivation over the last six decades. The distribution of number of farmers growing paddy crop and their average size of operational holdings observed in the study area is presented in Table 3.2. The average size of operational holdings for the sample farmers has been calculated to be 9 acres. Moreover, at disaggregated level, the average size of operational holdings is estimated to be the highest for large farmers (20.32 acres) and lowest for marginal farmers (1.68 acres). It has been found that the marginal farmers have minimum share of own land (1.33 acres) as compared to leased-in land (0.31 acres) thereby making net operated area of 1.68 acres. On the other hand, large farmers have own land of 15.67 acres with more leased-in land (3.80 acres) with leased-out land (0.26 acre) thereby having net operated area of 20.32 acres. The overall operational holdings of all farm sizes, own land worked out to be 6.85 acres with 1.66 acres leased-in and 0.08 acre being leased-out land making net operated area of 9.0 acres.

The uncultivable area is worked out to be the highest (1.11 acres) for large farmers, whereas, marginal farmers have the lowest level of uncultivable land (0.04 acres). This indicates that the highest operational holdings are held by large farmers, followed by medium farmers

(9.41 acres). The marginal farmers have 1.68 acres of land. The distributions of size of operational holdings of sample farmers show variations across different farm sizes.

Table 3.2: Characteristics of Operational Holdings (Acres per Household)

Farm Size	Owned Land	Uncultivated Land	Leased-In	Leased -out	NOA	Irrigated Area
Marginal	1.33	0.04	0.31	0.00	1.68	1.68
Small	3.42	0.60	0.58	0.00	4.60	4.60
Medium	6.98	0.56	1.94	0.07	9.41	9.41
Large	15.67	1.11	3.80	0.26	20.32	20.32
Overall	6.85	0.58	1.66	0.08	9.00	9.00

Source: Field Survey

3.3 Tenancy System

The enactment of tenancy legislation in 1962 and 1977 resulted in dramatic fall in the area under tenancy from 23.34 percent (1953) to 8 percent (1991). In the present context, tenancy can be taken as a mechanism of resource adjustment, access to credit institutions and credit system. The tenancies of operational holdings such as leased-in and leased-out land are explored in Table 3.3. There are various types of tenancy like crop-sharing, cost crop-sharing and fixed rent in cash. In the selected farmers of two districts, crop-sharing and fixed cash rent for all farm sizes are used. It is observed that the paddy received in terms of crop-sharing for leased-in land from marginal farmers is the highest at 42 percent for 0.13 acre, and 36 percent for 0.21 acre of land leased-in farm from small farmers.

Almost 29 percent of large farmers have leased-in land at an average of 1.09 acres for crop- sharing. In the case of fixed rent in cash transactions, 71 percent of farmers give more rent for utilization of leased-in land 2.71 acres with an average size. Nearly 65 percent for medium farmers give rent for leased-in land 1.26 acres with an average size. This indicates that most of the farmers irrespective of their farm size prefer fixed rent rather than crop-sharing. Crop-sharing was in practice in the earlier days, but nowadays most of them prefer fixed rent.

Table 3.3 Nature of Tenancy in Leasing-in/ Leasing-out Land (Percent of Households)

Farm Size	Crop Sharing	Crop & Cost Sharing	Fixed Rent in Cash	Others	Total	% Share of Tenancy in NOA
Leasing in						
Marginal	0.13 (42)	0	0.18 (58)	0	100	18.45
Small	0.21 (36)	0	0.37 (64)	0	100	12.61
Medium	0.68 (35)	0	1.26 (65)	0	100	20.62
Large	1.09 (29)	0	2.71 (71)	0	100	18.70
Overall	0.53 (32)	0	1.13 (68)	0	100	18.44
Leasing-out						
Marginal	0	0	0	0	100	0
Small	0	0	0	0	100	0
Medium	0	0	(0.07) 100	0	100	0.74
Large	0	0	(0.26) 100	0	100	1.28
Overall	**0**	**0**	**(0.08) 100**	**0**	**100**	**0.89**

Source: Field Survey

3.4 Sources of Irrigation

Water is a fundamental resource for development of agriculture. Water sources have been moving towards scarcity level, due to population growth of the country. As a result, it affects the water sources. We are facing challenges such as improving and safeguarding existing water sources, managing water demand across competing sectors and determining environmental requirements.

In Tamil Nadu, the net area irrigated improved from 28.6 lakh. ha in 2007-08 to 29.3 lakh ha in 2008-09. The increase of 2.4 percent is a marginal rise in the irrigation of canals, tanks and well irrigation during 2008-09. The irrigation intensity had also improved from 114 percent in 2007-08 to 115.7 percent in 2008-09. Likewise, the net irrigated area as percentage to net area sown and Gross irrigated area as a percentage to gross area sown also rose to more than 58 percent.

According to Economics and Statistics, Government of Tamil Nadu, 2009-10, the irrigation system in Tamil Nadu is consisted mainly of canal, tank and tube wells. When we compare the two districts, the irrigations system is better in Tiruvarur than Villupuram. The canals and tanks systems are there, but, majority of the farmers depend upon the ground water in Villupuram district. On the contrary, in Tiruvarur district, majority of the farmers depend upon the Cauvery canal water basin. Whenever the Mettur dam is opened for irrigation of the delta regions, they are benefited.

The different sources of irrigation system on selected sample respondents are given in Table 3.4. The table shows that the electric tube well irrigation facilities are used by 55.60 percent of small farmers. The large farmers using irrigation sources accounts for 42.90 percent. The entire operational area has been irrigated by canal, tube well and tank irrigation. In Tiruvarur district, farmers use Cauvery water sources located near the sea shore. So water sources are available in the district, whereas in Villupuram district, the number of canals and tanks available is less when compared to other region of the state, but water is not available from the rivers; the rivers are there without any water throughout the year. Even though, Ponnaiyar and Palar rivers pass through the district, they are not of much help for irrigation purposes. Most of the sample farmers are mainly using tube wells run by electricity. This indicates that the two districts have different sources of irrigation facilities. The table shows that the majority of the farmers make use of canal and tube well irrigation; 73.81 percent of marginal farmers, 71.52 percent of small farmers and 83.27 percent of large farmers use canal and tube well irrigation.

Table 3.4 Sources of Irrigation of Net Irrigated Area (Percent)

Farm Size	Only Canal	Canal +Tube Well	Electric Tube Well	Diesel Tube Well	Tanks	Open well	Others	Total
Marginal	0.08 (4.76)	1.24 (73.81)	0.09 (5.36)	0	0.23 (13.69)	0.04 (2.38)	0	1.68 (100)
Small	0.10 (2.17)	3.29 (71.52)	0.67 (14.57)	0	0.42 (9.13)	0.12 (2.61)	0	4.60 (100)
Medium	0.90 (9.56)	7.31 (77.68)	0.34 (3.61)	0	0.58 (6.16)	0.28 (2.98)	0	9.41 (100)
Large	0.98 (4.82)	16.92 (83.27)	0.89 (4.38)	0	0.96 (4.72)	0.57 (2.81)	0	20.32 (100)
Overall	0.52 (5.33)	7.19 (76.57)	0.50 (6.98)	0	0.55 (8.43)	0.25 (2.69)	0	9.00 (100)

Source: Field Survey

3.5 Cropping Pattern

The growth in the production of agricultural crops depends on many factors such as area cropped, input management and yield. The cropped area and productivity are determined by the fertility of soil, rainfall, irrigation, availability of agricultural labourers, climatic changes, prices etc. The principal crops like paddy, cereals and pulses, groundnut, cotton and sugarcane accounted for more than 60 percent of the gross cropped area of the State of Tamil Nadu.

Table: 3.5 gives details of cropping pattern of the sample households in Tiruvarur and Villupuram districts by making use of the percentage of Gross Cropped Area of major crops year during kharif, rabi and summer seasons. From the table, we find that 37.44 percent, 34.82 percent and 27.55 percent in the Gross Cropped Area during kharif, rabi and summer seasons respectively.

From the table, we find that paddy occupies the largest cropped area during all the seasons. Provision of paddy is more or less the same for the land by marginal, small, medium and large farmers during kharif season. Groundnuts are grown only during the rabi season and cotton is grown only during kharif season. Vegetables are grown only during rabi and kharif seasons. But paddy and pulses are grown in all the seasons.

The percentage of GCA for the kharif season for all selected crops in 37.44 percent while paddy accounts for 29.44 percent of GCA during the kharif season, all other crops (cotton, pulses and vegetables) put together represent only 8 percent of GCA. Similarly during the rabi season, in the total 34.82 percentage of GCA for all the selected crops. Paddy alone accounts for 26.19 percent of GCA, while combined GCA of all other crops (groundnuts, pulses and vegetables) is 8.63 percent only. During summer season, paddy accounted for 21.52 percent of GCA out of total 27.75 percent GCA for selected crops. But pulses and others occupied only 6.12 percentage of GCA. All this shows that paddy is a predominant major crop in Tiruvarur and Villupuram districts and this also points out the need for adequate supply of water for this crop.

Table 3.5 Cropping Pattern of Selected Farmers (Percent of GCA for the Whole Year)

Name of the Crop	Marginal	Small	Medium	Large	Overall
Kharif Seasons					
Paddy	29.42	30.21	28.14	29.98	29.44
Cotton	2.83	3.21	3.02	3.27	3.08
Pulses	3.41	2.19	3.63	3.14	3.09
Vegetables	1.12	1.15	2.82	2.21	1.83
Kharif Total	36.78	36.76	37.61	38.60	37.44
Rabi Seasons					
Paddy	26.84	27.61	24.98	25.33	26.19
Ground Nuts	3.89	2.24	3.83	4.81	3.69
Pulses	2.53	3.83	3.94	3.24	3.39
Vegetables	1.42	1.36	1.79	1.62	1.55
Rabi Total	34.68	35.04	34.54	35.00	34.82
Summer Seasons					
Paddy	22.58	20.83	21.34	21.34	21.52
Pulses	5.13	6.39	5.43	4.33	5.32
Others	0.83	0.98	1.08	0.73	0.91
Summer Total	28.54	28.20	27.85	26.40	27.75
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source: Field Survey

3.6 Utilization of Area under High Yielding Varieties

HYV is considered to be a very vital seed input among all the factors of productions. Hence, importance of HYV was realized by the Government of India during 1960s for its increase in the yield. Tamil Nadu is one of the better performing states in the adoption of new technology in farm production, particularly in the production of foodgrains. The Union and State Governments have given high priority to the use of HYV seeds in all crops. The main objectives of using HYV are increase in area, increase in production and high profits to farmers.

An important indicator of the level of adaptation of technology in agriculture is the use of HYV seeds for various crops. Seed is the most efficient means of increasing agricultural production and productivity. Though the use of HYVs depends largely upon the availability of irrigation, farmers in Tamil Nadu have been using the same even under rain fed conditions because of government's subsidy programmes coupled with extension.

Table 3.6 Percentage of Area under HYV Seeds

Name of the Crop	Marginal	Small	Medium	Large	Overall
Kharif Seasons					
Paddy	100	100	100	100	100
Cotton	100	100	100	100	100
Pulses	100	100	100	100	100
Vegetables	100	100	100	100	100
Rabi Seasons					
Paddy	100	100	100	100	100
Ground nut	100	100	100	100	100
Pulses	100	100	100	100	100
Vegetables	100	100	100	100	100
Summer Seasons					
Paddy	100	100	100	100	100
Pulses	100	100	100	100	100
Others	100	100	100	100	100

Source: Field Survey

An attempt has been made to explain the utilization of HYV seeds in paddy cultivation among the selected sample farmers in Table 3.6. The table reveals that all the farmers with different farm sizes in Tiruvarur and Villupuram districts use HYV seeds in all seasons rabi, kharif and summer. By using the HYV seeds, the farmers enjoyed high returns. The table shows, there was cent percent use of HYV seeds in both districts. This shows that the government succeeded in creating awareness among the sample farmers over the years about the advantages of using HYV seeds in crop cultivation.

3.7 Cropping Yield of Sample Districts

Table 3.7 gives details of the average yield of major crops grown by selected households of Tiruvarur and Villupuram districts of Tamil Nadu. The average yield of paddy is 22.89 quintals per acre during kharif season, followed by 21.39 quintals per acre during rabi season and it declined to 20.40 quintals per acre during summer season. It is interesting to note that during the kharif season, the average yield of paddy crop achieved medium size of farmers is the highest with 27.45 quintals per acre, whereas the largest farmers produce the highest yield of paddy per acre (23.56 quintals) during rabi season and the small farmers produced the highest yield of

paddy per acre (22.55 quintals). But production by the marginal farmers is at bottom in all the seasons because of their inability to use HYV seeds in a big way.

Table 3.7 Average Yield of Major Crops grown by the Selected Households (Quintal per Acre)

Name of the Crop	Marginal	Small	Medium	Large	Overall
Kharif Season					
Paddy	20.57	22.88	27.45	20.66	22.89
Cotton	6.57	6.98	7.12	6.73	6.85
Pulses	1.26	1.38	1.41	1.49	1.39
Rabi Season					
Paddy	19.89	21.15	20.96	23.56	21.39
Ground nut	4.67	5.21	4.98	5.42	4.95
Vegetables	1.56	1.42	1.67	1.71	1.59
Summer Season					
Paddy	18.43	22.55	19.71	20.89	20.40
Pulses	1.32	1.48	1.79	1.63	1.56

Source: Field Survey

Cotton is the second major crop grown in Tiruvarur and Villupuram districts. Table 3.7 reveals that the average yield of cotton per acre during the kharif season in the sample farms of all sizes is 6.85 quintals and medium farmers produce the highest yield of cotton (7.12 quintals per acre) and small farmers produce 6.98 quintals per acre. The yield of cotton for the large farmers (6.73 quintals per acre) is marginally lower than the yield for small farmers. The marginal farmers find themselves at the bottom with 6.57 quintals per acre.

In the case of pulses, large farmers enjoy the highest yield (1.49 quintals per acre) during the kharif season and medium farmers enjoy the highest yield (1. 73 quintals per acre) during summer season.

3.8 Value of Output and Marketing by Sample Farmers with different Farm Sizes

The agriculture sector has serious concerns about efficient functioning of marketing with different farms sizes of output and productivity. The output depends mainly on supply side factors, whereas the market provides the link between producers and final demand by consumers. The efficient functioning of the market depends largely upon producers and consumers.

Interventions in domestic agricultural markets can affect the efficient allocation of resources negatively thus making domestic agricultural sector less competitive in international markets. This effect can get further magnified through interventions in the broader trade policies. Efficient agricultural markets can also be a potent tool for poverty reduction.

The different value of output and marketed surplus (aggregate of all crops) are given in Table 3.8, clearly highlights that there are wide variations in the value output per household among different farm sizes. The overall output value of households of different farm sizes was to be Rs. 3, 46,385 per household and the marketed surplus was calculated to be found Rs. 3, 00,984 and the percentage share of total output marketed 84.94 percent. The remaining produce was used by the farmers for their own consumption and seeds purposes.

Table 3.8 Value of Output and Marketed Surplus (Aggregate of All Crops)

Farm Size	Value of Output (Main + byproduct)		Value of Marketed Surplus		Percent share of Output Marketed
	Rs. per Household	Rs. per Acre	Rs. per Household	Rs. per Acre	
Marginal	63633	37877	51708	30779	81.26
Small	186452	40533	155669	33841	83.49
Medium	341189	36258	296254	31483	86.83
Large	794268	39088	700306	34464	88.17
Overall	346385	38439	300984	32642	84.94

Source: Field Survey

It may also be noted that the percentage share of output marketed by medium and large farmers was 86.83 percent and 88.17 percent respectively, whereas for the marginal and small farmers, the percentages were at a lower level (81.26 percent and 83.49 percent respectively). The percentage figures for output market also reveals that agriculture in Tiruvarur and Villupuram districts is no longer subsistence farming without marketable surplus. Another point to be noted is that the percentage share of output market increases with the size of the farm.

3.9 Summary

In the demographic profile picture of sample size farmers in Tiruvarur and Villupuram districts. There exists significant difference among the different size of number of households i.e. 53 (33.13 percent), 44 (27.5 percent), 28 (17.5 percent) and 35 (22 percent) for marginal, small,

medium and large farms, respectively. The majority of the sample households are belonged to marginal and small farms. The majority of the farmers are well educated and very few farmers are illiterate this helps them to easily adapt new technology in agriculture. The majority of the households are belonged to OBCs and farmers belong to SC are very minimal and their farm holdings shows huge difference where farmer holds large and later holds less. The highest operational holdings is 20.32 acres for large farmers and lowest of 1.68 acres for marginal farmers.

Most of the farmers irrespective of their farm size prefer fixed rent rather than crop-sharing. Because the paddy received in terms of crop-sharing for leased-in land is highest of 0.13 acre (42 percent) for marginal farms, 0.21 acre (36 percent) for small farms and 1.09 acres (29 percent) for large farms. The average fixed rent paid for utilization of leased-in land is 2.71 acres (71 percent) where as 1.26 acres (65 percent) for medium farms.

Distributions of water resources among the two districts are very different. So, they depend on different method of irrigation process. In Tiruvarur district farmers depend on rivers as Cauvery river water is very much available to them whereas Villupuram district farmers do not have such rivers to support them. So, majority of Villupuram district farmers depends on tube irrigation added they also use canal and well irrigation. Farmers make use of canal and tube well irrigation is 73.81 percent, 71.52 percent and 83.27 percent of marginal, small and of large farms, respectively.

The Gross Cropped Area (GCA) is expanded by the sample farmers at 37.44 percent, 34.82 percent and 27.77 percent during kharif, rabi and summer seasons, respectively. Among different crops, paddy occupies the single most cropped area during all the seasons in both districts. It is more or less the same for the land by marginal, small, medium and large farmers during kharif season. It implies that the production level has declined due to continuous utilization of land in all three seasons.

The percentage of GCA for all selected crops is 37.44 percent, out of that paddy occupied the major portion of 29.44 percent and rest of the other crops like cotton, pulses and vegetables hold 8 percent during kharif season. Similarly, GCA is 34.82 percent for all the selected crops for paddy, 26.19 percent and for other crops, 8.63 percent during the rabi season. During summer season, paddy accounted for 21.52 percent out of total 27.75 percent GCA for selected crops. It shows that paddy is a predominant major crop in Tiruvarur and Villupuram districts in all three

seasons. It also implies that the need for adequate supply of water for this crop in all three seasons.

Modern technology in agriculture showed positive impact on Tiruvarur and Villupuram districts. The farmers enjoyed high returns by using the High Yielding Varieties (HYV) seeds. Sample farmers of both districts use the HYV seeds at cent percent level. Government succeeded in creating awareness among the sample farmers over the years about the advantages of using HYV seeds in crop cultivation. This is reflected in their crop cultivation as sample households in both the districts make use of HYV seeds for all the crops.

When, it comes to paddy yield in all three seasons. The yield of paddy per acre is 22.89 quintals, 21.39 quintals and 20.40 quintals during kharif, rabi and summer seasons, respectively. The highest yields per acre produced by medium farmers are 27.45 quintals and lowest yield by large farmers (23.56 quintals) during kharif season. During rabi season, small farmers produces highest yield per acre at 22.55 quintals. The marginal farmers produced the production with bottom level in all the seasons because of their inability to use HYV seeds in a big way.

The highest percent of output marketed is 86.83 percent and 88.17 percent by medium and large farmers, respectively, whereas the lowest share of output marketed is 81.26 percent and 83.49 percent by marginal and small farmers. Agriculture in Tiruvarur and Villupuram districts is no longer subsistence farming without marketable surplus. It is noted that the percentage share of output market increases with the size of the farm.

CHAPTER IV

ESTIMATION OF PRE-HARVEST LOSSES OF PADDY CROP IN TAMIL NADU

4.1 Introduction

Harvesting losses are faced by the farmers all over the World. The pre-harvest losses were critical to the farmers because they affect cost of production and profits, if any. During the pre-harvest stage, the crop are affected by a number of diseases such as incidence of insects, pests and diseases attack, birds, animal feed, rodents, monsoon problems and bad weather conditions. The pre-harvest losses not only affect the growth of crops but also affect the whole yield of those crops. According to of Kobe University study which was conducted in the five countries of Asia, out of five, four countries were affected due to rodents and insects. Another study conducted by World Bank revealed that in Bangladesh out of the total harvest losses of 19.7 percent, 12 to 13 percent of losses were caused by insects and rodents.

Paddy crop faces a number of pest problems like rice stem borer, leaf folder, plant hoppers, and diseases such as bacterial leaf blight, sheath blight, false mut during the growing seasons. Largely due to these reasons, increasing paddy production is becoming a major challenging task. Plant hoppers are one of the pests, which affect the streaming crop of paddy. In addition to that, farmers indulge in overutilization of fertilizers and pesticides to get high yield of crops.

In developing countries, the losses due to weeds, diseases and insects have been estimated to be 40 percent. In India, the brown spots of rice (*Cochliobolus miyabeanus*) were the serious problems caused by plant diseases during the great Bengal famine in 1943. The rice tango virus and the bacterial leaf blight of rice are the most devastating diseases in the new varieties. Sheath blight has become serious disease on rice in the nonconventional areas. Ironically, most of these diseases have caused destruction in crops grown under rain fed agriculture, indicating vulnerability of such cropping systems.

4.2 Constraints faced in Cultivation of Paddy Crop

During cultivation time, the farmers faced a number of constrains in the farm field. The constrains such as poor seed quality, water deficiency, pests and disease problems, high cost of

inputs, low output prices in the market are main constraints faced by farmers. The problems faced by the sample farmers in cultivation of paddy crop are shown in Table 4.1.

Table 4.1: Constraints faced in Cultivation of Paddy Crop (Percentage of Household) of Tiruvarur and Villupuram Districts of Tamil Nadu

Constraints	Most Important	Important	Least Important	Most Important	Important	Least Important
	Tiruvarur			Villupuram		
Poor Seed Quality	13.70	73.80	12.50	15.00	52.50	32.50
Water Deficit	32.50	36.30	31.20	13.80	60.00	26.20
Pest Disease problems	17.50	56.20	26.30	26.20	35.00	38.80
High Cost of Inputs	35.00	37.50	27.50	56.30	31.20	12.50
Low Output Price	40.00	48.80	11.20	57.50	20.00	22.50

Source: Field Survey Data

Among the constraints faced by farmers in the cultivation of paddy crop, low output price was reported as the most important constraint faced by 57.50 percent of the sample farmer in Villupuram, followed by 40 percent of the households in Tiruvarur. The high cost of inputs was the next important constraint faced by the sample farmer households. In Villupuram district, 56.3 percent of sample farmers reported high cost of inputs as the most important constraint whereas, the percentage was 35 percent for Tiruvarur sample households. Water deficiency was cited as most important constraint by 32.5 percent of Tiruvarur sample households and the figure for Villupuram was 13.8 percent. This shows farmers of Villupuram district face more water problems than the farmers of Tiruvarur district.

In Tiruvarur, the poor quality of seeds was reported as an important constraint faced by 73.80 percent of sample households and followed by pests and disease attack was cited as most important cause of 56.20 percent of the households; 48.80 percent of the sample farmers expressed low output price as the next important constraint. In Villupuram district, 60 percent of the sample households informed that water problem was an important constraint for cultivation of various crops. A majority of the farmers in Villupuram district depends on ground water only. The second important constraint faced by the sample farmers (52.50 percent) in Villupuram district was poor quality of seeds. Then 35 percent of the sample households informed that pests and diseases problem is an important problem faced by them.

Only 31.2 percent of households considered water deficiency as a constraint and only 28 percent in Tiruvarur district felt that high cost of inputs as a constraint. Generally farmers faced the problem of low quality of seeds distributed by different agencies there is no proper solution to control pests and diseases. Due to MNREGA scheme, the labour shortage becomes acute during summer season, water from Mettur dam does not come in the right time and available water source is inadequate for the crops to grow. During this season number of bacterial pests and diseases increases and their attacks on growing crops is also increases. The farmers followed the advices of agricultural officers to deal with the problem of pest control, if could not be controlled, then totally vanished by pesticides.

4.3 Estimation of Incidence of Pests and Diseases Attack and Crop Losses

Paddy pests are any organisms or microbes with the potential to reduce the yield or value of the seeds. They include weeds, pathogens, insects, nematode, rodents, and birds. A variety of factors can contribute to pest outbreaks, including the overuse of pesticides, improper irrigation, and high rates of nitrogen fertilizer application. Weather conditions also contribute to pest outbreaks. For example, rice gall midge and army worm outbreaks tend to follow periods of high rainfall early in the wet season, while traps outbreaks are associated with drought. It is rather difficult to identify the pests in time. Unless the farmers have some knowledge of the pests, it will be difficult for the farmers to identify the problem.

Table 4.2 Identification of Pests and Disease Attack (Percent of Households)

Particulars		**Tiruvarur**	**Villupuram**
HH able to distinguish Pests and Disease Attack		100.00	100.00
Assessment about the Severity of the Attack	Quantitative Assessment	17.5	11.2
	Qualitative Assessment	61.3	70.0
	Both	21.2	18.8

Source: Field Survey Data

The percentage of selected households that identified pests and diseases attack in the sample districts of Tamil Nadu is presented in Table 4.2. The data reveals that, all those sample households in both the districts are capable of identifying the pests and diseases attack. But only 17.5 percent of sample farmers of Tiruvarur district and 11.2 percent of Villupuram district sample farmers could make quantitative assessment about the attack of the diseases. On the other

hand, 61.3 percent of the farmers as sample in Tiruvarur district and 70 percent of the farmers in Villupuram district could make qualitative assessment of the severity of the attack. Most of the pests and diseases more frequently attacked Tiruvarur district as farmers owning to continuous use of land for cultivation in a year. This is the main reason for the attack of pests and diseases in the paddy crop in the Tiruvarur district.

Table 4.3 Incidence of Major Pests and Diseases (Percent of Households) in Tiruvarur District

Name of the Pests	Rank Severity			Frequency of Attack			Production Loss		
	Very Important	Important	Not Important	Every Season	Once in two seasons	Once in 3 seasons	Below 5%	5-10 %	10-25%
Major Pests									
Rice Stem Borer	68.80	11.20	20.00	67.50	18.80	13.80	75.00	21.2	3.80
Leaf Folder	25.00	46.20	28.80	73.80	16.20	10.00	77.50	7.50	15.00
Plant Hoppers	42.50	37.50	20.00	75.00	17.50	7.50	67.50	17.5	15.00
Others	15.00	6.20	78.80	76.20	13.80	10.00	68.80	16.2	11.20
Major Diseases									
Bacterial Leaf Blight	22.50	55.00	22.50	37.50	51.20	11.30	87.80	8.80	3.80
Sheath Blight	35.00	55.00	10.00	43.80	51.20	5.00	85.00	7.50	7.50
False Mut	6.20	66.30	27.50	18.80	47.50	33.80	70.00	27.5	2.50

Source: Field Survey Data

The opinion of the sample households in Tiruvarur district with regard to the incidence of major pests and diseases and their impact on production is given in Table 4.3. While ranking severity of the pests nearly 69 percent of the respondents ranked the severity of Rice Stem Borer pest as very important; 42.5 percent of respondents ranked the severity of Plant Hoppers as very important. But the severity of Leaf Folder and Others was ranked very important by only 25 percent and 15 percent of respondents. They ranked the severity of Plant Hoppers as important but not very important. The Others category was ranked unimportant by a majority of respondents (78.8 percent).

A large majority of the respondents expressed the view that the major pests attacked the crops every season. And more than 90 percent of the respondents put the production loss at meager 5 percent on account of the pests. In the case of Rice Stem Borer alone, 84 percent of the respondents put the production loss at 5 percent.

A majority of the respondents (55 percent and above) ranked the severity of the diseases- Bacterial Leaf Blight, Sheath Blight and False Mut as important but not very important. A majority of the respondents (nearly 50 percent) expressed the view that the frequency of the attack of the diseases was once in two years. A large majority of them (more than 86 percent) put the production loss at 5 percent.

Table 4.4 Incidence of Major Pests and Diseases (Percent of Households) Villupuram District

Name of Pests	Rank Severity			Frequency of Attack			Production Loss		
	Very Important	Impor tant	Not Important	Every Season	Once in two seasons	Once in three seasons	Below 5%	5-10 %	10-25%
Major Pests									
Rice Stem Borer	22.5	61.2	16.2	55	37.5	7.5	83.8	8.8	7.5
Leaf Folder	16.2	55	28.8	78.8	17.5	3.8	90	10	0
Plant Hoppers	33.7	48.8	17.5	58.8	28.7	12.5	93.8	6.2	0
Others	43.8	52.5	3.7	74.5	15.5	10	91.2	8.8	0
Major Diseases									
Bacterial Leaf Blight	37.5	51.2	11.3	1.2	10	88.8	86.3	12.5	1.2
Sheath Blight	28.8	42.5	28.7	35	41.2	23.8	88.8	11.2	0
False Mute	23.8	41.2	35	20	42.5	37.5	96.2	3.8	0

Source: Field Survey

Table 4.4 gives the views of the sample respondents in Villupuram district with regard to the incidence of major pests and diseases and their impact on production. While ranking the severity of the pests, 61 percent of the respondents ranked the severity of the Rice Stem Borer as important. The percentage of households which considered the severity of rank for Leaf Folder, Plant Hopper and 'others' as 'important' are 55 percent, 49 percent and 53 percent respectively. A large majority of the respondents expressed their views that major pests attacked the crops every season. Nearly 90 percent of them put the production loss below 5 percent.

A large proportion of respondents (51 percent in the case of Bacterial Leaf Blight, 42 percent in the case of Sheath Blight and 41 percent in the case of False Mute) ranked the severity of the plant diseases as important. When giving their opinion about the frequency of attack of the diseases, 89 percent of the respondents gave the frequency of attack for Bacterial Leaf Blight as once in three seasons. But 41 percent and 43 percent of respondents expressed the opinion that

Sheath Blight and False Mut attacked the crops once in two seasons. And there was near unanimity among a great majority of respondents (86 percent to 96 percent) that production loss owning to these diseases was below 5 percent.

A comparative study of the incidence of the major pests and diseases in Tiruvarur and Villupuram districts shows that the intensity of the attack by pests seems to be greater in the former district. But both districts seem to suffer from major plant diseases almost in equal measurement of course, with differences in frequency of attack.

Table 4.5: The Magnitude of Crop Loss due to Pests, Diseases and Weed Infestation- Tiruvarur

Description	Marginal	Small	Medium	Large	Overall
Actual Production with Attack (Quintal/Acre)	20.06	25.09	21.78	22.07	23.43
Normal Production without Attack (Quintal/Acre)	22.88	28.12	24.92	25.49	25.35
Loss of Output (Quintal/Acre)	2.82	3.03	3.14	3.42	1.92
Percentage of Loss over Actual Production	14.06	12.08	14.42	15.50	8.21
Percentage of Loss over Normal Production	12.33	10.78	12.60	13.42	7.58

Source: Field Survey Data

The scale of crop loss due to pests and diseases and weed infection in paddy crop for Tiruvarur district of Tamil Nadu is given in Table 4.5. The table gives details of normal production and actual production and loss of output due to various diseases in that district. We find from Table 4.5 that loss of output (quintal/acre) among same households in Tiruvarur district, 92 percent for all the farmers (marginal, small, medium and large) as a whole. But large farmers suffered heavier loss with 3.42 quintal per acre. When we look at the percentage of loss from the attack of pests, plant diseases and weed infestations in actual production. We find that it varies from 14 percent, 12 percent, 14 percent and 16 percent for marginal, small, medium and large farmers respectively. We may note that these figures are at variance with the perception of the farmers who felt that the percent of production loss was below 5 percent (see table 4.4), of course weed infestations not in the Table 4.5.

Table 4.6: The Magnitude of Crop Loss due to Pests, Diseases and Weed Infestation- Villupuram

Description	Marginal	Small	Medium	Large	Overall
Actual Production with Attack (Quintal/Acre)	19.21	19.28	23.63	21.34	21.68
Normal Production without Attack (Quintal/Acre)	21.70	21.05	26.36	24.27	23.35
Loss of Output (Quintal/Acre)	2.49	1.77	2.73	2.93	2.48
Percentage of Loss over Actual Production	12.96	9.18	11.55	13.73	11.44
Percentage of Loss over Normal Production	11.47	8.41	10.36	12.07	10.62

Source: Field Survey Data

Table 4.6 gives details of the magnitude of crop loss due to pests, diseases and weed infestations. We find from the table that the loss of output (quintal per acre) among sample households in Villupuram district is 2.48 quintal per acre for all the farmers (marginal, small, medium and large) as a whole. But large farmers suffered heavy loss at 2.93 quintal/acre. When we look at the percentage of loss from the attack of pests, diseases and weed infestations, in actual production. We find that it varies from 13 percent, 9 percent, 12 percent and 14 percent for marginal, small, medium and large farmers respectively. We may note that these figures are at variance with the perception of the respondents who put the percentage of production loss at 5 percent (table 4.4), of course, weed infestations are included in the table 4.6.

4.4 Methods adopted by the Sample Farmers for the Control of Pests and Diseases

Various chemical methods are adopted in order to control pests and diseases for growing crops. Table 4.7 gives details of total cost of chemical methods adopted for pest and disease control per acre in Tiruvarur district. The majority of the farmers with different farm sizes applied only one spray per acre in order to control the pests and the diseases in paddy crop. The total cost of weedicide (cost of chemicals and labour lost) varied between Rs.303.53 to Rs.344.62 per acre for different farm sizes. The cost per acre was the lowest for large farmers (Rs.303), whereas the medium size farmers incurred the highest cost of Rs.345. On the average, the farmers sprayed the chemical only once per acre, total cost per acre (chemical and labor cost) in the case of insecticides Rs.317.04 for marginal farmers, whereas for the large farmers cost per acre during season was highest of Rs.395. The average cost incurred by respondents with different farm sizes to control the insecticide in Tiruvarur district is Rs.346 per acre.

Table 4.7 Cost of Chemical Methods adopted for Pests and Disease Control (Rs. /Acre) Tiruvarur

Description	Marginal	Small	Medium	Large	Overall
% HH adopted control measures	100.00	100.00	100.00	100.00	100.00
Weedicide					
No. of Sprays/Acre	0.85	1.15	0.92	0.70	0.91
Cost of Chemicals	251.85	233.50	260.77	218.03	241.04
Labour Cost	72.59	89.50	83.85	85.50	82.86
Total Cost	324.44	323.00	344.62	303.53	323.90
Insecticide					
No. of Sprays/Acre	1.00	0.95	1.08	1.10	1.03
Cost of Chemicals	228.89	238.50	253.08	298.50	254.74
Labour Cost	88.15	89.50	90.00	96.50	91.04
Total Cost	317.04	328.00	343.08	395.00	345.78
Fungicide					
No. of Sprays/Acre	1.11	1.15	0.92	1.15	1.08
Cost of Chemicals	238.89	240.50	217.69	232.00	232.27
Labour Cost	95.19	97.00	83.08	94.00	92.32
Total Cost	334.08	337.50	300.77	326.00	324.59

Source: Field Survey Data

The fungicides were sprayed roughly only once per acre by all the farmers. The total cost (cost of chemical and labour cost) was the highest for small farmers Rs.338 and the lowest for medium farmers Rs. 301.

The table indicates that weedicides, insecticides and fungicides were used regularly by all the sample farmers. The cost varied from one seasons to another and farm to farm size, because, the price of chemical varied from one seasons to another and from area to another area. The private agents have been selling chemical products with huge margin. The labour cost also varied from one area to another.

Table 4.8 gives details of the cost of chemical methods adopted for pest and disease control in Villupuram district. The table reveals that almost all the sample farmers with different farm sizes used weedicides, insecticides and fungicides to control pests and diseases in paddy cultivation. Table 4.8 reveals that the number of sprays applied per acre varied for different pesticides and also for different farm sizes. We find from the table that the total cost (cost of chemicals and labour cost) for weedicides varied according to the size of the farm. The average

cost for all the farms was Rs.299. But it was the lowest of Rs.257 per acre for the medium and the highest of Rs. 373 per acre for large farm.

In the case of insecticides, the total cost was the lowest (Rs. 422 per acre) for the small farm, whereas it was the highest (Rs.484 per acre) for the large farm. In the case of fungicides, the total cost was more or less the same for farms of all sizes. It was in the immediate neighborhood of the average cost (Rs. 362 per acre). In short, the table reveals that large farmers spent more on weedicide and insecticides.

Table 4.8 Cost of Chemical Methods adopted for Pests and Diseases Control (Rs/Acre) Villupuram District

Description	Marginal	Small	Medium	Large	Overall
% HH adopted control measures	100.00	100.00	100.00	100.00	100.00
Weedicide					
No. of Sprays/Acre	0.16	0.32	0.57	1.00	0.51
Cost of Chemicals	223.07	192.00	177.86	292.00	221.23
Labour Cost	73.08	75.60	79.29	81.33	77.33
Total Cost	296.15	267.60	257.15	373.33	298.56
Insecticide					
No. of Sprays/Acre	1.70	1.64	1.65	1.68	1.67
Cost of Chemicals	366.69	342.72	374.86	394.67	369.74
Labour Cost	74.39	78.80	83.29	89.53	81.50
Total Cost	441.08	421.52	458.15	484.20	451.24
Fungicide					
No. of Sprays/Acre	1.15	1.64	1.15	1.13	1.27
Cost of Chemicals	273.46	281.60	291.43	287.00	283.37
Labour Cost	85.77	80.12	76.07	73.00	78.74
Total Cost	359.23	361.72	367.50	360.00	362.11

Source: Field Survey Data

4.5 Biological Methods Adopted for Pests and Disease Control

All sample households in paddy crop producing districts of Tiruvarur and Villupuram did not use biological methods. According to the Agriculture Officer of Tiruvarur district, only a small percentage of farmers used the biological methods for controlling the pests and diseases in the paddy crop (They are not part of sample households, they are outside the sample). Specifically, Agricultural Scientist Nammalvar has done a lot of propaganda about the usefulness

of the biological methods in paddy crop for the control of the pests and diseases. He has focused not only on paddy, almost on all the crops. He expressed the views to use the biological methods in agriculture for promoting environment safeguards. In Villupuram district, all the sample farmers adopted chemical methods alone for controlling the pests and diseases.

4.6 Sources of Information for Pests and Diseases Control by Sample Farmers

Table 4.9 gives details of the sources of information for pests and disease control management in Tiruvarur and Villupuram districts. Various agencies have given advices to control the pests and diseases in the paddy crop. Specifically, Government agents, private agents, fellow farmers, news papers and agricultural universities have given advice to the farmers for pest control management. The Government of Tamil Nadu has popularized the best practices of pest management in the state since 1990s. Recently, Agriculture Minister, Government of Tamil Nadu (15. 08. 2013) visited China for observing high value of production in paddy and control measures of various pests and diseases.

Table 4.9 gives details of the opinion of the households in the sample about the relative importance of various agencies in providing extension services to control pests and diseases in Tiruvarur and Villupuram districts. While 66 percent of Tiruvarur district households regarded the services provided by the Government extension agent, as the most important, only 19 percent of the households in Villupuram district considered the services provided by Government extension agent as most important. The poor utilization of the services of Government agency in Villupuram district is a matter of concern and needs further study in depth. But 59 percent of Villupuram district households were considered the services of private input dealers as most important, where the figure for the above services for Tiruvarur district households is only 15 percent. The high percentage in Villupuram district, in a way, may be attributed to the easy availability of agricultural inputs on credit from private dealers. About 45 percent of sample households in Tiruvarur district considered the services of fellow farmers as most important. But only 9 percent of sample households considered the services of fellow farmers as most important. Of course, 68 percent of households in Villupuram district regarded the services of fellow farmers as important. It is also possible that difference as percentages on this score are a matter of semantics. A large majority of the households in both the districts were of the opinion that the services provided by TV/Radio/News papers, Agricultural University/KVK were of least

important. Agricultural University may intensify its efforts to propagate the new techniques of production and innovative agricultural practices.

Table 4.9 Extension Service on Pests and Diseases Control Management (Percent of HH)

Rank of Sources	Tiruvarur			Villupuram		
	Most Important	Important	Least Important	Most Important	Important	Least Important
Government Extension Agent	66.2	18.8	15	18.8	37.5	43.7
Private Input Dealer	15	2.5	82.5	58.8	30	10.2
Fellow Farmers	45	18.8	36.2	8.7	67.5	23.8
TV/Radio /News Paper	6.2	11.3	82.5	12.5	32.5	55
Agricultural University / KVK	15	13.8	71.2	2.5	15	82.5

Source: Field Survey Data

4.7 Household Suggestion to Reduce the Pre-Harvest Losses

Both regions of sample households have given the following suggestions relating to pre-harvest losses to the farmers.

- Government may give advice from beginning of the paddy crop cultivation till the harvesting stage. It should play the role of a caretaker at every stage of paddy production.
- Government should create awareness among the farmers about the pests, diseases and weeds. The agent should be given advice about how to control pests, diseases and weeds.
- At present, chemicals used in the control of pests and diseases and weeds are not effective in many cases. Government should give advice to the firms manufacturing chemicals relating to the quality of that product.
- Government/Private agencies should arrange special camps relating to pre-harvest losses in every village of paddy growing region and the farmers should be given advice as how to control the pre-harvest losses in that season.
- Government should provide better quality seeds, fertilizers and chemicals in time. Otherwise, the farmers will suffer. Most of the time, the government selling centres are closed without any reasons. With the result that farmers are forced to purchase pesticide etc. from private dealers travelling long distance.

- Government should open the agro-centre in at least every panchayat village. Otherwise, farmers will be put to unnecessary hardship for reasons of time and distance and they have to incur sizeable transport costs for purchase of agricultural inputs like seeds and chemical fertilizers.
- Government should give training to the farmers for controlling the pre-harvesting losses caused by pests and diseases and weed infection in the farm field.

4.8 Summary

This chapter discusses about the pre-harvest losses of paddy crop in Tamil Nadu. Farmers face number of constraints during the cultivation of paddy. In that, Low output price was the most important constraint faced by 57.50 percent sample farmers in Villupuram, and 40 percent in Tiruvarur district. Simarly, High cost of inputs was also the most important constraint faced by 56.3 percent sample farmers in Villupuram and 35 percent of sample farmers in Tiruvarur. Finally, Water deficiency was also cited as most important constraint by 32.5 percent sample farmers in Tiruvarur and 13.8 percent sample farmers in Villupuram.

The quantitative assessments about the attack of the diseases were identified by 17.5 percent and 11.2 percent of sample farmers in Tiruvarur and Villupuram districts. The qualitative assessments of the attack were identified by 61.3 percent and 70 percent of sample farmers in Tiruvarur and Villupuram districts. Most of the pests and diseases more frequently attacked, Tiruvarur farmers than Villupuram farmers owning to their continuous use of land for cultivation in a year. Rice Stem Borer, Plant Hoppers and Leaf Folder ranked as very important diseases with the production loss of 5 percent level in both the districts of Tiruvarur and Villupuram districts. Other diseases like false mute, bacterial leaf blight and sheath blight is also seemed to be important loss making diseases. A comparative study of the incidence of the major pests and diseases in Tiruvarur and Villupuram districts shows that the intensity of the attack by pests seems to be greater in the former district. But both districts seem to suffer from major plant diseases almost in equal measurement of course, with differences in frequency of attack.

The overall loss of output per acre is about 1.92 quintals and 2.48 quintals for all the farms in Tiruvarur and Villupuram districts, whereas, heavier loss suffered by large farms is about 3.42 quintals and 2.93 quintals in Tiruvarur and Villupuram districts.

The chemical cost (Weedicide) per acre was the lowest of Rs.303 for large farmers and highest cost of Rs.345 for medium size farmers (sprayed only once) and lowest of Rs. 257 for medium and highest of Rs. 373 for large farm in Tiruvarur and Villupuram districts respectively. Similarly, the total cost per acre for insecticides was lowest of Rs.317.04 for marginal farmers, highest cost of Rs. 395 for the large farmers and lowest of Rs. 422 for small farmers and highest of Rs. 484 for the large farmers in Tiruvarur and Villupuram districts.

Government services to the farmers are very important in the cultivation of crops. About 66 percent and 19 percent of sample farmers was reported the services provided by the Government extension agent, as the most important in Tiruvarur district and Villupuram districts. But 59 percent and 15 percent is considering the services of private input dealers as most important in Villupuram and Tiruvarur districts. This huge difference implied that the poor utilization of the services of Government agency in Villupuram district is a matter of serious concern and needs further study in depth. The high percentage in Villupuram district, in a way, may be attributed to the easy availability of agricultural inputs on credit from private dealers.

Advice from the fellow farmers on pest control were said to be most important by 45 percent and 67.5 percent by Tiruvarur and Villupuram districts. The majority of the households from both the districts were of the opinion that the services provided by TV/Radio/News papers, Agricultural University/KVK were of least important.

CHAPTER V

ESTIMATION OF POST-HARVEST LOSSES OF PADDY CROP IN TAMIL NADU

5.1 Introduction

Post-production operations vary from one region to another. Even though, operations vary from small landholdings to large farming activities, the post-harvest operations are dissimilar in developed and developing countries. Post-harvest operations such as threshing, cleaning, winnowing, drying, storage, packing and transportation and marketing are different processes in the agriculture, particularly in paddy crop. In addition to harvesting losses, threshing and winnowing loss, transportation and storage losses are there. Households' suggestions relating to the post-harvest losses are also dealt in this chapter.

FAO (2011) examined fruits and vegetables category roots and tubers category and found that lead in proportion of losses globally with 20-30 percent lost across most regions in world. Even in developed regions, losses are as high as 28 percent for roots and tubers. Latin America registered the highest loss of 28 percent in fruits, followed by North America and Central Asia (25 percent), Europe (24 percent), America South East Asia (23 percent) and Sub- Saharan Africa (18 percent) and Asia (17 percent). The loss is very high in the case of oil seeds and pulses. North America and Central Asia registered highest loss of 20 percent in oil seeds, followed by Sub Saharan Africa (19 percent), South East Asia (18 percent), America (12 percent) and Asia (11 percent). In the case of cereals, the highest loss in foodgrains is registered by North America and Central Asia and Sub Saharan Africa at 14 percent, followed by South East Asia (13 percent), Asia (12 percent) and Latin America (10 percent). The study reveals that the North America and Central Asia regions with highest post-harvest losses in cereals, fruits and vegetables and oil seeds. South East Asia registered second highest loss in the world is in food items. On other hand, food items lowest level of loss registered in Asia.

Post-harvest losses are both quantitative and qualitative and they are the result of spillage, inefficient retrieval, inefficient processing, inadequate machinery, poor operator skills, biological deterioration, and infestation by storage pests.

The traditional technologies could not cope with the increased volume of the harvest and handling the wet season crop has been a new experience. The field losses are usually actual

physical grain loss, measurements of grain that shattered or spilled. Storage losses may be based on samples where levels of pest infestation are measured. Drying and milling losses are usually derived loss estimates, or compared with control samples processed in the laboratory.

In general, manual harvesting has lower loss levels than mechanized one. However, if manual harvesting is delayed due to a lack of labour, then losses will be incurred due to shaking of overripe grain. Threshing by trampling or beating does not cause losses. However, as farm labour becomes scarce, reaping and threshing machines, or combines are used. There is a trade-off between the need to mechanize and the higher level of losses with machines. The inability of farmers to harvest, thresh, and dry grain has been the primary cause of huge field losses. The production losses not only affect the individual farmer, but are also the economy as whole.

Economic loss results not only due to deterioration in the quantity and quality of the grain but is also influenced by some factors within the post-harvest system. It can hamper the growth of production and income. The adaptation of mechanical system (harvesting, threshing, and drying) can cut working time, while at the same time, permitting an increase in production by reducing labour required and exploiting the land to better advantage. Commercially, if the transport system is inadequate, the farmer may find it impossible to sell the produce within the required time-limit and in the places where market prices are the most attractive. The fact of having to forgo a potential profit is loss of money to the farmer. If a farmer is not able to store the produce in complete security with the available storage facilities, the produce need to be sold immediately after the harvest, thus making farmer unable to earn profit through selling the produce at maximum market price. Once again, missing a profit is an economic loss to the farmer. The sequences of such situation often go beyond individual's loss. This affects the production and economy of the entire nation.

5.2 Production Loss during Harvest Season

Basically, during the harvest season, farmers have been adopting two methods such as manual and mechanical harvesting in the paddy crop. In Asia, the majority of the farmers have used manual method. But in the current situation, the mechanical harvesting is unavoidable, because most of the agricultural labours migrated to urban areas, and government schemes such as MNREGS. Due to shortage of labour force in the agriculture, the farmers are forced to use the machines during harvest season.

During harvest, nearly one-third of edible items food produced for human consumption is wasted and this is about $1.3 billion loss per year globally. Food grains are wasted throughout from production to final consumption stage. In high and medium income countries in the world, food is to a great extent not wasted, it is thrownaway. In low income countries, food is mainly lost during early and middle stage of harvesting time.

Table 5.1 gives details of quantity lost at different stages of harvest for paddy crop in Tiruvarur district. Harvesting is done at early, middle and late seasons. The average area harvested by a household during the mid-season is 3.19 acres. The corresponding figures for early and late seasons are 1.65 acres and 2.43 acres. The percentage of area harvested during the mid-season is the highest (42.3 percent) comparison with 35.89 percent and 21.79 percent for late and early seasons respectively. The percentage of area manually harvested is not more than 9 percent in any season but more than 90 percent of the area is mechanically harvested. The scarcity and high cost of labour are the probable reasons for a large majority of the farmers opting for mechanization of agricultural operations, especially during harvest season. Harvest loss is reported a medium of 71 percent and 73 percent for early and late periods respectively. The loss was reported as low by 74 percent of households owning the mid-season.

Table 5.1 Quantity Lost at Different Stages of Harvest for Paddy Crop in Tiruvarur District

Stages of Harvest and Variety	**Early**		**Mid**		**Late**	
	Local	**HYV**	**Local**	**HYV**	**Local**	**HYV**
Area Harvested per HH (Acres)	-	1.65	-	3.19	-	2.43
Area Harvested (Percent)	-	21.79	-	42.3	-	35.89
Area Manually Harvested (Percent)	-	8.82	-	7.28	-	4.29
Area Mechanically Harvested (Percent)	-	91.18	-	92.72	-	95.71
Ranking Loss- High	-	5.88	-	9.09	-	1.79
Medium	-	70.6	-	16.67	-	73.21
Low	-	23.52	-	74.24	-	25.0
Quantity Lost during Harvest						
Kg. per Acre of Harvest	-	92.32	-	51.2	-	87.63
Kg. per Quintal of Harvest	-	3.87	-	2.21	-	3.68
Loss percent of Harvest Amount	-	3.87	-	2.21	-	3.68

Source: Field Survey Data

The quantity lost during harvest in terms of Kilos per Acre of harvest was the highest during early harvest (92.32 Kg per acre) and the loss was 87.63 Kg per acre during late season. But it was only 51 Kg per acre during mid-season. The percentage loss of harvest for early, mid and late seasons were 3.87 Kg per quintal, 2.21 Kg per quintal, and 3.68 Kg per quintal respectively, incur heavier loss (92 Kg per acre harvest loss).

Table 5.2 gives details of quantity lost at different stages of harvest for paddy crop in Villupuram district. The average area harvested by a household during mid-season is the largest at 3.14 acres. The correspondence figures for early and late seasons are 0.15 acres and 1.15 acres respectively. The percentage of area harvested during the mid-season is the highest (60 percent) in comparison with 35.20 percent and 4.80 percent for late and early seasons respectively. The crop in almost the entire area is mechanically harvested owing to very limited supply of labour because of the preference of the landless agricultural labour for national employment guarantee schemes like MNREGS. High cost of human labour is another reason.

Harvest loss is reported as medium by 83 percent of households during early season. The corresponding figures for mid and late seasons are 35 percent and 68 percent respectively. The loss was ranked low by 58 percent of households during mid-season. The corresponding figures for early and late seasons are 17 percent and 11 percent. Only 20 percent of households and 7 percent of households ranked the loss as high during medium and late seasons. The households reported nil loss during early season.

The quantity lost during harvest in terms of kilo per acre of harvest was the highest during the late season (88.48 Kg per acre). And it was 72 Kg per acre and 68 Kg per acre during early and mid seasons. The percentage loss of harvest for early, mid and late seasons was 2.96 Kg per quintal, 2.86 Kg per quintal and 3.60 Kg per quintal respectively.

A comparative study of table 5.1 and 5.2 reveals that the sample households in Tiruvarur district incur heavier loss (92 Kg per acre) than the sample households in Villupuram district (72 Kg per acre) during the early harvest season. And the average harvested area per household is larger in size in Tiruvarur than in Villupuram all the harvesting seasons. It is also observed that a majority of sample households (60 percent) in Villpuram district harvest the paddy during the mid seasons than the sample households (42 percent) in Tiruvarur district during the corresponding season.

Table 5.2 Quantity Lost at Different Stages of Harvest for Paddy Crop in Villupuram District

Stages of Harvest and Variety	Early		Mid		Late	
	Local	HYV	Local	HYV	Local	HYV
Area Harvested per HH (Acres)	-	0.15	-	3.14	-	1.15
Percentage Area Harvested	-	4.80	-	60.00	-	35.20
Area Manually Harvested (Percent)	-	0	-	1.33	-	0
Area Mechanically Harvested (Percent)	-	100.00	-	98.67	-	100
Ranking Loss- High	-	0	-	7. 00	-	20.45
Medium	-	83.33	-	35.00	-	68.19
Low	-	16.67	-	58.00	-	11.36
Quantity Lost during Harvest						
Kg per Acre of Harvest	-	71.75	-	67.79	-	89.3
Kg per Quintal of Harvest	-	2.96	-	2.87	-	3.60
Loss percent of Harvest Amount	-	2.96	-	2.87	-	3.60

Source: Field Survey Data

5.3 Production Loss during Threshing and Winnowing Stages

Threshing and winnowing are important processes in the farm activities. Threshing is a kind of operation separating the grains from the plants. The above operations may be carried out in the field or on the threshing floor, by land or with the help of animals or machines. Whatever the system used, it is very important that threshing be done with care; otherwise, these operations can cause breakage of the grains or produce husks, thus reducing the quality of the product and subsequent losses from the action of insects and moulds.

The threshing and separation of grains from the crop is done in a variety of ways. Threshing through harvesting machine is a quick process. The details of paddy quantity lost during threshing and winnowing activities in Tiruvarur and Villupuram districts are given in Table 5.3. 67 percent of the sample households in Tiruvarur district make use of the threshing machine, whereas, in Villupuram district only 53 percent of the sample households make use of threshing machine. That shows farmers in the sample households in Tiruvarur make use of machines for threshing than their counter parts on Villupuram district. The average quantity lost during threshing activities by sample farmers in Tiruvarur is 2.11 Kg per quintal in Tiruvarur district but the loss in threshing in Villupuram district (0.83 Kg per quintal). 80 percent of

sample farmers in Tiruvarur rank the loss as low because they make larger use of threshing activities.

Table 5.3 Quantity Lost during Threshing and Winnowing

Stages of Harvest and Variety	Tiruvarur		Villupuram	
	Local	HYV	Local	HYV
Area/ Quantity Mechanically Threshed % of HH	-	67	-	53
Ranking Loss	-	-	-	-
High	-	8	-	3
Medium	-	12	-	20
Low	-	80	-	77
Quantity Lost during Threshing	-	-	-	-
Average Loss (KG per Acre)	-	-	-	-
Average Loss (KG per Quintal)	-	2.11	-	0.83
Loss Percent of Threshed amount	-	-	-	-
Area/Quantity Manually Winnowed (Percent)	-	-	-	-
Ranking Loss	-	-	-	-
High	-	8.0	-	-
Medium	-	24.0	-	-
Low	-	68.0	-	-
Quantity Lost during Winnowing	-	-	-	-
Average Loss (Kg per Acre)	-	-	-	-
Average Loss (Kg per Quintal)	-	0.18	-	-
Loss Percent of Winnowed amount	-	-	-	-

Source: Field Survey Data

The average quantity lost during winnowing activities by sample farmers in Tiruvarur district is 0.18 Kg per acre. The advantage of mechanized threshing of paddy crop keeps the production loss at a minimum level when compared to manual threshing in the farm. 68 percent of sample households ranked the loss as low, followed by 24 percent of farmers who ranked the loss as medium and 8 percent of farmers ranked the loss as low during the winnowing process.

Almost all the sample farmers in Villpuram were not engaged in winnowing activities during the harvesting season. The majority of the sample households in Villupuram sell their produce within a week as they are in dire need of money.

5.4 Production Loss during Transportation and Handling Stages

Labour intensive system of grain movement serves to minimize capital investment in countries where cost of labour is low. Most of the paddy is manually loaded and unloaded from

trucks, tractors between farming field and marketing place. The greater the grain losses, the higher the cost burden to the farmers. The transportation of the foodgrains to primary markets by the farmers is also done in bulks using tractors, trolleys or lorries.

Table 5.4 Quantity Lost during Transportation and Handling - Tiruvarur District

Mode of Transportation	Head Load	Bullock Cart	Trolley	Tempo	Others	Total
Average Quantity Transported (Quintals per HH)	-	-	-	125.68	-	125.6
Average Distance Covered (KMS)	-	-	-	2.58	-	2.58
Transportation Cost (Rs. per Quintal)	-	-	-	9.86	-	9.86
Ranking of Loss (Percent of HH)	-	-	-	0.00	-	0
High	-	-	-	12.50	-	12.50
Medium	-	-	-	15.00	-	15.00
Low	-	-	-	55.00	-	55.00
Quantity Lost during Transport	-	-	-	0.00	-	0
Average Loss (Kg per Quintals transported)	-	-	-	0.56	-	0.56
Percent of amount transported	-	-	-	-	-	-
Quantity Lost during Handling	-	-	-	-	-	-
Average Loss (Kg per Quintals Handled)	-	-	-	-	-	-
Percent of amount Handled	-	-	-	-	-	-

Source: Field Survey Data

Table 5.4 gives details of quantity lost during transportation and handling in Tiruvarur district. Most of the government purchases centres are within 5 Kms in the district during the three harvesting seasons. A majority of the sample households used lorries and tempo as mode of transportation for paddy crop. The average quantity transported to marketing place was 125.6 quintals per households, whereas, the average distance covered from farming filed to marketing place was about 2.58 Kms and the transportation cost was Rs. 9.86 per quintal.

A majority of sample households (55 percent) in Tiruvarur district reported low level of loss during transportation of paddy. The average loss during transportation incurred by the sample farmers was 0.56 kilogram per quintal. The transportation losses for the sample farmers are negligible. The majority of the farmers make use of pucca plastic bags during transportation

of agricultural commodities. Therefore, the losses are reduced during transportation of commodities to market place.

Table 5.5 Quantity Lost during Transportation and Handling - Villupuram District

Mode of Transportation	Head Load	Bullock Cart	Trolley	Tempo	others	Total
Average Quantity Transported (Quintals per HH)	-	-	-	132.03	-	132.03
Average Distance Covered (Kms)	-	-	-	19.06	-	19.06
Transportation Cost (Rs. per Quintal)	-	-	-	14.64	-	14.64
Rank of Loss (Percent of HH)	-	-	-	-	-	-
High	-	-	-	2.50	-	2.50
Medium	-	-	-	30.00	-	30.00
Low	-	-	-	67.50	-	67.50
Quantity Lost during Transport	-	-	-	0.00	-	0.00
Average Loss (Kg per Quintals transported)	-	-	-	0.65	-	0.65
% of amount transported	-	-	-	-	-	-
Quantity Lost during Handling	-	-	-	-	-	-
Average Loss (Kg per Quintals Handled)	-	-	-	-	-	-
Percent of amount Handled	-	-	-	-	-	-

Source: Field Survey Data

Table 5.5 shows the quantity lost during transportation and handling in Villupuram district. The majority of the sample households in Villupuram make use of tractors, tempos and lorries as mode of transportation carrying the agricultural commodities to market. The average quantity of paddy transported to market place for sale is 132.03 quintals per household. The average distance covered from farm field to market place by the sample farmers is 19.06 Kms. In Villupuram district, there are only two government procurement centres, Villupuram and Ulundoorpet and they are nearly 20 to 25 Kms from the farmers' location. Therefore, the farmers incur high cost of transportation (Rs. 14.64 per quintal) for carrying the paddy to market place. The loss was ranked as low by 67.5 percent of the sample respondents of the district. The average loss during transportation was to be found that 0.65 kilogram per quintal. The farmer did not incur any loss during handling.

It would be advantages for the farmers to sell their produce to government procurement agencies. But, private commission agents purchase in farming field with transportation. The

sample farmers are forced to sell their commodities to private agencies, after harvest to get immediate cash to settle their dues.

When we compare the two districts of Tiruvarur and Villupuram, we find that the majority of the sample households used the government procurement centre which was within a distance of 5 Kms in Tiruvarur. Therefore, the respondents in Tiruvarur transported their produce easily to the government procurement centres. Most the paddy purchased by the government procurement centre with moderate prices. The transportation charges are Rs.9.86 per quintal in Tiruvarur but in Villupuram, they account for Rs. 14.64 per quintal. But in Villupuram, as only two government procurement centre are there. The farmers had to transport their produce for a long distance with huge transportation costs. Therefore, Government of Tamil Nadu can set up *Government Procurement centres* during the harvesting seasons within a distance of 10 Kms from the farm. This is essential one for the farmers in that area. Otherwise, they have to spend huge amount for transportation.

5.5 Production Loss during Storage Time

The farmers generally store their grains in simple granaries constructed from locally available materials. A majority of the paddy crop is stored in open place in Tiruvarur and Villupuram districts for a short period of a few days because of the non-availability of storage facilities in villages. In reality, the farmers safeguard their produce which then keep for themselves for consumption purposes and seed corn in gunny bags and plastic bags. It is that some paddy is lost to birds, rodents, insects and diseases. In South Asia and other developing countries farmers safeguard 50 to 80 percent of their produce for own consumption, including cattle feed, seed corn.

The details of quantity lost during storage in Tiruvarur and Villupuram districts are given in Table 5.6. The table reveals that the 41 percent of the sample respondents of Tiruvarur store their produce in a pucca house for safeguarding the foodgrains and 32 percent of the sample households use the open place for storage of grains after harvesting. The majority of the sample respondents in Villupuram district use open place (87 percent) as mode of storage for protecting the foodgrains for a short period. The farmer in the sample households in the district had no proper storage facilities as most of them are marginal farmers.

The average amount stored was 0.88 quintal per household in Tiruvarur district, whereas in Villupuram district, the average amount stored was 0.62 quintal per household. The average number of days during which the grain was preserved was 175 days (6 months) per household in Tiruvarur, whereas, it was 10 days per household in Villupuram due to inadequate storage facilities in the district.

Table 5.6 Quantity Lost during Storage

Place of Storage	Tiruvarur				Villupuram			
	Kutcha	Pucca	Godown	Others	Kutcha	Pucca	Godown	Other
Mode of Storage								
Open	-	31.82	-	-	-	87.0	-	-
Plastic Bag	-	27.28	-	-	-	-	-	-
Pucca	-	40.90	-	-	-	13.0	-	-
Steel Drums	-	-	-	-	-	-	-	-
Others	-	-	-	-	-	-	-	-
Amount Stored (Qtls per HH)	-	0.88	-	-	-	0.62	-	-
Percent of HH Who dried before storing	-	-	-	-	-	-	-	-
Average Number of Days (Per HH)	-	175.0	-	-	-	10.00	-	-
Rank of Loss in Storage	-	-	-	-	-	-	-	-
High	-	25.00	-	-	-	-	-	-
Medium	-	50.00	-	-	-	56.00	-	-
Low	-	25.00	-	-	-	44.00	-	-
Quantity Lost during Storage	-	-	-	-	-	-	-	-
Due to Weight Loss(Kg/Qtls)	-	0.24	-	-	-	0.19	-	-
Due to Rodents (Kg/Qtls)	-	0.25	-	-	-	0.21	-	-
Due to Fungus(Kg/Qtls)	-	0.22	-	-	-	0.06	-	-
Storage Cost Rs. per Quintal	-	0.79	-	-	-	0.98	-	-

Source: Field Survey Data

The large sizes of farms in Tiruvarur district helped farmers' storage facilities for preserving their produce. As they had greater staying power, they could avoid post-harvest slump in prices and sell their produce when demand and conditions were favorable to them. Nearly 25 percent of sample households in Tiruvarur district ranked the loss to storage as high, 50 percent

ranked the loss as medium and the remaining 25 percent ranked the loss as low. In the case of sample households in Villupuram district, no one household ranked the loss due to storage as high but 56 percent and 44 percent of sample households ranked the loss as medium and low respectively.

The average quantity lost during paddy storage was 0.24 Kg per quintal due to weight loss in Tiruvarur and 0.25 Kg per quintal due to rodents and 0.22 Kg per quintal due to fungus pretentious during the storage of those commodities by the sample farmers. The corresponding figures were 0.19 Kg per quintal due to weight loss, 0.21 Kg per quintal due to rodents and 0.06 Kg per quintal due to fungus. The higher percentage of loss due to fungus might be because of the long duration (nearly 6 months) of storage. The storage cost per quintal is Rs. 0.79 Kg per quintal in Tiruvarur district, whereas it was 0.98 Kg per quintal in Villupuram district.

5.6 Production Loss during Harvest Seasons

Production loss during harvest season is discussed in Table 5.7 which also shows post-harvest losses of paddy in Tiruvarur and Villupuram districts for different operations at farm level for three crop seasons in Tamil Nadu. The loss of paddy in Villupuram district which occurred during harvesting seasons was 3.36 Kg, 3.19 Kg, 3.14 Kg and 2.94 Kg for marginal, small, medium and large farmers in the sample households respectively. The overall quantity loss of paddy in the Villupuram district was 3.16 Kg per quintal. The loss occurred during harvest was 3.12 Kg per quintal, 3.08 Kg per quintal, 3.14 Kg per quintal and 3.07 Kg per quintal for marginal, small, medium and large size of sample households, respectively in Tiruvarur district. If we look at the quantity lost in harvest by the size of the farm, we find that in sample household with medium size of farms incur the highest loss of 3.14 Kg per quintal in Tiruvarur district, whereas the sample households with marginal farm incur the highest loss (3.36 Kg per quintal). The overall farm level harvest loss in Tiruvarur district was 3.10 Kg per quintal. It is observed on the basis of overall loss in Villupuram sample farmers lost more during harvest seasons than Tiruvarur's sample households.

Next in importance is the quantity lost in post-harvest means the quantity lost in storage. The overall figure for quantity lost in storage is 2.34 Kg per quintal for sample households in Tiruvarur district, whereas the figure is 0.84 Kg per quintal for those in Villupuram district. If we

look at the quantity lost in storage by the size of the farm, we find that those with medium size farm incur the highest loss in storage.

Table 5.7 Total Post-Harvest Losses per Quintal by Farm Size

Particulars	Tiruvarur					Villupuram				
	Marginal	Small	Medium	Large	Overall	Marginal	Small	Medium	Large	Overall
Quantity Lost in Harvest (Kg per Quintals)	3.12	3.08	3.14	3.07	3.10	3.36	3.19	3.14	2.94	3.16
Quantity Lost in Threshing (Kg per Quintals)	1.73	2.57	2.77	1.38	2.11	1.12	1.07	0.66	0.46	0.83
Quantity Lost in Winnowing (Kg per Quintals)	0.15	-	0.46	0.10	0.18	-	-	-	-	-
Quantity Lost in Transport (Kg per Quintals)	0.73	0.56	0.50	0.44	0.56	0.84	0.81	0.54	0.40	0.65
Quantity Lost in Handling (Kg per Quintals)	-	-	-	-	-	-	-	-	-	-
Quantity Lost in Storage (Kg per Quintals)	1.95	1.74	3.37	2.28	2.34	0.95	0.66	1.08	0.65	0.84
Total Post Harvest Loss (Kg per Quintals)	7.68	7.95	10.24	7.27	8.29	6.27	5.73	5.42	4.45	5.47

Source: Field Survey Data

In Tiruvarur district it is 3.37 Kg per quintal and in Villupuram district it is 0.84 Kg per quintal. The highest storage losses in Tiruvarur district may attribute to the long period of storage (average number of days of storage per household is 150), whereas, for sample households in Villupuram district, the corresponding figures is 10 days (see Table 5.6).

The overall quantity lost in threshing is larger for sample households in Tiruvarur district (2.11 Kg per quintal) when compared with the overall threshing losses in Villupuram district (0.83 Kg per quintal). The overall winnowing losses are marginal for Tiruvarur sample households (0.18 Kg per quintal), whereas the corresponding figures is zero for Villupuram sample households. The quantity lost in transport is larger for Villupuram households (0.65 Kg per quintal) than for Tiruvarur households (0.56 Kg per quintal) because the farmer had to

transport their produce for sale over relatively longer distance. It may be noted that there is no loss in handling.

The bottom line is that the sample households in Tiruvarur district incur heavier overall post-harvest losses of 8.29 Kg per quintal whereas the sample households in Villupuram district incur lesser overall loss of 5.47 Kg per quintal.

5.7 Quantitative aspects of Storage and Pest Control Measures by the Farms

A storage facility plays an important role in the agricultural sector. It is really helpful to the farmer during the selling time. The facilities are used not only for preserving the produce for home consumption but also for selling it at a high price in the market. On other hand, the quality of the storage facilities depends on the quality of materials used in the construction of the store house.

This section deals with the awareness among the sample farmers about the availability of storage facilities, maintenance of storage facilities, structure of the storage system, physical conditions of the storehouses, the methods adopted by the farmers for controlling the pests and diseases during the storage time.

Table 5.8 gives details of some quantitative aspects of storage. In Tiruvarur and Villupuram districts, 160 households were surveyed, out of which, only 5 households in Tiruvarur district were having storage facilities with pucca buildings. In Villupuram district only 3 sample households were having pucca storage facilities to preserve their agricultural produce. This implies that the majority of sample households were not interested in storing their produce for a long period as they were in urgent need of money. They stored only the required paddy for consumption purposes at home. It is observed that majority of the sample farmers temporarily stored their paddy in open place for a few days, before they sold it in the market.

In Tiruvarur district, 60 percent of the sample households stored their produce in storehouses with roof made of asbestos sheet and walls made of burnt bricks. 80 percent of the sample had storehouses with floor made of concrete cement, followed by 20 percent of the sample households with storehouses whose floor was made of mud. The height of the platform of the storage house was about within 6 inches.

The physical conditions of roofs, walls and floors of storehouses of a very large majority of sample households in both the districts are in a good condition. All the storehouses have rat

guards. The average age of the storage structures of the sample households are about the 15 years in both the districts. The cost of permanent storage is higher in Tiruvarur district (Rs.3569 per households than in Villupuram district (Rs. 3125 per household). But the cost of storage in kutcha or cemented house is lower in both districts Tiruvarur (Rs.1280) and Villupuram (Rs.1250). The sample households incur very low cost towards maintenance of storehouses and pest control during storage.

Table 5.8 Some Quantitative aspects of Storage (Percentage of Households)

Particulars		Tiruvarur	Villupuram
Nature of Storage			
Roof made of	Grass Thatched	-	-
	Crop by-Product	40	32
	Plastic Cover	-	-
	Metal	-	-
	Others	60	68
Wall made of	Burnt bricks	60	74
	Woven basket	-	-
	Mud	40	26
	Open wall	-	-
Floor made of	Concrete	80	68
	Earth	20	32
	Wooden	-	-
Percent of household having platform			
Height of the platform	Less than 6 inches	100	100
	6-12 inches	-	-
	Above	-	-
Physical conditions			
Roof	Leaking roof	24	9
	Good roof	76	91
Walls	Damaged wall	14	28
	Good conditions	86	72
Guards	Rat guard installed	100	100
	No rat guards	-	-
Floor	Good condition	93	81
	Broken	7	19
Cost of Storage			
Average Age of the Storehouses (Years per Household)		15.60	15.00
Cost of Permanent Storehouses Structure (Rs. Per Household)		3568.75	3125.00

Cost of kutcha or cemented house for storage (Rs. Per household)		1280	1250
Maintenance of Storage			
Roof	Every Year	40	60
	Every Two Years	40	40
	2-5 Years	20	-
Walls	Every Year	60	45
	Every Two Years	40	55
	2-5 Years	-	-
Rat Guards	Every Year	64	78
	Every Two Years	36	22
	2-5 Years	-	-
Storage Pests Control			
Sun Drying	Monthly	-	32
	Quarterly	29	68
	By-annual	71	-
Others	Monthly	-	-
	Quarterly	-	-
	By-annual	-	-

Source: Filed Survey

5.8 Household Suggestions for reducing the Post-Harvest Losses

The sample households of Tiruvarur and Villupuram districts made specific suggestions for reducing post-harvesting losses during the paddy crop cultivation. During the cultivation of paddy, the farmers faced a number of problems from the time of sowing to harvesting period, particularly; they have to maintain the crop with care when the crop is ripe for harvest; otherwise they will make huge losses. Tiruvarur and Villupuram districts are among the top four districts (other two are Tanjore and Nagapattinam) produce the highest amount of paddy in the state.

The suggestions made by sample households to reduce losses are as follows;

- Government should purchase the paddy from the farm, so that unwanted losses in the farm can be minimized.
- Government should provide jute bags to the farmers at subsidized prices.
- Government should construct the storehouse facilities in every village panchayat union.
- Government should build a ground for drying the produce of farmers.

- Rat menace should be controlled or eliminated.
- Farmers should take more care on paddy crop during the time of threshing and winnowing.
- During transportation, farmers incur loss when they take their produce through kutcha roads. So there is need for improving and constructing more pucca roads which will enable the farmers to sell their produce at the government purchase centers during in limited time.
- Government should fix the procurement price for paddy well in advance.
- Government should provide paddy harvesting machines, other farm equipment at subsidized rates.
- Government should organize free camps to educate farmers about post-harvesting management in every panchatyat.
- Government should set up Procurement Centres within 10 Kms from the village especially during harvest season.
- Farmer should harvest the crop in right time otherwise, he will incur huge loss.
- Government should set up dry ground at every village.
- The storage structures should be maintained in good condition and guarded against rat menace.
- Urea, fertilizers and chemical pesticides should be provided by Government in right amounts and in right time; otherwise, the farmers will suffer, as they have to buy the chemical fertilizers higher prices from private agencies.
- Paddy harvesting machines are mostly used due to shortage of labour at the village level and this helps in reducing the cost.
- Farmers should take care in transportation of the farm produce to the marketing centres.
- Government can set up seed purification centres in every village panchayat union for seed purification.
- Farmers may follow organic farming in the agriculture field for protecting clean environment.

- A majority of the farmers did not have storage facilities in the two districts due to least level of land utilization. Therefore, storage facilities may be created at every village panchayat level.
- Government should purchase the paddy directly for the welfare of common man. This will help in maintaining prices and control inflation.

5.9 Summary

The quantity lost during harvest was highest at early harvest is 92.32 Kg per acre in Tiruvarur district, whereas, in Villupuram district, the quantity lost during harvest was highest at the late season of 88.48 Kg per acre. Tiruvarur district, incur heavier loss of 92 Kg per acre than the Villupuram district of 72 Kg per acre during the early harvest season. And the average harvested area per household was larger in size in Tiruvarur district than in the Villupuram district in all the harvesting seasons. It was also observed that majority of sample households about 60 percent in Villupuram district harvest the paddy during the mid-season than in Tiruvarur district of 42 percent at the same season.

About 67 percent in Tiruvarur district make use of the threshing machine and the average quantity lost during the process was 2.11 kg. Whereas, in Villupuram district only 53 percent make use of the machine and 0.83 percent of quantity loss occurs in the process. Tiruvarur sample households make use of the machine more than the Villupuram district. Similarly, under winnowing only Tiruvarur district engaged in this process in Villupuram district no such activity was seen.

During transportation of paddy the average loss occurred was 0.56 kilogram per quintal and 0.65 kilogram per quintal and the average quantity transported to marketing place was 125.6 quintals per households and 132.03 quintals per households in Tiruvarur and Villupuram districts respectively.

A comparative study on districts, Tiruvarur and Villupuram shows majority of the sample households used the government procurement centre in both districts. It was within a distance of 5 Kms in Tiruvarur district with the transportation charge of Rs.9.86 per quintal and Rs. 14.64 per quintal in Villupuram district. But in Villupuram, only two government procurement centre’s are there. This increases the transportation costs and need special attention of government to

increase the number of Government Procurement Centres during the harvesting seasons (at least 10 Km from the farm).

About 41 percent of the sample respondents store their produce in a pucca house for safeguarding the foodgrains and 32 percent use the open place for storage of grains after harvesting in Tiruvarur district. The majority of the sample respondents in Villupuram district use the open place as mode of storage for a short period. The farmer in the sample households in the district had no storage facilities as most of them are marginal farmers. The average amount grains stored was 0.88 quintal per household and 0.62 quintal per household in Tiruvarur district and Villupuram districts. The average number of days during which the grain was preserved was 175 days (6 months) per household in Tiruvarur, whereas, it was only 10 days per household in Villupuram due to inadequate storage facilities in the district.

The large size of farms in Tiruvarur district helped farmers in storage facilities for preserving their produce. As they had greater storage power, they could avoid post-harvest slump in prices and sell their produce when demand and conditions were favourable to them. 25 percent of sample households in Tiruvarur district ranked the loss to storage as high, 50 percent as medium and the remaining 25 percent as low. In Villupuram district, no one household ranked the loss due to storage as high but 56 percent and 44 percent of sample households ranked the loss as medium and low respectively.

The quantity lost in storage was 2.34 Kg per quintal in Tiruvarur and 0.84 Kg per quintal in Villupuram. We found that those with medium size farm incur the highest loss in storage. In Tiruvarur district, it was 3.37 Kg per quintal and in Villupuram district it was 0.84 Kg per quintal. The highest storage losses in Tiruvarur district may attribute to the long period of storage (average number of days of storage per household 150), whereas, for sample households in Villupuram, the corresponding figures is 10 days.

The quantity lost in threshing was larger for sample households in Tiruvarur, 2.11 Kg per quintal when compared with the overall threshing losses in Villupuram district of 0.83 Kg per quintal. The overall winnowing losses are marginal for Tiruvarur district sample households 0.18 Kg per quintal, whereas, the corresponding figures is zero for Villupuram district sample households. In Tiruvarur district, overall post-harvest loss was heavier about 8.29 Kg per quintal whereas in Villupuram district it was just 5.47 Kg per quintal.

In Tiruvarur and Villupuram districts, only 5 households in Tiruvarur were having storage facilities with pucca buildings. In Villupuram only 3 sample households were having pucca storage facilities to preserve their agricultural produce. This implies that the majority of sample households were not interested in storing their produce for a long period as they were in urgent need of money.

The average age of the storage structures of the sample households are about 15 years in both the districts. The cost of permanent storage is higher in Tiruvarur district (Rs.3569 per households than in Villupuram district (Rs. 3125 per household).

CHAPTER VI

CONCLUDING OBSERVATIONS AND POLICY MEASURES

This chapter sums up the findings from the study as well policy measures for the improvement of bottlenecks found from the study. Agriculture sector is the major contribution to livelihood of the major portion of population in many developing countries like India. Growths of these countries are dependent upon the nature and extent of agricultural development. Increase in the allocation to this sector leads to the economic development automatically. There are functional relationships between agricultural development and government spending. Public expenditure on agricultural sector is directly influenced by the process of growth (Jothi Sivagnanam, 2006).

The growth of the agriculture sector in India is still a challenging one as policy makers neglect the concentration on this sector. The Union and State governments are considering only industrial development not the agriculture development. Government spending on agriculture sector had declined over a period of time. Demand of foodgrains has increased due to huge population in the country. So, it is essential to increase food production to overcome the problem of food crisis yet to come in the near future.

Since independence the agriculture production has increased as the result of High Yielding Varieties with the help of modern technology. On the other, increase in the production gave birth to more chemical inputs like fertilizers which automatically lead to new crop diseases and pests. This also reduces the fertility of soil which will ultimately reduce production in future. Farmers face number of constraints from pre-to post-harvest stages in the agricultural sector. During the pre-harvest stage more utilization of chemical could not control the diseases and pests but reduces the fertility of soil. Chemical manufacturing companies are not ready to produce fully efficient disease and pest control chemicals. As there intension is on profit, this make farmer to buy the inefficient chemicals frequently. This increases the total cost of chemical inputs in the production and lead to two successive evils one increase in the price of the commodity and the other reduction in the profit margin of farmer. The process of post-harvest stage starts from harvesting and ends when agricultural commodities are marketed. During this stage farmers have wasted the huge amount of produce of commodities due to unawareness, lack of skills and lack of handling techniques.

6.1 Major Findings

It becomes necessary to investigate the pre-and post-harvest losses of paddy crops to bring out some suitable policy measures to restrict these losses to a reasonable level. Keeping the above cited reasons into account, the various conclusions from the study can be drawn as under:

Farmers face various constraints while cultivating the paddy crop i.e. low output price, High cost of inputs, water deficiency etc. Among them low output price reported as the most important constraint faced by both Villupuram (57.50 percent) and Tiruvarur districts (40 percent). The Second most important constraint was high cost of inputs reported in Villupuram district as 56.3 percent and 35 percent in Tiruvarur district and water deficiency as next important constraint by 32.5 percent in Tiruvarur district and 13.8 percent in Villupuram district.

Only about 17.5 percent and 11.2 percent of sample farmers from Tiruvarur and Villupuram districts could make quantitative assessment about the attack of the diseases. On the other hand, 61.3 percent and 70 percent of sample farmers from Tiruvarur and Villupuram districts could make qualitative assessment of the severity of the attack of the diseases. Tiruvarur district farmers realized more frequent attacks by pests and diseases on their crops compared to Villupuram district due to continuous use of land cultivation in a year.

Majority of the respondents from Tiruvarur district expressed the view that the major pests attacked the crops every season. While ranking the severity of the pests nearly 69 percent ranked the severity of Rice Stem Borer pest as very important. The next severity was identifies as Plant Hoppers pests for which 42.5 percent ranked as very important. And more than 90 percent of the respondents put the production loss at meager 5 percent on account of the pests. In the case of Rice Stem Borer alone, only 84 percent of the respondents put the production loss at 5 percent.

In Villupuram district, a large majority of the respondents expressed the view that major pests attacked the crops every season. Nearly 61 percent sample farmers ranked the severity of the Rice Stem Borer pest as severe and important continued by Leaf Folder, Plant Hopper and others as important with 55 percent, 49 percent and 53 percent respectively. Nearly 90 percent of them put the production loss below 5 percent. A large proportion of respondents (51 percent in the case of Bacterial Leaf Blight, 42 percent in the case of Sheath Blight and 41 percent in the case of False Mute) ranked the severity of the plant diseases as important. Though both districts

Tiruvarur and Villupuram suffer from major plant diseases in equal measurement but they differ in the frequency of attack where Tiruvarur district faces severe attack than Villupuram district.

The overall loss of output in Tiruvarur district is about 1.92 quintal/acre for all the farmers as a whole. In that large farmers suffered a heavier loss of 3.42 quintal/acre whereas least loss was realized by marginal farmers of 2.82 quintal/acre. By measuring the difference between the loss of actual and normal production, large farmers undergoes huge loss of 2.08 percent and lowest was small farmers at 1.3 percent.

The overall loss of output/acre in Villupuram district is 2.48 quintal for all size of farmers. Large and small farmers incurred huge losses of 2.93 and 1.77 quintal. By comparing the loss of actual and normal production, large size farmers incur 1.66 percent and small farmers incur minimum loss of 0.77 percent.

When it comes cost of chemicals adopted by the sample farmers to the control pests and diseases Tiruvarur district seems to be better economical than Villupuram district in terms of chemical cost like weedicide, insecticide and fungicide. The overall total cost per acre of weedicide was Rs. 324 in Tiruvarur district and Rs. 299 in Villupuram district. This shows Villupram district holds better position in weedicide chemical cost. On the other, Tiruvarur district is with the lower cost on insecticide and fungicide of Rs. 246 and Rs. 325 compared to Rs. 451 and Rs. 362 in Villupuram district.

On the sources of information for pests and diseases control 66 percent of sample farmers from Tirvarur district claimed government extension services as most important and only 19 percent in Villupuram district. More than 58 percent of the sample farmer from Villupuramm district reported private input dealer as most important due to easy availability of agricultural inputs on credit. This shows the poor utilization of government services in Villupuram district which need to be concentrated. Majority of the sample farmers from both the districts were of the opinion that services provided by TV/Radio/News papers, Agricultural University/KVK were of ‘least important’. Agricultural University may intensify its efforts to propagate the new techniques of production and innovative agricultural practices to the farmers.

Production loss during harvest season occurs due to early or late harvesting. The highest quantity loss happens during the early stage of harvest, 92.32 kg/acre in Tiruvarur district and 71.75 kg/acre in Villupuram district. Quantity loss also occurs due to late harvesting which is 87.3 kg/acre in Tiruvarur district and 89.30 kg/acre in Villupuram district. But during mid

season, the quantity loss occurred is just 51.2 kg/acre and 67.79 kg/acre in Thiruvarur and Villupuram districts respectively. This shows that harvesting in the mid season can save 41.2 kg/acre and 21.51 kg/acre in Thiruvarur and Villupuram districts respectively. The quantity lost per quintal at early stage is 3.87 kg and 2.96 kg; the quantity lost per quintal at later stage 3.68 and 3.60 kg; during the mid season loss occurred is 2.21 kg and 2.87 kg in Thiruvarur and Villupuram districts. This implies that harvesting on mid season can save 1.66 kg/quintal and 0.73kg/quintal in Tiruvarur and Villupuram district.

About 67 percent and 53 percent of sample farmers in Tiruvarur district and Villupuram district make use of the threshing machine. Sample households in Tiruvarur district make use of more threshing machines than Villupuram district. This was also reflected in average quantity lost where Tiruvarur is with heavier loss of 2.11 Kg per quintal whereas in Villupuram district it is only 0.83 Kg per quintal.

Similarly, due to winnowing activities the average quantity loss is 0.18 Kg per acre in Tiruvarur district. About 68 percent sample farmers ranked the loss due to winnowing activities is low and just 8 percent of sample farmers ranked it as is high in Tiruvarur district. But in Villupuram district, majority of the sample households sell their produce within a week as they are in dire need of money.

The average quantity per households transported to marketing place was 125.6 quintals with the average distance of 2.58 Kms in Tiruvarur district and 132.03 quintals with the average distance of 19.06 Kms in Villupuram district. During transportation of paddy the average loss incurred was 0.56 Kg/quintal and o.65 Kg/quintal in Tiruvarur and Villupuram districts. About 55 percent and 67.5 percent of sample farmers reported low level of losses occurred in respective districts. This implies that during transportation Villupuram district faces high loss than Tiruvarur district.

Majority of the sample households in Tiruvarur and Villupuram districts uses the government procurement centre which was 5 Kms distance in Tiruvarur and 19 Kms in Villupuram district. The transportation charges per quintal from harvesting place to the government procurement centre was Rs.9.86 and Rs. 14.64 in Tiruvarur and Villupuram districts respectively.

In regard to foodgrain storage 41 percent of the sample respondents in Tiruvarur district store their produce in a pucca house and 32 percent use the open place after harvesting. But in

Villupuram district 87 percent of sample respondents use the open place as mode of storage for a short period and 13 percent use pucca house for storage. The sample households in Villupuram district had no proper storage facilities as most of them are marginal farmers. The average amount stored was 0.88 quintal per household in Tiruvarur district, whereas in Villupuram district, it was 0.62 quintal per household. The average number of days during which the grain preserved was 175 days (6 months) per household in Tiruvarur district, whereas, it was 10 days per household in Villupuram district due to inadequate storage facilities in the district.

The average quantity lost per quintal during paddy storage was 0.24 Kg. due to weight loss, 0.25 Kg. due to rodents and 0.22 Kg. due to fungus pretentious in Tiruvarur district. The corresponding figures in Villupuram district were 0.19 Kg per quintal due to weight loss, 0.21 Kg per quintal due to rodents and 0.06 Kg per quintal due to fungus. The higher percentage of loss due to fungus might be because of the long duration (nearly 6 months) of storage. The storage cost per quintal Rs. 0.79 Kg. in Tiruvarur distrcit, and 0.98 Kg. in Villupuram district.

A comparative study on these two districts, results in the following conclusions on various post-harvest losses. The average quantity loss per quintal occurred during harvest in Tiruvarur district was 3.10 Kg and 3.16 Kg in Villupuram district. It is found highest loss was incurred by marginal and medium size of farmers in Villupuram and Tiruvarur districts is 3.36 Kg and 3.14 Kg. The quantity lost per quintal in storage is 2.34 Kg in Tiruvarur district and 0.84 Kg in Villupuram district. We find that those with medium size farms incur the highest loss 3.37 Kg per quintal during storage in Tiruvarur district, whereas it was 1.08 Kg per quintal in Villupuram district. The highest storage losses in Tiruvarur may attribute to the long period of storage (average number of days of storage per household 175), whereas, in Villupuram, it was just 10 days. The overall quantity lost per quintal in threshing activities is 2.11 Kg and 0.83 Kg in Tiruvarur and Villupuram districts. The overall transport loss per quintal was 0.56 Kg and 0.65 Kg in Tiruvarur and Villupuram districts. The overall post-harvest loss was heavier (8.29 Kg per quintal) in Tiruvarur district compared to Villupuram district (5.47 Kg per quintal).

As majority of sample farmers use open place in the districts (Thiruvarur and Villupuram), only 5 and 3 sample farmers were having pucca buildings for storage purposes. This also implies that due to urgent need of money, farmers are not ready to store their produce for longer period. Also the cost of constructing permanent storage buildings is higher in Tiruvarur district (Rs.3569 per households) than in Villupuram district (Rs. 3125 per household).

But the cost of storage in kutcha or cemented house is lower in both districts- Tiruvarur (Rs.1280 and Villupuram (Rs.1250). This makes sample farmers to prefer kutcha or cemented house compared to pucca houses.

6.2 Policy Suggestions

Keeping the above cited conclusions into consideration the following policy issues can be drawn:

- Government should give consistent advices to the farmers from the beginning stage of paddy crop cultivation to harvesting stage. It should play the role of a caretaker at every stage of paddy production.

- Government and other private dealers should create awareness among the farmers to control pests, diseases and weeds.

- Chemicals used by the farmers are not effective in controlling the pests and diseases and weeds. So, government should regulate the chemical manufacturing firms to maintain their quality of the product.

- Government/Private agencies should arrange special camps to train farmers to reduce pre- and post-harvest losses in every village of paddy growing regions.

- Government should provide better quality seeds, fertilizers and chemicals to the farmers in time. Government selling centres were closed frequently without any reasons, as a result farmers are forced to purchase from private dealers.

- Government should open the agro-farm centres at every panchayat village level to reduce hardship of farmers due to time and distance which incur sizeable transport costs.

- Government should provide jute bags to the farmers at subsidized prices.

- Government should construct the godown facilities and drying facilities in every village panchayat union.

- Good infrastructures facilities should be built in rural areas which can reduce transportation cost and losses.

- Government should fix the procurement price for paddy well in advance.

- Government and co-operative societies should provide paddy harvesting machines and other farm equipment at subsidized rates.

- Government should set up Procurement Centres during every harvest season.

- Farmer should harvest the crop within time; otherwise, he will incur huge loss**.**
- The storage structures should be maintained in good condition and guarded against rat anemone.
- Government can set up seed purification centres in every village panchayat union for seed purification.
- Farmers may follow organic farming in the agriculture field for protecting clean environment.
- Government should purchase the paddy directly from the farmers for the welfare of common man. This will help in containing prices and in controlling inflation.

Reference

Annual Report, Ministry of Agriculture, Government of India, New Delhi, Various Year 2008-09.

Annual Report, Ministry of Agriculture, Government of India, New Delhi, Various Year 2009-10.

Annual Report, Ministry of Agriculture, Government of India, New Delhi, 2012

ASSOCHAM (2013) *Huge Post Harvest Losses for India*, Economics Times of India

Atanda S.A, Pessu P.O., Agoda S., Isong and IkotunI (2011) *The Concepts and Problems of Post–harvest Food Losses in Perishable Crops*, Africa Journal Food Science, August.

Basavaraja.H, Mahajanashetti. S.B and Naveen C. Udagatti (2007) *Economic Analysis of Post-harvest Losses in Food Grains in India: A Case Study of Karnataka*, Agricultural Economics Research Review Vol. 20 January-June.

Dante B. de Padua (2012) *Post Harvest Handling in Asia Rice,* Agricultural Engineering Division International Rice Research Institute, Philippines.

Estimation of Cost of Cultivation in Tamil Nadu, Tamil Nadu Agriculture University, Coimbatore, Tamil Nadu.

Gangwar L.S., Dinesh Singh and Singh D.B (2007) *Estimation of Post-Harvest Losses in KinnowMandarin in Punjab Using a Modified Formula*, Agricultural Economics Research Review Vol. 20 July-December.

Richard N. Strange and Peter R. Scott (2005) *Plant Disease: A Threat to Global Food Security*, Annual Review Phytopathol

Roy, Pal, (2013) *Multi-locational Studies to Reduce Post Harvest Losses during Harvesting, Handling, Packing, Transportation and Marketing of Mango in India*, The Times of India

Seasonal Crop Report, Department of Economics and Statistics, Government of Tamil Nadu, Chennai-06.

Statistical Hand Book of Tamil Nadu (2012), Department of Economics and Statistics, Government of Tamil Nadu, Chennai-06.

Tamil Nadu Economic Appraisal, (2008-09) Department of Economics and Statistics, Government of Tamil Nadu, Chennai-06.

Tenth Five Year Plan 2002-07, Government of India, New Delhi, 2012