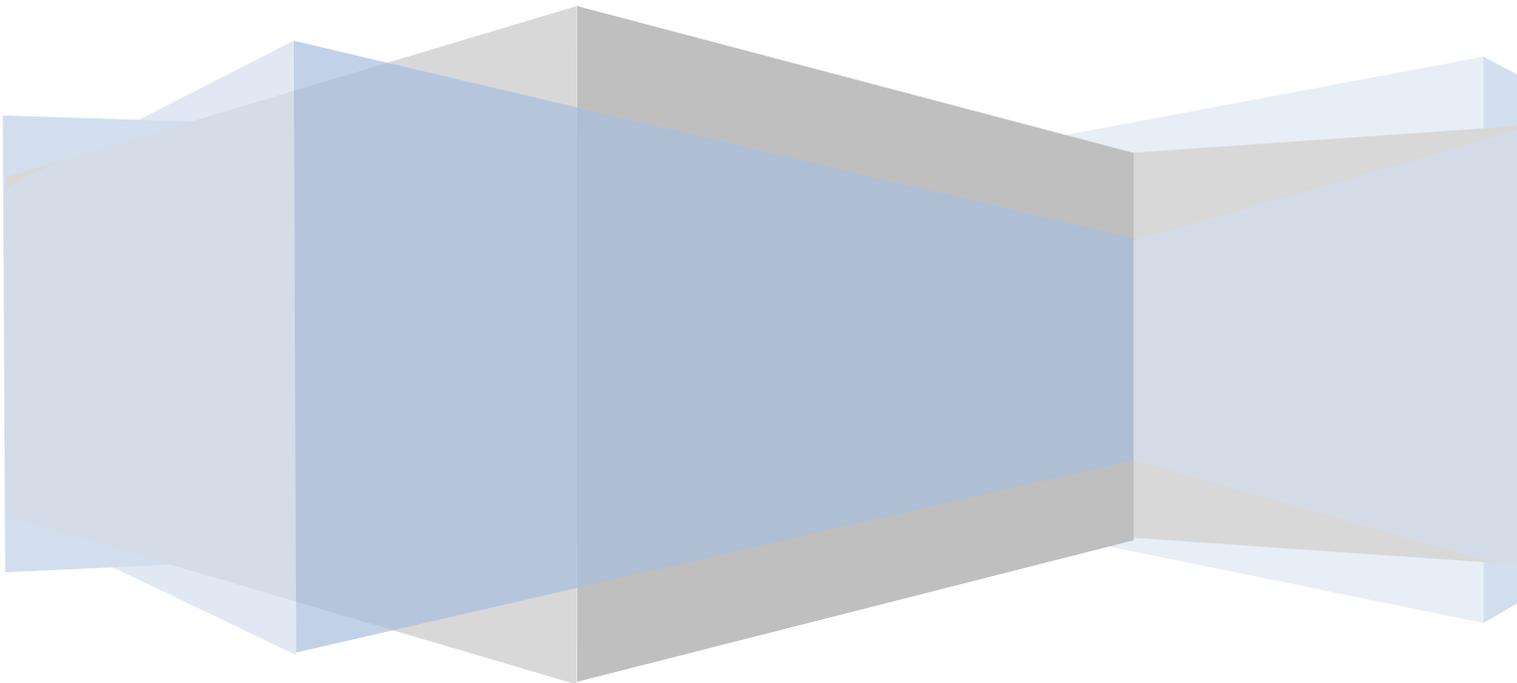


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Executive Summary

**Spread of New Varieties of Hybrid Rice
and its Impact on the Overall Production
and Productivity in Tamil Nadu**

K. Jothi Sivagnanam



AERC Research Study No: 153

Executive Summary

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1. Introduction

Food production plays a crucial role in the economic development as well as human development of the nation. It is one of the important ingredients of food security mission. Focus on food security has been consistently growing during the last three decades. Nowadays, food security is one of the main themes and it is abundantly recognized in the world. Rapid economic growth of a nation should be concerned with food security and its impact on human welfare and socio-political stability. Despite some success in addressing food production shortfalls in South Asian countries, India continues to have the largest number of people suffering from poverty and malnutrition. Food production in the region is just enough for the increasing population. Foodgrain availability in India covered 170 kilograms per person in 1960s and it has witnessed threefold increase in most of the 21st century (DES, 2011).

The technological innovation in agricultural production plays pivotal role in ensuring food security in the world. Many challenges are faced by agriculture due to land and water scarcity and pressure on natural resources. In India, the government is facing great challenges in ensuring food security for its people in the near future. The Intergovernmental Panel on Climate Change Report estimated that the agricultural yield will be reduced by 30-40 percent in 2050 due to weather conditions in the world. India has been identified as a major risk zone with increase in drought prone area due to adverse impact of climate change (Hindustan Times, 2008). Therefore, India needs to find new varieties for human survival. Indian agricultural scientists have introduced a number of hybrid varieties of different crops in the last two decades. If India had not to adopted hybrid varieties, it would have faced food crisis now and in future.

Hybrid rice is one of the important varieties for the food security and agriculture development in the World and India. Hybrid rice varieties have not reached most of the poorest households in India even after two decades of their introduction. There is slow development in the area and production of hybrid rice among various states in India. There are challenges regarding development of hybrid rice seeds in terms of ensuring the production of adequate quantity of high quality hybrid seeds that are resistant to pests, diseases and tolerant against abiotic stresses and aesthetic consideration of consumers. In terms of adoption of hybrid rice technology, regions that are traditional rice growing regions have not showed interest in hybrid rice technology preferring to continue the HYV rice varieties for a variety of

reasons including lack of demand from consumers because of their cultural preferences regarding the qualities associated with cooked rice.

1. 1. Background of the Study

Hybrid rice technology is likely to play a key role in increasing the rice production. During the year 2008, hybrid rice was planted in an area of 1.4 m.ha. and an additional rice production of 1.5 to 2.5 million tonnes was added to our food basket through this technology. More than 80 percent of the total hybrid rice area is in eastern Indian states like Uttar Pradesh, Jharkhand, Bihar, Chhattisgarh, with some little area in states like Madhya Pradesh, Assam, Punjab and Haryana. As rice is a key source of livelihood in eastern India, a considerable increase in yield through this technology has a major impact on household food and nutritional security, income generation, besides an economic impact in the region. In view of this, hybrid rice has been identified as one of the components under the National Food Security Mission (NFSM) launched by the Government of India (GOI). The approach is to bridge the yield gap in respect of rice through dissemination of improved technology and farm management practices.

1.2 Objectives of the Study

- To indicate the extent of adoption and the level of participation by the different categories of farmers in the cultivation of hybrid rice.
- To assesses the overall impact of hybrid rice cultivation on rice production and productivity in Tamil Nadu.
- To study the economics of cultivation of hybrid rice varieties versus HYVs in Tamil Nadu.
- To identify factors determining the adoption of hybrid rice varieties in Tamil Nadu.
- To address various constraints and outline the prospects for increasing hybrid rice cultivation; and
- To suggest policy measures for expansion of hybrid rice cultivation.

1.3 Data base and Research Methodology

Primary data has been collected from two districts namely Nagapattinam and Tiruvarur of Tamil Nadu. In each of the districts of Nagapattinam and Tiruvarur, two representative blocks namely Kuttalam, Mayladuthurai, Needamangalam and Valangaiman are taken respectively and within each block two villages are selected. In each district, 40 hybrid rice growers from the list of hybrid rice growing cultivators

are drawn at random from household farmers on the basis of their proportion in the universe. In addition to the above sample, conventional 10 HYV rice growers but non-adopters of hybrid rice are selected randomly from households with different land sizes amongst HYV rice growing cultivators following the same method. Thus, altogether, 50 rice growing cultivators are selected from each district (Tiruvarur and Nagapattinam). In all, 100 rice growing cultivators among two districts form the selected sample size in the study.

For the primary survey, the reference years are 2009-10 and 2010-11. Accordingly, two kharif seasons and two rabi seasons for the rice crop are covered in the study. It can be observed that the majority of the farmers fall in the small farmers' category (35 percent) and large farmers (29 percent). The percentage of farmers in medium and marginal size is 23 percent and 13 percent respectively. About 100 sample households have been chosen from eight villages in the four blocks of Nagapattinam and Thiruvarur districts of Tamil Nadu at the rate of two villages in a block and two blocks from each district on the basis of official list. From each village, 20 sample farmers and 5 sample farmers are selected based on hybrid adopters and non-adopters basis respectively based on the official list in a particular village.

1.4 Major Findings

2. Growth of Rice Cultivation in Tamil Nadu

The area under rice cultivation expanded from 16.96 lakh ha (74.91 percent) to 17.55 lakh ha (76.12 percent) during pre-hybrid rice period for winter season. It increased to 14.44 lakh ha during second post- hybrid period upto 2011-12. The area declined to 2.52 lakh ha during three decades due to urbanization, real estate and non-cultivable area in Tamil Nadu. The production of rice increased from 38.91 lakh tonnes to 50.14 lakh tonnes during pre-hybrid period. During post-hybrid period, it declined to 36.28 lakh tonnes but increased to 83.88 lakh tonnes in 2011-12. Production of rice increased by 44.97 lakh tonnes during three decades due to increase in yield of rice, advanced technology used in the cultivation and favourable monsoon.

A comparative analysis of the three seasons in Tamil Nadu shows that, the winter season makes the most predominant contribution in area and production of rice during three decades. The majority of the farmers cultivated rice during the winter season due to favourable climatic conditions. The autumn season contributed more than the summer season. The average yield rate of rice per hectare during autumn season is more than in winter and summer seasons in all the pre-and post-hybrid

periods. During the autumn season, yield rate increased from 2741 kg./ha. to 3440 kg/ha during pre-hybrid period, but it first declined to 3240 kg./ha. and again increased to 6186 kg./ha during post-hybrid rice period. During summer season, the average yield rate increased from 2462 kg./ha to 2809 kg./ha during pre-hybrid rice period, whereas in post-hybrid rice period, the yield increased further to 3071 kg./ha during the first phase and 5836 kg./ha during the second phase.

2.1 Trend and Composition of Hybrid Rice in Tamil Nadu

The area under hybrid rice cultivation in total area of rice in Tamil Nadu increased to 0.59 percent in 2011-12 against 0.06 percent in 2006-07. It is expanded by 0.53 percent between 2006-07 to 2011-12. It also means in a way that the state has not evinced much interest in hybrid rice technology. Tamil Nadu had only less than one percent of total area under hybrid rice cultivation compared to all-India percentage of 3.5 percent. The state could not adopt the hybrid rice technology even after two decades. The technology did not spread to many districts of Tamil Nadu in a big way.

The area expanded under hybrid rice cultivation was only 0.01 percent: Thiruvarur (265 ha), Kancheepuram (248 ha.), Theni (173 ha.), Thanjavur (116 ha.) and Perambalur (100 ha.). The percentage share of hybrid rice in total area under rice recorded the highest percentage (0.28 percent) in Thiruvarur (5330 ha.), followed by Theni (1618 ha.) with 0.08 percent and Pudukkottai (1494 ha.) with 0.08 percent, Cuddalore (1250 ha) with 0.07 percent during 2011-12.

The lowest share was recorded by Erode (4.38 ha.) at 0.0002 percent. Districts like Kancheepuram, Perambalur and Thanjavur stopped cultivating hybrid rice during 2011-12. Many districts adopted hybrid rice varieties only to a small extent. Even today some of the districts in Tamil Nadu like Thiruvallur, Karur, Dindugal, and Kanniyakumari did not adopt the hybrid rice technology, mainly because of lack of awareness among the farmers, small amount of availability hybrid seeds, technical problems, and high cost of cultivation and absence of enthusiasm from government.

2.2 Growth and Instability of Rice Production in Tamil Nadu

It is observed that the growth trends in rice production were significantly higher in second post-introduction period of hybrid rice than in the pre-introduction period of hybrid rice. Rice production during second post-hybrid rice period was the highest at 10.55 percent than the yield in the pre-introduction period (2.57 percent). The average highest yield of rice was 10.32 percent during second post-hybrid rice

period and 2.36 percent during pre-introduction period. The area, production and productivity were exhibiting negative trends during first post-hybrid rice period largely due to *Tsunami, Thana effect* and drought.

At the aggregate level, the area increased marginally from 0.20 percent in pre-introduction phase to 0.21 percent during the second post-introduction period, but declined to -4.57 percent during the first post-introduction period. Production increased to 10.55 percent during 2004-05 to 2011-12 against 2.57 percent during 1985-86 to 2003-04, but it declined to -8.17 percent during 1993-94 to 2003-04. The yield of rice increased to 10.32 percent during second post-introduction period from 2.36 percent during pre-introduction period. But during the first phase of post-introduction period, it witnessed a negative trend (-3.78 percent).

A comparative study of the three seasons (autumn, winter and summer) shows that the area under rice cultivation witnessed a declining trend from 0.58 percent during autumn to -0.59 percent in winter and -2.99 percent in summer. Production, however, witnessed a positive but declining trend with 3.66 percent, 2.89 percent and 0.16 percent during autumn, winter and summer seasons respectively. The average yield rate of rice was 3.06 percent, 3.50 percent and 3.25 percent, respectively during those three seasons.

2.3 Growth of High Yielding Varieties of Rice (HYVs) in Tamil Nadu

The majority of the farmers have adopted the HYV technology but the hybrid rice technology did not spread to even one percent level in Tamil Nadu. Farmers in many districts are ignorant about the hybrid rice technology even after two decades. Area under the HYV seeds are negatively related with almost all the seasons like autumn, winter and summer during both the study periods of 1995-96 to 2003-04 and 2004-05 to 2009-10. The area under cultivation has declined due to urbanization and industrialization and become non-cultivable land in Tamil Nadu during the past two decades.

The winter season witnessed a better growth than during autumn and summer seasons. Within the winter season, the second post-hybrid rice period witnessed a constant growth of 5.25 percent than the first post-hybrid rice period of 1995-96 to 2003-04 (13.74 percent). When we look at the post-hybrid rice period, the area under HYV rice for winter and autumn seasons is more stable with co-efficient of variation of 5.25 and 9.45 respectively during 2004-05 to 2009-10 than the co-efficient of variation of 13.72 and 23.38 respectively during 1995-96 to 2003-04 period. The area

under winter season witnessed steady growth with a co-efficient of variation of 11.16 during 1995-96 to 2009-10 when compared with autumn (20.03 co-efficient of variation) and summer season (32.47 co-efficient of variation).

3. Status of Adoption of Hybrid Rice at the Farm Level

3.1 Sample Farmers and their Distribution according to Farm Size

Among the hybrid adopters, the small (33.75 percent) and large landholders (32.50 percent) are very much interested to adopt hybrid rice cultivation techniques. Both types of farmers have occupied two-thirds of hybrid rice cultivation area. On the contrary, the marginal farmers represent only 9.0 percent. It is observed that small and large farmers are adopting hybrid rice technology as their land size is quite enough to implement the technology. Further, the small and large farmers are able to cope with new technology, which involves high cost of operation, whereas, significant proportion of marginal farmers are unable to emulate the technology because of high cost and small landholdings. In the case of non-adopters, they prefer to adopt HYV rice cultivation as it requires low cost of cultivation. Further, they are continuously cultivating with the same traditional technology given their knowhow in the HYV cultivation technique.

3.2 Socio-economic Characteristics

About 92.50 percent of the sample hybrid rice cultivators fall in the age group of 19-60 years, whereas 85 percent of non-adopters are found in the same category. Only 5 percent of the hybrid farmers are found in the age group of above 60 years, while 10 percent of the non-adopters are in the same category. About 85 percent are having primary to graduate level of education among hybrid adopters and non-adopters. The education levels of the sample farmers helped them adopt the hybrid rice cultivation technology. Even though, the numbers of educated farmers are high, they could not adopt the hybrid rice technology frequently due to constraints like inadequate supply of seeds in the study area and lack of adequate government support.

It is found that nearly 88 percent of hybrid adopters and 95 percent of non-adopters belonged to Other Backward Castes (OBC). A meagre percentage of SC farmers were hybrid adopters (12.50 percent) and non-adopters (5 percent). In the study area, the majority of the lands are held by Vanniyar, Kallar and Thever communities who belonged to the OBC category.

3.3 Cropping Pattern

The total gross cropped area declined from 698.85 ha. in 2009-10 to 609.68 ha. in 2010-11 among hybrid rice adopters and it has increased from 76.43 ha. to 78.85 ha. for the non-adopters. During the kharif season, the share of hybrid rice cultivation in the gross cropped area has increased from 2.43 percent in 2009-10 to 3.58 percent in 2010-11, whereas it has increased from 1.74 percent to 3.78 percent during rabi season. During rabi season, the share of HYV rice in the gross cropped area increased from 35.59 percent to 38.60 percent.

The share of cultivated area of HYV rice declined due to excessive utilization of land. It indicates that hybrid rice was mainly cultivated in the study area during kharif and rabi seasons alone and not during the summer season due to lack of availability of seeds and diversification of cropping pattern from paddy to pulses in the study area. The highest share of pulses in gross cropped area declined to 11.04 percent in 2010-11 from 16.35 percent in 2009-10 during summer season.

Among non-adopters, the percentage share of HYV rice increased from 2.65 percent in 2009-10 to 5.13 percent in 2010-11 during summer season. A majority of them were cultivating the HYV rice instead of hybrid rice varieties due to unawareness of the scheme and high intensive technology needed. It indicates that the majority of the sample farmers cultivated hybrid rice varieties within a variation ranging from 2 percent to 4 percent during reference period of study.

3.4 Area Coverage of Adoption of Hybrid Rice by the Farm Households

The average area for paddy cultivation has declined marginally from 3.19 ha. in 2009-10 to 2.88 ha. in 2010-11. Similarly, the HYV rice cultivation area has also declined from 89.34 percent (2.85 ha.) in 2009-10 to 85.42 percent (2.46 ha.) in 2010-11. On the contrary, the area under hybrid rice cultivation has increased from 10.66 percent (0.34 ha.) to 14.58 percent (0.42 ha.) between the two reference periods. The hybrid rice cultivation area had increased marginally (4 percent). It has ranged from 0.24 ha. to 0.42 ha. across the different sizes of the farm holdings during 2009-10 and the same has ranged between 0.37 ha. and 0.52 ha. during 2010-11 marking a slight increase.

There is a considerable change observed among the small, medium and large farmers with respect to the area under cultivation. The shift is sharp in the case of small farmers recording an increase from 14.28 percent to 23.53 percent of the area. The farmers are ready to diversify farm lands for the cultivation of HYV rice than

hybrid rice varieties due to easy availability of seeds, well known technology and conventional farming technique. But, the hybrid rice cultivation involves high cost of operation, inadequate seed supply and one-time seed usage and unknown technology.

3.5 Access to Hybrid Rice Technology

About 86.25 percent reported that they have participated in the frontline demonstration programme conducted by the government. About 82.50 percent reported that they have participated in training programme organized by the government; 77.50 percent farmers came to know about hybrid rice technology through extension workers. The farmers are informed about the technology by the agricultural department officers who visited the villages. The agriculture officer could not solve the problems relating to distribution of hybrid rice seeds due to limited material available.

About 63 percent of the hybrid rice adopters have gathered information through the training programme conducted by the government; 62 percent have reported that they received information from the extension workers of the agriculture department, state government and demonstration programme conducted by the government of Tamil Nadu. The number of beneficiaries of hybrid rice seeds received from the government has declined from 100 percent in 2009-10 to 98.63 percent in 2010-11 on full subsidy basis. Regarding hybrid rice seed sales, government has the monopoly in the study area. The government officials provide hybrid seeds to selected farmers based on their socio- economic status and land holding status.

3.6 Determinants of Participation in Hybrid Rice Cultivation

The coefficient results indicate that the farm size (medium size) is an important variable in adopting the hybrid rice technology, which is significant at 10 percent level. Age factors and household size of the hybrid rice adopters are also positively related but the results were insignificant. On the contrary, education and size of workers are negatively related with participation in hybrid rice adoption. The family and hired labour are inadequate in the field because of government schemes (MGNREGS) and due to the relatively higher wage rates in the urban areas. Educated youth are not entering into the farm cultivation, because they think that it is beneath their dignity.

4. Impact of Hybrid Rice Cultivation on Overall Production

Even after two decades from the introduction of the hybrid rice cultivation in 1994, it had not spread widely in all states of India due to various constraints such as

technological unawareness among the farmers, high cost of cultivation, high seed cost and one time use of seed. However, the area of hybrid rice to total rice area has increased from 0.39 percent in 2000 to 3.2 percent in 2008. It indicates that the hybrid rice technology has not reached the core farmers as compared to other commercial crops. The majority of farmers are dropping out of the hybrid rice cultivation because of low market price, high cost of cultivation, high cropping time, hybrid rice not being accepted by the traders, low seed quality, one time usage of seed.

4.1 Productivity Performance of Hybrid Rice and HYV Rice

The average yield rate of hybrid rice adopters is better than HYV rice cultivators during 2009-10 and 2010-11. It is found to be 7021 kg/ ha. And for HYV rice adopters, it is 5615 kg/ha. This shows that the hybrid rice adopters have achieved 25.04 percent additional yield rate over the high yielding rice adopters during 2009-10. During 2010-11, the hybrid rice adopters have recorded high yield of 7133 kg/ha. than high yielding rice cultivators (5872 kg/ha). The average hybrid rice yield rate had increased (21.48 percent) significantly over the high yielding rice varieties during 2010-11. But, the average yield rate of hybrid rice has declined marginally from 25.04 per cent to 21.48 percent.

The yield performance of hybrid rice improved from 7021 kg/ha. in 2009-10 to 7133 kg/ha. in 2010-11. Yield performance of HYV rice also increased from 5615 kg/ha to 5872 kg/ha. Among different farm households, hybrid rice yield was better than high yielding rice varieties in both the years. The small and large size of sample farmers has obtained the highest yield among hybrid rice adopters in both the years. The large and the marginal farmers obtained the highest yield among high yielding rice cultivators in both the years.

4.2 Factors Affecting Productivity

There is a significant relationship between manure, seeds, human and mechanized labour and they are positively related with productivity of hybrid rice cultivation. The variables like seed, manure, human labour and mechanized labour are very supportive to the farmers for cultivation of hybrid rice in the study area. Seeds are one of the main deciding factors in the hybrid rice production. Supplying seeds at zero cost is very effective and welcomed by the farmers in both the study areas. Ironically, other variables such as fertilizers, irrigation, and pesticides are negatively related to the production of hybrid rice cultivation. Irrigation is also one of the main factors in determining the production and scarcity of water affects the agricultural

production severely due to salt content. Therefore, the production of paddy is badly affected, and declined. The authorities may have to take measures to rectify the problems.

There exists a positive relationship between production and manure and human labour. The natural manure and human labour are among the most important determinant factors in the adoption of HYV rice cultivation. Since seeds are available at zero cost, the farmers are happy to use them as required for cultivation. On the contrary, there is a negative relationship between production and fertilisers, irrigation, mechanized labour and plant protection.

There is a positive relationship between production and fertilizers among hybrid adopters and non-adopters. The fitted model explained 90 percent of the variation in the yield of high yielding varieties of rice in the study area. On the contrary, a majority of farmers are using the manure with high cost; irrigation is a major problem faced by the farmers as they rely on river water rather than ground water. It is found that the seeds are having germination problem to the high yielding rice cultivators; as they are available at zero cost, they have been used continuously. The price of pesticides is higher in the study area and not only that, sometimes, the pesticides are hoarded for speculative motive and artificial scarcity is created in order to increase the price and to make abnormal profits. Therefore, the price and paucity in the supply of pesticides affect the production of paddy in the study area.

5. Comparative Economics of Hybrid Rice and HYV Rice Cultivation

5.1 Input Use Pattern for Cultivation of Hybrid and HYV Rice

Seeds utilized by HYV and hybrid adopters are 82.68 kg/ha and 12.78 kg/ha, respectively. HYV rice adopters utilized more seeds than the hybrid adopters due to non-availability of hybrid seeds and the cost of seeds also inhibited them to procure more hybrid seeds. The majority of the hybrid rice adopters used more pesticides (6.35 time of spray) than HYV rice cultivators. The human labour utilized by hybrid rice adopters was higher than that of HYV rice adopters.

The hybrid adopters used more chemical fertilizers (535 kg /ha) than HYV rice cultivators (279.37 kg/ha). It may be noted that the majority of hybrid rice adopters used more inputs than HYV rice cultivators except seeds; the hybrid adopters are supposed to pay more surveillance than the HYV adopters which cost more human days as well as money. It could be observed that wide variations are there in the inputs like seeds, manure, fertilizers, pesticides, irrigation and human labour

among hybrid rice adopters and non-adopters. The farmers are having lack of technical knowledge to adopt the hybrid rice technology in the farm. Therefore, the hybrid rice adopters hesitate to cultivate the hybrid seeds.

The average number of sprays used by hybrid rice adopters (165.7 days) is higher than HYV rice cultivators (129.08 days). The total inputs required for the hybrid rice adopters are significantly higher than high yielding rice cultivators except seeds. The hybrid rice adopters have invested more in organic manures, chemical fertilizers, plant protection, and machinery than high yielding variety rice cultivators.

5.2 Operation-wise Labour Absorption in Hybrid Rice and HYV Rice Cultivation

The hybrid rice adopters used more human labour (165.70 days/ha) while HYV rice adopters used lesser amount of labour (129.08 days/ha). More man-days of human labour are used for uprooting of seedlings, harvesting, and post- harvesting by hybrid rice adopters than by HYV rice adopters. The average total man-days for hybrid rice adopters is higher than those for HYV rice cultivation. Specifically higher man-days of labour are used for uprooting of seeds, harvesting and post-harvesting by hybrid rice adopters than high yielding rice cultivators.

The average man-days of female labour used by high yielding rice adopters is 59 days, whereas the hybrid rice adopters used 47 days of female labour. The number of man-days of female labour used for uprooting of seedling by hybrid rice adaptors was higher than that of the high yielding rice cultivators. The man-days used for harvesting and post-harvesting by high yielding rice cultivators (24 days) are more than those used by hybrid rice adopters (21 days). The majority of female labour could not participate in the work of manuring, application of chemical fertilizers and spraying plant protection chemicals.

5.3 Cost of Inputs for Hybrid and HYV Rice Cultivation

The labour cost alone accounted for about 46.56 percent and 50.84 percent of the total cost for hybrid rice adopters and HYV rice cultivators, respectively. The cost of machinery charges is 15.96 percent and 15.08 percent of total cost, respectively for hybrid and HYV rice adopters. The costs of chemical fertilizers are 10.33 percent and 10.64 percent, respectively. The cost of cultivation per hectare of hybrid rice adopters and HYV rice cultivators are more or less the same (48-50 percent).

The highest average cost of cultivation for hybrid rice adopters worked out to Rs. 30,298/- per ha, while for HYV rice it was Rs. Rs. 27,550/- per ha during 2009-

10. The farmers growing hybrid rice realized a gross return of Rs.70,523/- per ha, while the gross return realized for HYV rice varieties was Rs.61,403/- per ha. As a result, the gross return received by hybrid rice cultivators is 12.94 percent higher than that of the HYV rice cultivators. The average yield of hybrid rice is 70.20 quintal/ha, while that of high yielding rice is 56.62 quintal/ha during 2009-10. It is observed that there was significant yield gain from hybrid rice than high yielding rice in the study area. It is reported that the hybrid rice cultivation had a yield advantage of 13 percent among hybrid rice adopters over that of HYV rice adopters.

The average market price received by the hybrid rice adopters and HYV rice cultivators is about Rs. 935.61/- and Rs. 939.13/- per quintal. There is no significant variation in price received by the farmers who cultivate hybrid rice and high yielding rice. This is attributed to the traders, who did not favour the product of hybrid rice variety. The traders do not quote a separate price for hybrid rice adopters, because, both the hybrid rice and the HYV rice varieties are getting the same market price from the Government Procurement Centres and private agents. Hybrid rice adopters could not receive higher price at the Government Procurement Centre.

The cost of cultivation for hybrid rice adopters is Rs.30, 275 per ha, which is higher than that of HYV cultivators at Rs.27,049 per ha. It is noted that the hybrid rice adopters have spent more money during the cultivation due to the higher cost of seeds, machinery and labour compared to HYV rice cultivators. The labour cost alone accounted for about 45.29 percent and 53.64 percent of total cost respectively for hybrid and HYV rice cultivators. The cost of machinery charges are 15.0 percent and 12.19 percent of the total cost respectively for hybrid and high yielding rice adopters. The cost of chemical fertilizers is about 12.43 percent for hybrid rice adopters and 11.82 percent for non-adopters.

The farmers growing hybrid rice realized a gross return of Rs.75,985/- per ha, while the gross return realized in HYV rice varieties is Rs.62,698/- per ha. Thus, the gross return received from hybrid rice is 17.48 percent higher than that of the high yielding rice. The results indicate that the average yield of hybrid rice is 71.33 quintal/ha, while that of HYV rice is 58.29 quintal/ha during 2010-11.

During 2010-11, the average market price received by the hybrid rice adopters and HYV cultivators is about Rs. 994/- and Rs. 997/- per quintal, respectively. There is no significant variation in price received by the farmers for hybrid and HYV rice in 2010-11. As noted already, both the Public Procurement Centre and private

marketing agents perceive that there is no variation among the hybrid and HYV in terms of quality. Therefore, they pay more or less the same price for both the varieties.

6. Grain Quality and Marketing Aspects

6.1 The Volume of Marketing

The hybrid rice output was 93.79 percent; it was 95.64 percent for HYV rice cultivators during 2009-10. The average market price received by the sample farmers is about Rs.890 per quintal for HYV rice cultivators. Price for HYV rice received by the sample farmers is about Rs.892/- per quintal. It was about to Rs. 972/- per quintal for hybrid rice adopters.

The hybrid rice adopters have sold 93.79 percent of their output in 2009-10 and it has increased to 94.15 percent in 2010-11, whereas the output sold by HYV rice cultivators has slightly declined from 95.64 percent to 94.78 percent between 2009-10 and 2010-11. Among non-adopters, the average HYV rice output sold declined from 95.68 percent in 2009-10 to 95.36 percent in 2010-11. The output of HYV rice sold has varied from 93 percent to 96 percent among different farm size holdings. A majority of the farmers in the study area sell almost 95 percent of their output due to urgent need for money and settlement of loans borrowed.

The average price received for hybrid paddy increased from Rs.972 per quintal in 2009-10 to Rs.1060.52 per quintal in 2010-11, whereas for HYV rice variety, the average market price increased from Rs. 892 per quintal to Rs. 1048 per quintal during the same period. The demand for paddy increased during those periods due to inflationary trends and bad economic conditions. Among non-adopting sample farmers, the average market price for HYV rice increased from Rs.890 to Rs. 986 per quintal.

6.2 Seasonal Flow of Marketing

Hybrid adopters sold relatively greater proportion of paddy output immediately after the harvest in the months of August and September. During 2009-10, the highest proportion of paddy sold was in the month of January during Kharif season (21.04 percent) and October during Rabi season (22.65 percent) by hybrid-adopters. Among the hybrid rice adopters, the highest proportion of sale for HYVs is in the month of March during Kharif season (24.65 percent) and October for Rabi season (23.15 percent).

A majority of the farmers' hybrid rice adopters and HYV rice cultivators sell their produce in the month of August and September during kharif season. A majority of them sell their produce immediately after harvest not only due to urgent need for money but also to avoid weight loss if the produce is kept for a longer period and majority of the Government Procurement Centres during these months work for the welfare of the farmers.

During 2010-11, the highest proportion of sale was in the month March for Kharif season (20.71 percent) and October for Rabi season (19.51 percent) for HYV rice. A majority of them reported that they sell their paddy during kharif and rabi seasons and they also reported that they cultivate alternative crops during summer season. Among non-adopters, the highest proportion of sale of HYV rice is in the months of March (25.89 percent) and October (22.74 percent) for kharif and rabi seasons, respectively. It is noted that the majority of the sample farmers sell their paddy immediately after the harvest. They sell their produce both in the Government Procurement Centres and to the private agencies.

7. Problems and Prospects for Increasing Hybrid Rice Cultivation

7.1 Farmers' Awareness about Adoption of Hybrid Rice Technology

In Tamil Nadu, farmers were aware of hybrid rice technology, but they were hesitant to adopt the same as resources were inadequate. Nearly 99 percent got the information from the training programmes, around 45 percent stated that frontline demonstration technique is a better format and 98 percent reported that the training programmes were considered as vital and had close proximity towards generating awareness about the hybrid rice cultivation technique among the farmers in the study area.

With respect to the popular varieties of hybrid rice, about 80 percent reported that KRH-2 is a popular variety in the study area in which 80 percent reported hybrid rice got more yield over HYV rice. KRH was popular among 20 percent of the sample farmers with 70 percent of yield advantage over HYV rice. A major chunk of the respondents have got awareness about the adoption of hybrid rice technology through government training programmes organized in the study area.

7.2 Problems faced by the Sample Farmers relating to Input use, Production and Marketing

About 65 percent reported that they get hybrid seeds in time during planting season. About 35 percent reported that they received the hybrid seeds at reasonable

price. It is noteworthy to highlight that cost of HYV seeds is much less than the cost of hybrid seeds in the market.

In the case of quality of hybrid seeds, majority of the respondents (71 percent) expressed dissatisfaction over the quality of hybrid seeds provided by the government. The majority of them reported that poor germination of the seed is an important factor affecting yield gain to the farmers. The majority of the hybrid seed producing companies are in the private sector. They do not care about preservation of quality or seed germination. Availability and accessibility of the seeds at the right time is another constraint as 66 percent of the sample farmers reported that accessibility is the major constraint due to inadequate possession of the seeds by the agricultural department. As far as yield advantage is concerned, a majority of respondents (76.20 percent) reported that the yield gain of hybrid rice is better than HYV rice. This shows that they have better experience, and better yield gain than HYV rice and they feel satisfied with adoption of hybrid rice technology. About 34.40 percent and 33 percent of the sample farmers reported that they receive more yield gain of 10-15 percent and 15-20 percent over HYV rice. Regarding the frequency of replacing hybrid seed, 79 percent of hybrid adopters indicate that they replace hybrid seed every year, while 21 percent reported replacing seeds variety every alternate year.

Hybrid seed can be used only one time, while HYV seeds can be used from the produce after each harvest. The agriculture department is providing the hybrid seed only to the select farmers in a village due to inadequate supply. The sample farmers reported that yield gain of hybrid rice was better than HYV rice. The average yield of hybrid rice is 12-15 percent higher than that of the HYV rice. The majority of them feel that the hybrid seed cost is very high in the market.

Nearly 97.5 percent used chemical fertilizers, 67.5 percent received the assistance from institutional bodies about the usage of fertilizers out of which 62.5 percent followed the recommendations and 37.5 percent didn't follow due to lack of awareness and the financial constraints. With regard to the source of availability of the fertilizers, around 55 percent accessed through government agency and 45 percent brought them from private market.

The proportional usage of fertilizers among hybrid and HYV rice cultivators show that generally hybrid rice adopters use more fertilizers than HYV rice cultivators. A majority of them (73 percent) reported that hybrid rice adopters utilized additional fertilizers than that of HYV rice cultivators. It is noted that the hybrid rice

adopters used more fertilizers than the farmers using HYV rice varieties due to superior yield and minimal damage to crop because of pests and diseases.

About 83 percent reported that their crops have been directly attacked by pests and diseases. A majority of them (83 percent) reported that they have applied pesticides to control pests and diseases. Regarding the easy availability of pesticides, 80 percent reported that they easily get the pesticides in the market. About 96 percent reported that they have used pesticides in correct doses for the plant protection. A majority of them (95 percent) reported that hybrid rice varieties are more susceptible to pests and diseases and they spread through air from neighbouring farms.

HYV rice adopters were more aware about the use of pesticides than hybrid rice adopters due to new arrival in the farm. About 76 percent noted that their ideas about hybrid rice cultivation are highly sensitive to crop management practices-use of key inputs and time bound operations. Thus, the hybrid rice adopters should follow the recommendations of the agricultural scientists and agricultural officials of the Government.

About 31.20 percent are in need of more credit for using hybrid seeds. About 38 percent obtain credit from commercial banks or co-operative banks. The majority of sample farmers (58 percent) receive credit from co-operative banks as they are located nearby and also easily accessible. A majority (71.20 percent) of the farmers have reported that banking institutions take a long-time for providing credit facilities. It is noted that hybrid rice adopters need more money than HYV rice cultivators as the cost of cultivation of hybrid rice is relatively higher than that of the HYV rice.

About 98 percent reported that they face problems relating to marketing of hybrid rice. Traders did not accept the hybrid rice on par with HYV rice in the market. Demand for the hybrid rice is relatively low in the market and they discourage these varieties by offering low price. Lower price is the major challenge the farmers are facing in selling the hybrid variety. The other perceptions prevailing about the hybrid varieties include lack of consumer demand for these varieties, poor cooking and preservation and getting broken during the milling stage. All these together push the price of hybrid varieties southward.

7.3 Farmers' Perceptions Relating to Hybrid Rice Cultivation

About 83 percent reported that they have more yield gain from hybrid rice cultivation over HYV rice due to advanced technology used. About 58 percent reported that they enjoyed more profits due to adoption of hybrid rice cultivation.

Hybrid rice is considered to be inferior in terms of quality than HYV rice. About 36 percent reported that grain quality of hybrid rice is poorer than HYV rice. The hybrid rice is poor in quality due to lack of seed quality and poor germination. More than half of the sample farmers (56.40 percent) have reported that hybrid rice is not tastier. About 68 percent reported that hybrid rice is poor in terms of cooking quality.

About 91.20 percent respondents have reported that the traders and millers did not generally accept the hybrid rice grain. Hybrid rice grain quality is very poor in comparison with the grain quality of HYV rice. Traders and millers could not sell their hybrid grain in the open market. A majority of the people rejected hybrid rice grain in the market due to the low quality of grain, poor taste, broken rice and it does not align well with the south Indian taste buds.

Regarding the economic viability of hybrid rice cultivation, 69 percent responded that they are convinced about it and 31 percent gave a negative answer. About 60 percent reported about the non-availability of seeds and felt that the cost of cultivation for hybrid rice is very high. The others (32 percent) reported that hybrid rice cultivation is more susceptible and vulnerable to pests and diseases.

About 57.50 percent have reported that they did not intend to continue growing the hybrid rice in future. The others (42.50 percent) reported that they were willing to continue the hybrid rice cultivation given the fact that the hybrid seeds are free of cost and technical advice is given by the agriculture department, Government of Tamil Nadu. A majority of the sample respondents (85 percent) reported that they will get high yield from hybrid rice cultivation by continuing the cultivation.

7.4 Reasons for Non-adoption of Hybrid Rice Cultivation in the Farm Field

About 60 percent have not heard of any of the new hybrid rice varieties in the study area. Hence, they have no reason to shift to a new variety with all the accompanying risks. This is also evident from the fact that about 40 percent of the non-adopters fully know about the hybrid varieties but preferred to continue with HYVs. Further, two thirds of the farmers (65 percent) feel that the profitability is lower even with higher yield. And all the respondents find that hybrid rice varieties command lower price and about 20 percent felt that it required more fertilizers which mean high cost. The sample farmers (55 percent) have known two hybrid rice varieties (KRH, KRH-2).

About 45 percent reported that they have heard of the Government hybrid rice promotion programme. The remaining 55 percent do not know about the hybrid rice promotion scheme. A majority of the farmers are using HYV rice and they have been getting adequate yield and profit. The agricultural officials of that district could not spread the hybrid rice cultivation through all those households, under these circumstances.

More than half of them (55 percent) have received suggestions from village level workers and agricultural officers. A total of 55 percent of non-adopters had expressed their willingness to grow the hybrid rice varieties in the next year. The main reason for the non-adoption is that the farmers have not heard of the availability of government assistance.

About 93 percent of the non-adopters have reported that they have not heard about the assistance for adoption of hybrid rice seeds. According to non-adopters, the lower price for hybrid rice compared to HYV rice is yet another major reason for not adopting the hybrid varieties. About 65 percent of the non-adopting sample farmers have not witnessed the hybrid rice varieties in the nearby area.

About 35 percent of the non-adopting farmers reported that they could not get pure quality of hybrid seeds in the study area. The Government provides hybrid seeds bought from the private sector. Half of the non-adopters (50 percent) reported that they are ready to accept new hybrid rice varieties in future considering higher yield gain. A majority of the sample farmers have known about hybrid rice yield gain and profitability. Many of them do not know about the support and assistance of the government. Therefore they are ready to accept hybrid rice varieties because of higher yield and free seeds issued by the Government with other technical support to the farmers.

The farmers face many constraints in the marketing of the hybrid rice. Both the private traders and the Government procurement centre in the study area are not trading the hybrid rice varieties on par with other varieties. In addition, Government Procurement Centre could not fix higher price for the hybrid rice due to poor grain quality and broken condition. Therefore, the hybrid rice cultivators are getting lower price for their produce in the private market as well as in the Government procurement centre.