PREFACE

Though we achieved self sufficiency in food production by now, the productivity level of several crops in our country was very low. Suboptimal use of inputs and insufficient adoption of most productive technology, often linked to lack of market integration leads low productivity. About 44 per cent of total operated area was ploughed by 85 per cent of the total cultivators who were small and marginal farmers. The people operating small farms in developing countries have to cope with the risks of these small businesses and have long faced heavy challenges. Today, these challenges are particularly severe and the aspirations of young people on small farms have changed. Globalization and the integration of international markets are stimulating intense competition, offering some opportunities but also new risks. The transformation in agriculture poses the biggest economic challenges of our time. It entails growth into specialized, market-oriented farms to few; for others, part-time farming combined with off-farm rural jobs; and for others, a move out of agriculture. Policy must take a long-run view to support and guide this process efficiently, effectively and in social fairness. In Tamil Nadu on an average 92 per cent of the operational holdings are predominated by marginal and small farm category. More than 75 per cent of the holdings are ploughing less than 0.37 hectare only. In Tamil Nadu, the Agricultural sector witnessed deceleration from 1990ôs onwards since the growth in agriculture face major constraints such as growing water scarcity, increasing land degradation, urbanization, declining farm sizes and rise in cost of labour. It is also known that small farmers face several challenges in the access to inputs and marketing. They need a level playing field with large farms in terms of accessing land, labour, water, inputs, credit, technology and markets towards increase in Productivity.

The study entitled ñIdentification of Strategies to increase the Productivity at Small and Marginal Farms in Tamil Naduò funded by the State Planning Commission was taken up to address the above issues in a systematic manner.

The research team whole heartedly acknowledges the financial support from the State Planning Commission, Government of Tamil Nadu and also support extended by the Scientists at the Regional and Agricultural Research Stations, Krishi Vigyan Kendra, officials of the Department of Agriculture, Co-operatives, Commercial banks and sample

respondents who enthusiastically participated in the discussions while collecting information and data. It is our humble duty to express our sincere thanks to the Vice ï Chancellor and Member (Agriculture and Irrigation) for all his technical guidance and support in implementing this research project. We gratefully acknowledge the administrative support and guidance extended by the Director (CARDS).

M.Thilagavathi

Identification of Strategies to increase the Productivity at Small and Marginal Farms in Tamil Nadu

Executive Summary

Agriculture as the single largest industry of our country gives direction and substance for the speedy growth of the nationôs economy through contributing 14.8 per cent share in GDP and creating 56 per cent of workforce to the country. Since from 1950-51, fivefold increase in food production (i.e. from 50.8 MT to 203 MT in 1999-2000 and 247 MT in 2012 - 13) can be achieved through technological breakthrough and also with farming communityôs enterprising sprit and hard work. Even though we achieved self sufficiency in food production by now, the productivity level of several crops in our country was very low. The increasing number of holdings as well as growing marginalisation of land holdings has become a matter of concern to the policy makers. About 85 per cent of the total cultivators were small and marginal farmers. They have shared 44 per cent of total operated area in India with the average size of small holdings as 1.42 ha. and marginal holdings size as 0.38 ha. In Tamil Nadu on an average 92 per cent of the operational holdings are predominated by marginal (77.19%) and small farm (14.56%) category (Agrl.census 2010 -11). More than 75 per cent of the holdings are ploughing less than 0.37 hectare only. Thus, the small holding character of Indian agriculture is much more prominent today than even before.

In Tamil Nadu, the Agricultural sector witnessed deceleration from 1990ôs onwards (Net sown area reduced from 6.03 m.ha to 4.95 m.ha during the period 1960 -2011) due to growing water scarcity, increasing land degradation, urbanization, declining farm sizes and rise in cost of labour. Recurring droughts and price crashes due to seasonal gluts, insufficient storage facilities, poor marketing facilities, non availability of credit and insurance facilities to small and marginal farmers increases the vulnerability of these groups due to income variations. Under these circumstances, it needs to examine the productivity performances of small and marginal farms in Tamil Nadu. Hence this study proposed with the following objectives,

Objectives of the Study

1. to identify the productivity gap of major crops grown at farm level in different production environments
2. to assess the constraints in terms of resource access (land, water, labour, credit and technology) at farm level
3. to assess the awareness and adoption level of crop production technologies at farm level
4. to study the level of support of various institutions and infrastructure facilities to small farms in Tamil Nadu and
5. to analyse the factors responsible for the yield differences at farm level and to suggest the suitable policy measures to increase the productivity level at small farms in Tamil Nadu

Sampling and Methodology

This study was based on primary data regarding general particulars of sample farms, cropping pattern, productivity of crops, resource use pattern, technology awareness and adoption, input access, risk, climate change adaptation mechanism, institutional support and marketing (Finance, extension services, storage, marketing and other infrastructural facilities) constraints were collected at farm level by using structured interview schedule. The other relevant data on general particulars of the study area, inputs availability, institutional facilities, etc. was collected from the relevant secondary sources. Three stages purposive sampling method was followed in the selection of district, block and villages. Thus five districts namely Villupuram, Salem, Dindigul, Thanjavur and Ramanathapuram were selected from five agro climatic zones except high rainfall and hilly zones of Tamil Nadu. From the selected districts Vanur, Thalaivasal, Thoppampatti, Orathanadu and Muthukulatoor blocks were selected. From each block six villages (5× 6 villages) covering major crops in total 30 villages were selected for the study based on the similar criteria. From each village ten farmers were selected randomly for the study. Thus the total sample farmers of 300 numbers (5 ×1× 6 ×10) were selected. To assess the constraints faced by both irrigated and rainfed farmers both the farmers

were selected proportionately based on area under irrigation and rainfed situation from the selected blocks for the study. The details were collected through personal interview method by using prepared structured interview schedule from the sample farmers and collected data were analysed by using descriptive statistical tools, yield gap analysis, garrettôs scoring technique and production function model.

Salient Findings of the Study

- The average size of holding is lesser in Villupuram district i.e 0.89ha when compare to other districts. Well is the main source of irrigation i.e. more than 85 per cent of cultivated area is irrigated through wells in Villupuram, Salem, Dindigul districts. Tanks and canals are the major sources of irrigation in Ramanathapuram and Thanjavur districts which was supplemented through wells.
- The cropping intensity was very high in Dindigul district (179%) followed by 161 and 149% in Thanjavur and Salem districts. It was very low in Villupuram and Ramnad districts i.e 128 and 116%.
- In Villupuram district, paddy occupies (43 per cent) major share in net sown area followed by sugarcane (19.1 per cent) and ground nut (12.3 per cent). Pulses, cumbu, cotton and ragi crops shared major area under cultivation.
- Paddy occupies major area (0.41 ha) with the average productivity of 5461 kg/ ha in sample farms of Villupuram district followed by sugarcane. ADT37 and BPT5204 varieties were preferred by most of the farmers in this district. The yield gap in paddy was assessed as 2.04 t/ha in Villupuram district. The variety Co86032 in sugarcane was preferred by the farmers widely in Villupuram district. The average yield of sugarcane was 125 t /ha. The yield gap in sugarcane was identified as 35t/ha. Green gram (Co2), Tapioca (MVD 2) and Groundnut (TMV 7) were the other major crops in sample farms of Villupuram district.
- In Salem district, more diversified cropping pattern was observed. In food crops, Paddy and maize occupies 16 and 13 per cent share of total net sown area followed by tapioca and ground nut which is mostly grown in rainfed situation. The high value crops like cotton, sugarcane, turmeric, coconut and mango are the other major crops major crops grown in this district.

- Turmeric crop (BSR 1, Co 2) occupies major area (0.46 ha) under irrigated situation followed by maize crop (0.31ha) in Salem district. Hybrid varieties (NK 6240, NK6866 and Pioneer) are preferred by the farmers in maize. The average productivity of maize was 3.9 t/ha. The sorghum crop (Paiyur 2) was cultivated mainly for fodder purposes The average productivity was 9.3 tonnes per ha. Paddy (ADT 45) and tapioca (Rose and MVD 1) are the other major crops found in sample farms. The average productivity of paddy was 5.2 t/ha and it was 31 t/ha for tapioca. The yield gap for paddy, maize and Sorghum crop was 1.13 t/ha, 1.33 t/ha and 1.24 t/ha.
- Coconut and fodder sorghum crops were identified as major crops followed by maize both under irrigated and rainfed condition. Vegetables and medicinal crops took major share in crop cultivated area in Dindigul district.
- In Dindigul district, fodder sorghum (Co(S)28, Co 30, Co 8) occupies major area both in irrigated and rainfed condition (0.26 and 0.16 ha) with the average productivity of 8.3 t/ha followed by maize (Pioneer, ganga,naga, Co3, Gothavari, kanchan) in sample farms(0.33 and 0.06 ha) with the average productivity of 3.7 t/ha. Paddy (ADT45, CO43, white ponni) and Ground nut (TMV 7) are the other major food crops grown in sample farms. The average productivity of paddy and ground nut was 5.2 and 2.7 t/ha. Vegetables and medicinal plants occupies major share in other crops. The yield gap was 1.0 t/ha, 1.8t/ha and 1.5 t/ha in paddy, maize and sorghum crops.
- In Thanjavur district, Paddy (ADT 36, 38 and 43) and pulses (black gram VBN 2) occupies major area of cultivation. The other crops like sugarcane, ground nut, tapioca occupies major area in the district.
- In Thanjavur district, Paddy and black gram occupies major area (1.17 and 0.44 ha) in sample farms followed by ground nut. The average productivity of paddy, black gram and groundnut was 5.2, 2.4 and 2.7 t/ha. The yield gap was 2.1, 1.3 and 1.7 t/ha in paddy, black gram and ground nut.

- In Ramanadhapuram district, Paddy (ADT 36 and MDU 5), chillies (Mundu), cotton (MCU 7), coconut and sugar crops occupies major area. In sample farms, paddy, chillies, cotton and sorghum occupies major area (0.47, 0.41, 0.13 and 0.13 ha). The average productivity of paddy, chillies and cotton was 4.4, 1.5 and 1.2 t/ha. The yield gap was 0.9, 0.3 and 0.2 t/ha.
- Level of awareness on crop varieties was found to be high among farmers in Dindigul (83%), Thanjavur (80%), Salem (75%), Villupuram (75%) and very low in Ramanadhapuram (6.7% of sample farmers).
- Level of awareness seems to be high in drip irrigation methods i.e 80%, 72%, 70%, 63% and 55% in Dindigul, Thanjavur, Villupuram, Salem and Ramanathapuram districts followed by mechanization.
- Awareness level was high in soil and water testing i.e 40.0% and 46.7% in salem and low in Ramanathapuram i.e 20.0% and 13.3%.
- Level of awareness on fertilizer doses, time and level of application of fertilizer and application of plant protection chemicals seems to be high in Salem and Dindigul districts and it was low in other districts.
- Technology adoption was seems to be high in varietal adoption as 60%, 53%, 47% in Thanjavur, Dindigul and Salem districts and low in Ramanathapuram district (6.7%) but it was 33% in Villupuram district.
- Level of adoption on fertilizer doses and time of application of fertilizer and adoption of recommended plant protection chemicals seems to be high in Dindigul, Salem and Thanjavur districts and it was low in other districts.
- Mechanization was followed at higher level in Thanjavur (63%), Salem (50%) and low in Villupuram (47%), Ramanathapuram (43%), Dindigul (40%) districts.
- In Villupuram, Salem, Dindigul and Thanjavur districts most of the sample farmers unaware about the soil testing. Occurrence of problem soil and higher cost in land reclamation were the major problems in Ramanathapuram district.

- Inadequacy of rainfall and its poor distribution, non availability of seed and labour in peak time and higher wages found to be the major problems in all districts. Poor knowledge on technologies due to lesser contact with technical persons, non availability of tools and machineries suitable to small and marginal farms were the major identified constraints for lower productivity at farm level in study districts.

Conclusions

The future of sustainable agriculture growth and food security in India depends on the performance of small and marginal farmers since they occupies more than 85percent of the total cultivators and shared 44 per cent of total operated area. In Tamil Nadu we have experienced deceleration in agricultural growth since from 1990ôs onwards. The results of this study revealed that small and marginal farms are having more crop mix and intensive cultivation practices. Food crops along with commercial crops took major share in crop cultivation. The sample farmers in all districts do not possess the knowledge on soil and water quality assessment and suitable crop varieties which are the foremost needed one to increase the productivity level. Inadequate rainfall, drought, cost of labour and non availability of seeds and labour in required time were the major constraints affected the productivity of all crops. Input dealers are playing key role in providing technical guidance to the farmers.

Policy implications

1. Small farms are having more crop mix and intensive cultivation practices. Hence the farmers could be taught with soil testing and land reclamation measures in detail. Recommendations based on soil test should be thoroughly explained to the farmers by the officials.
2. Large scale demonstrations to be conducted for major crops. High yielding varieties may be popularized in paddy, millets and maize crops. Efforts will be taken to demonstrate the crucial technologies to the farmers in major crops.
3. Enhancing the soil health through green manure, FYM, mulching, biofertilizers and micro nutrients application increases the productivity.

4. Integrated Pest and Disease Management would be adopted for pest and disease monitoring and Management and introducing superior crop varieties which are resistant to pest and diseases and introduction of farm machineries suitable for various crop operations increases the productivity of all crops.
5. Strengthening farmer capacity through establishment of networking systems and enabling them to access quality inputs for intensive agriculture production and to adopt best agricultural practices for enhanced productivity.
6. The small and marginal farmers are less capital intensive. Hence they are not in position to invest more in Agriculture which emphasized the need of financial support for them. Hence the procedural formalities in provision of credit may be relaxed for them where ever it is possible.
7. The non- farm employment opportunities provides more livelihood support for the small and marginal farmers. Hence efforts will be taken to increase the suitable non ï farm employment opportunities in rural areas.
8. To cope up the rainfall deficiency, efforts will be taken to intensify the implementation of water shed development activities towards construction of check dam and creation of farm ponds. Also water conservation technologies like drip irrigation methods may be popularized among the small farms
9. To cope up labour scarcity in rural areas mechanization may be popularized through demonstration.
10. Different models for marketing collectively by the small and marginal farmers like self help group model, co-operative model, small producer co-operatives and contract farming may be practiced to overcome constraints in accessing inputs, credit, extension and marketing.
11. Proper maintenance and management of godowns built confidence among the farmers to store their commodity in godowns. Measures will be taken for proper management of godowns.

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Identification of Strategies to increase the Productivity at Small and Marginal Farms in Tamil Nadu

1. Introduction

Agriculture as the single largest industry of our country gives direction and substance for the speedy growth of the nationôs economy through contributing 14.8 per cent share in GDP and creating 56 per cent of workforce to the country. Since from 1950-51, fivefold increase in food production (i.e. from 50.8 MT to 203 MT in 1999-2000 and 247 MT in 2012 - 13) can be achieved through technological breakthrough and also with farming communityôs enterprising sprit and hard work. Even though we achieved self sufficiency in food production by now, the productivity level of several crops in our country lags behind with our neighboring countries which are all enjoying similar agro-climatic condition. It shows that the full potential of our land have not been tapped in our country towards achieving the production. It may be due to uneconomical size of holding (i.e 2.3 ha. in 1970-71 to 1.42 ha. in 2010-11) due to increase in population, subdivision and fragmentation of land holdings due to breakdown of joint family system encouraging conversion of semi-medium and medium group of farmers into group of small and marginal farmers and prevalence of gap in technology transfer and adoption of recommended technologies at farm level.

The increasing number of holdings as well as growing marginalisation of land holding has become a matter of concern to the policy makers. As per Agricultural Census reports, the number of operational holdings increased substantially from 70.49 million in 1970-71 to 97.73 million in 1985-86 which further increased to 105.29 million in 1990-91 and 117 million in 2010 -11. A major shift has been in marginal and small farm holdings. About 85 per cent of the total cultivators were small and marginal farmers. They have shared 44 per cent of total operated area in India with the average size of small holdings as1.42 ha. and marginal holdings size as 0.38 ha(Annexure 1). Thus, the small holding character of Indian agriculture is much more prominent today than even before. The future of sustainable agriculture growth and food security in India depends on the performance of small and marginal farmers. It was also observed that, the small farms output in terms of physical quantity and in value terms are varying state to state which was

higher in Punjab, but it was lower in Tamil Nadu. Thus, the declining average farm size in developing countries may not demonstrate any superior economic efficiency of small farms. It does, however, indicate that even tiny landholdings remain a valued component of a diversified livelihood in the presence of highly imperfect land, labor, and capital markets.

Small farms are typically operated by poor people who use much labor from both their own households and their (equally or more) poor neighbors. Many farm surveys have shown that the smaller the holding, the more labor per unit area is applied (Cornia, 1985; Heltberg, 1998). If there were no transaction costs in labor markets, this would not happen, but given the costs of supervising hired labor, larger farmers tend to employ fewer workers than would otherwise be optimal. Moreover, small farm households have more favorable expenditure patterns for promoting growth of the local nonfarm economy, including rural towns. They spend higher shares of incremental income on rural non tradables than large farms (Hazell & Roell, 1983; Mellor, 1976), thereby creating additional demand for the many labor-intensive goods and services produced in local villages and towns. Notwithstanding the advantages of small farms in developing countries, policy has often favored large farms, through access to subsidized credit, protection for the output of such farms, and infrastructure provision in areas of large farms, among other measures. Policy makers have often seen large farms as modern, technically advanced, and efficient, a view reinforced by large-scale farmers themselves who are often better organized to lobby for public support.

The economic reforms did not include any specific package specifically designed for agriculture. Particular worry is agriculture sector which showed lower than 2% per annum in the decade of mid-1990s to mid-2000s. Fortunately, it recorded growth of 3.5 per cent per annum during 2004-05 to 2010-11. 12th Five Year Plan (2012-17) aims to achieve 4% growth in agriculture. The 12th Five Year Plan Approach Paper also indicates that agricultural development is an important component of faster, more inclusive sustainable growth approach. The per capita availability of agricultural land in India is shrinking from 0.46 ha (1951) to 0.15 ha. in 2010 as against the global average of 0.6 ha. The per capita availability of water is decreasing day by day. It was more than 5300 m3 in 1951, had decreased to 1905 m3 in 1999 and is likely to be less than 1500 m3 by 2025 which is ñstressò level. The agriculture sector in India uses nearly 85% of the available water

though the irrigation efficiency is only 20 to 50%.While taking agriculture progress as a whole, Tamil Nadu has registered a recorded annual growth rate of 2.2 to 2.4 which is far below to national average of 2.67 per cent per annum.

Subsequently it was observed that there has been significant increase in the use of modern inputs in Indian agriculture over time. During the period 1950ï 51 to 2003ï 04, the percentage of net irrigated area to net cultivated area increased from around 17 to 41. The literature showed that the access to irrigation has increased for all categories of farmers (40 to 51% at small farm level and 16 to 31% at large farm level) but it was observed that the large farmers capitalize on cheaper sources like canals while small farmers have to rent water. About 40 per cent of the irrigated area for large farmers was from canals while it was less than 25 per cent in the case of small and marginal farmers (NCEUS, 2008). Small farms are having more crop mix and intensive cultivation practices. During the same period, fertilizer consumption showed a significant rise from less than 1 kg/ha to 90 kg/ha. Similarly, the percentage of area under high yielding varieties (HYVs) to cereals cropped area has risen from 15 in 1970ï 71 to 75 in the late 1990s. The share of agriculture in electricity consumption also rose from 4 per cent in 1950ï 1 to nearly 30 per cent in recent years. All this led to a significant increase in agricultural output over time. There are also high returns from investments in agricultural R&D, rural roads and other infrastructure and knowledge generation. But the higher productivity of smallholdings would disappear with the adoption of superior technology, modernisation and growth in general. It is also known that small farmers face several challenges in the access to inputs and marketing. They need a level playing field with large farms in terms of accessing land, labour, water, inputs, credit, technology and markets. Small holdings also face new challenges on integration of value chains, liberalization and globalization effects, market volatility and other risks and vulnerability, adaptation of climate change etc. (Thapa and Gaiha (2011). Recent ñworld-wide processes of farm change ï commercialisation of increasing proportions of input and output: institutional developments such as super markets; privatization of key aspects of technical progress, and of output and process grades and standards ï now indicate large farm focusò (p.59, Lipton, 2006). Therefore, support is needed for small holdings in the context of these world-wide processes of farm change.

Agriculture at a glance in Tamil Nadu: The overall state economy has recorded an impressive growth rate with both the GSDP and NSDP at constant prices showing a compound growth rate of about 6.7 per cent per annum during the period 1999-2000 to 2008-09, while the GSDP and NSDP from agricultural and allied activities have recorded a meager growth of only 1.5 per cent per annum during the same period. The share of agriculture in the Net State Domestic Product at current prices has declined from 15.93 per cent to 11.48 per cent during the latest decade. The gross cropped area in 2010-11 accounted for about 44.1 per cent (5.75 m ha.) of the total geographical area, with a net area sown for 38 per cent (4.95 m ha.) which was declining gradually from 6.03 m.ha from1960 onwards. The area under fallow lands including culturable waste, current and other fallow lands are increasing steadily over a time period. Fifty eight (58 %) per cent of the net area sown was irrigated (2.91 m ha) in Tamil Nadu. The gross irrigated area reached a peak of 35 lakh ha during the 1970s after which it is decreasing to around 33 lakh ha in 2010-11.The stateôs irrigation potential in terms of per-capita is lower i.e., 0.08 ha., than Indiaôs average of 0.17 ha. The dryland farming covers a sizeable area constituting close to 50 per cent of the gross cropped area in the State and remains inefficient in terms of productivity due to non realization of their full potential. The annual average rainfall at all India level is 1200 mm whereas the rainfall in Tamil Nadu is 930 mm. The cropping intensity of the state was 1.161 during 2010 -11.The cropping pattern of the state shows that paddy occupies 33 per cent followed by millets and pulses each 11 per cent. Food and non food crops shared 74% and 26% of the total cropped area. The crops viz., maize, sunflower, fruits, vegetables, plantation crops and sugarcane recorded significant positive growth rates in all the three parameters viz., area, production and productivity. In spite of the significant positive growth in yields, the area under sorghum, bajra, groundnut, and cotton has declined significantly.

In Tamil Nadu, the Agricultural sector witnessed deceleration from 1990ôs onwards since the growth in agriculture face major constraints such as growing water scarcity, increasing land degradation, declining farm sizes and rise in cost of labour. In Tamil Nadu on an average 92 per cent of the operational holdings are predominated by marginal (77.19%) and small farm (14.56%) category (Agrl.census 2010 -11). More than 75 per cent of the holdings are ploughing less than 0.37 hectare only. Agricultural lands

have also come under increasing pressure due to rapid urbanization. Tamil Nadu ranks first in urbanisation among the fifteen major States in the country. According to the 2001 Census, Tamil Nadu has emerged as the State with the highest level of urbanisation (43.86 per cent) in the country. Recurring droughts and price crashes due to seasonal gluts, insufficient storage facilities, poor marketing facilities, non availability of credit and insurance facilities to small and marginal farmers increases the vulnerability of these groups due to income variations. Moreover, the land use, cropping pattern and crop diversification underwent significant changes in the last two decades in Tamil Nadu.

Under these circumstances, it needs to examine the productivity performances of small farmers in terms of trends in agricultural growth, cultivation patterns, access to resources (land, labour, water, inputs including technologies and credit), participation of small holding agriculture in various developmental programmes, linking small holders with markets, differential policies and institutional support for small holders and, challenges and future options for small holding agriculture including information needs for the livelihood improvement of small farms through higher productivity achievement in small farms.

2. Review of Past Studies

During the 1960s and 1970s there was an intense debate on the observed inverse relationship between farm size and per hectare agricultural productivity in India. It was subsequently argued that the higher productivity of smallholdings would disappear with the adoption of superior technology, modernisation and growth in general. A large number of studies during the 1960s and 1970s provided convincing evidence that crop productivity per unit of land declined with an increase in farm size (Sen 1962, 1964; Mazumdar 1965; Khusro 1968; Hanumantha Rao 1966; Saini 1971; Bardhan 1973; Berry 1972) which provided strong support for land reforms, land ceiling and various other policies to support smallholders on ground of efficiency and growth. Subsequently, various analysts started exploring reasons or factors for higher productivity of smallholders (Berry and Cline 1979; Bhalla 1979; Binswanger and Rosenzweig 1986; Dong and Dow 1993; Frisvold 1994; Raghbendra et al 2000) and some of them even questioned the inverse relationship between farm size and productivity. Bhalla and Roy (1988) observed that the

inverse relation between farm size and productivity weakened and disappeared when soil quality variable was included in their study. Chadha (1978) analysing farm level data for three agro-climatic regions in Punjab for 1969-70, reported that the inverse relationship had ceased to hold in more dynamic zones. Ghose (1979) argued that an essential precondition for the existence of the inverse relationship phenomenon is technical backwardness implying that with the advances in technology the inverse relationship will vanish. Similar to this, Deolalikar (1981) observed that the inverse size-productivity relationship cannot be rejected at low levels of agricultural technology in India, but can be rejected at higher levels. Rudra (1968) concluded that ñthere is no scope for propounding a general law regarding farm size and productivity relationshipò. Chattopadhyay and Sengupta (1997) in the context of West Bengal, reported that the inverse relation between farm size and productivity was stronger in agriculturally developed regions. On the other hand, Hanumantha Rao (1975) and Subbarao (1982) reported a positive relationship between farm size and productivity and attributed this to higher application of fertiliser and other cash-intensive inputs on large farms. Dyer (1997) argued that the inverse relationship is neither a product of superior efficiency on the part of small farms nor is it due to better quality land on the small farms but arises from the desperate struggle for poor peasants for survival on below subsistence plots of land. Hence, Dyer (1997) opined that redistribution of land on the basis of the inverse relation argument, far from alleviating poverty and creating employment opportunities, will only deepen and perpetuate extreme levels of exploitation and poverty. Foster and Rosenzweig (2010) using plot level panel data (over the span 1999-2008), of the Rural Economic Development Survey (REDS) data of the National Centre for Agricultural Economics and Policy Research (NCAER), and using a model incorporating supervision costs, risks, credit-market imperfections and scale economies associated with mechanisations, report that small-scale farming is inefficient in India. Thapa and Gaiha (2011) using all India survey, REDS, 2006 of NCAER data analysed the farm size crop yields relationship, using the Kernel density function, and observed that the relation varies with food commodity group. They also report that ñwhile much lower fractions of smallholders are concentrated in lower ranges of yields compared with medium-and large-landholders, segments of smallholders also obtain very low yieldsò. Fan and Connie (2005) show that to increase labour productivity, and

therefore, farmerôs income, either land productivity has to increase or land to labour ratio has to improve. Given the consensus that smaller farms have a lower land-labour ratio than large farms, Dyer (1997) and Havnevik and Skarstein (1997) argue that smaller farms enjoy higher land productivity in the short term, but over the long-term land productivity tends to drop. They argue that this long-term drop in land productivity results from over intensive cultivation of the land in order to maintain labour productivity, when more and more people need to survive on the same small area of farmland, and as the smaller farms are resource-poor to invest in preserving soil fertility, soil productivity eventually becomes exhausted and land productivity drops. A similar reasoning is given by Hazell (2011) who also maintains that many of the advantages of smallholders disappear as countries develop. The reasoning given for this is that as the per capita income rises, the economy diversifies and workers leave agriculture and the wage rate goes up. It then becomes more efficient to have progressively larger and more mechanised farms. Lower productivity and slow growth in some developing countries and in small family farms raise specific concerns. The gap between farmers' yields and technical potential yields reflects the largely suboptimal use of inputs and insufficient adoption of most productive technology, often linked to lack of market integration. Yield gaps were estimated to range from 11% in East Asia to 76% in Sub-Saharan Africa in 2005 (FAO, 2011b). Measures to reduce the productivity gap between actual levels and the technical potential could offer high returns in terms of food security, nutrition and rural income gains (World Bank, 2008). Studies show that high returns can also be achieved by reducing gender gaps in productivity on small family farms. According to FAO, closing gender productivity gaps associated with unequal access to resources and inputs could raise total agricultural output in developing countries by 2.5-4%, leading to a reduction of 12-17% in the number of undernourished globally (FAO, 2011a).

3. Objectives of the Study

1. to identify the productivity gap of major crops grown at farm level in different production environments
2. to assess the constraints in terms of resource access (land, water, labour, credit and technology) at farm level

3. to assess the awareness and adoption level of crop production technologies at farm level
4. to study the level of support of various institutions and infrastructure facilities to small farms in Tamil Nadu and
5. to analyse the factors responsible for the yield differences at farm level and to suggest the suitable policy measures to increase the productivity level at small farms in Tamil Nadu

4. Sampling and Methodology

Considering various agro-climatic zones of Tamil Nadu, except hilly and high rainfall zones all other 5 zones of Tamil Nadu considered for the study (Table 1). Three stages purposive sampling method has been followed in the selection of district, block and villages by using net cropped area, proportion of small and marginal farmers and sources of irrigation (Well, Tank+Well, Canal and Tank) as basic criteria (Annexure 2). Thus five districts namely Villupuram, Salem, Dindigul, Thanjavur and Ramanathapuram were selected for the study. From the selected districts Vanur, Thalaivasal Thoppampatti, Orathanadu and Muthukulatoor blocks were selected purposively for the study. From each block six villages (5× 6 villages) covering major crops in total 30 villages were selected for the study based on the similar criteria. From each village ten farmers were selected randomly for the study. Thus the total sample farmers of 300 numbers (5 ×1× 6 ×10) were selected from the five agro climatic zones of Tamil Nadu (Table 3).To assess the constraints faced by both irrigated and rainfed farmers both the farmers were selected proportionately based on area under irrigation and rainfed situation from the selected blocks for the study. The data regarding general particulars of sample farms, cropping pattern, productivity of crops, resource use pattern, technology awareness and adoption, input access, risk, climate change adaptation mechanism, institutional support and marketing (Finance, extension services, storage, marketing and other infrastructural facilities) constraints were collected at farm level by using structured interview schedule. The other relevant data on general particulars of the study area, inputs availability, institutional facilities, etc. was collected from the relevant secondary sources. To supplement the data gathered in the questionnaire surveyfocus group discussions were conducted at

different levels which help us to understand the constraints at farm and village level which makes hurdles in achieving higher productivity. Data generated through household surveys will be tabulated and processed by statistical analysis to derive useful conclusions and to suggest the strategies to increase the productivity of small and marginal farming.

Table 1. Different Agro Climatic Zones of Tamil Nadu

SI.No	Agro Climatic Zones	Districts Covered	Soil type
1	North Eastern Zone	Kancheepuram, Thiruvallur, Cuddalore,Vellore,Villupuram and Tiruvannamalai	1.Red Sandy Loam 2.Clay Loam 3.Saline Coastal Alluvium
2	North Western Zone	Dharmapuri, Krishnagiri, Salem and Namakkal (part)	1. Non Calcareous Red 2. Non Calcareous Brown 3.Calcareous Black
3	Western Zone	Erode, Coimbatore, Tiruppur, Theni, Karur(part),Namakkal (part),Dindigul, Perambalur and Ariyalur(part)	1.Red Loamy 2.Black
4	Cauvery Delta Zone	Thanjavur, Nagapatinam, Tiruvarur, Trichy and parts of Karur,Ariyalur,Pudukkottai and Cuddalore	1.Red Loamy 2.Alluvium
5	Southern Zone	Madurai,Sivagangai,Ramanathapuram, Viruthunagar,Tirunelveli and Thoothukudi	1. Coastal Alluvium 2.Black 3.Red Sandy Soil 4.Deep Red Soil
6	High Rainfall Zone	Kanyakumari	1. Saline Coastal 2. Alluvium 3.Deep Red Loam
7	Hilly Zone	7.The Nilgiris and Kodaikanal (Dindigul)	Latertic

Table 2. Sampling Villages and Farmers selected for the study

Agro Climatic zone	Study district	Villages selected	No.of farmers selected
North eastern	Villupuram	Vanur	10
		Semangalam	10
		Konjimangalam	10
		Uppuvelur	10
		Ranganapuram	10
		Nallavur	10
			60
Central	Salem	Navalur	10
		Punavasal	10
		Siruvachoor	10
		Periyeri	10
		Kattukottai	10
		Manivilundhan	10
			60
Western	Dindigual	Kariyampatti	10
		Koothampondi	10
		Kallimanthayam	10
		Porulur	10
		Melkaraipatti	10
		Kothayam	10
			60
Cauvery delta	Thanjavur	Paulavan kadu	10
		Vadacheri	10
		Kavarapattu	10
		Okkanadu keelayur	10
		Kakkarai	10
		Kulamangalam	10
			60
Southern	Ramanathapuram	Nallur	10
		Vengalakurichi	10
		Adhankothankudi	10
		Ponnakaneri	10
		Puliankudi	10
		Prabakalur	10
			60
Total sample size			**300**

4.1Analytical Approach

Descriptive statistical analyses, Average, Percentage, Standard deviation and Coefficient of Variation were used to study the basic characteristics of the sample respondents such as age, education, farming experience, family particulars, area under crops, livestock details, income and employment pattern of sample households and basic details of the study area.

a) Garrett's Scoring Technique

To identify the causative factors for the lower productivity in small farms, the constraints faced by the farmers in access to various resources and knowledge level on various attributes (land, labour, credit, seed, water, fertilizer and chemical inputs, mechanization, information and marketing) contributing on productivity of crops were identified and the farmers were asked to rank them accordingly. Ranks were converted into scores using per cent position for each of the assigned rank by using the following formula.

$$\text{Per cent position} = \frac{100\left(R_{ij} - 0.50\right)}{N} \qquad \ldots\ldots\ldots(1)$$

Where

R_{ij} - Rank assigned for the i^{th} category by the j^{th} respondent

N - Number of reasons assigned by the j^{th} individual

Using the table developed by Garrett, mean of the score was arrived. Highest mean score was ranked first. Thus, according to the mean score, reasons were ranked in each itemwise.

b) Yield Gap Analysis

Several studies stated methods to estimate the yield gap in crop productivity. According to (cf. Lobell et al., 2009) four methods can be distinguished to estimate yield gaps at a local level (1) field experiments,(2) yield contests, (3) maximum farmer yields based on surveys, and (4) crop model simulations. The first step associated with each method is to estimate yield ceilings as represented by Yp (yield under irrigated situation)

and Yw (yield under rainfed situation) for a given crop in a given location or region. Yg (yield gap) is then calculated as the difference between farmerôs Yp or Yw and Ya(actual farm yield). Although field experiments and yield contests can be used to estimate Yp and Yw for a given location and under a specific set of management practices, they require well-managed field studies in which yield-limiting and yield-reducing factors are eliminated (e.g., nutrient deficiencies, and diseases), and they must be replicated over many years to obtain a robust estimate of average Yp orYw and their variation (Cassman et al., 2003). The latter may be a serious limitation in practice because it is difficult to avoid all abiotic and biotic stresses and to do so consistently in a field study lasting several years. Also, in real-world farming, single crops are part of cropping and farming systems that often constrain sowing and harvesting dates. Hence, field experiments and yield contests used as a basis for estimating Yp or Yw must use sowing dates and cultivar maturities that are representative of the prevailing cropping systems in the region of interest if they are to serve as benchmarks for these systems. Surveys among farmers to estimate maximum yields from upper percentiles represent another approach to estimate Yp or Yw (Lobell et al., 2009). If crop production resources (including soil properties) and input levels have also been recorded, methods such as the boundary line approach or frontier analysis can be used to identify the highest yields for a given level of resource availability (Tittonell et al., 2008a; Fermont et al., 2009; Grassini et al., 2009; Hochman et al., 2009; Wairegi et al., 2010; Hochman et al., 2012a). However, if obstacles prevent all surveyed farmers from realizing Yp or Yw, then Yg will be underestimated. Such obstacles must operate at the same scale as the yield gap analysis and could include lack of access to inputs, lack of markets, and lack of knowledge or access to it. While field experiments, yield contests and highest yields obtained by farmers are useful to determine maximum achievable yields in a specific location or across a population of fields (i.e., best genotype × environment× management interaction, G × E× M), it is difficult to know for certain if all biotic and abiotic stresses were avoided.

In this study, Yield Gap is the difference between the progressive farmerôs yield and average farm yield which explains the gap due to soil and climatic factors, crop management factors, technologies available, cultivation practices etcsince the farmers are cultivating old varieties and hybrid varieties in many of the crops.

Yield gap = Yf ï Ya ----------(2)

Progressive farm Yield: Progressive farm yield (Yf) is the yieldof a crop cultivar when grown with water and nutrients nonlimitingand biotic stress effectively controlled situation under the guidance of technical experts.

Average yield (Ya) is defined as the yield actually achieved in a farmerôs field. To represent variation in time and space in a defined geographical region, it is defined as the average yield (in space and time) achieved by farmers in the region under the most widely used management practices (sowing date, cultivar maturity, and plant density, nutrient management and crop protection).

c) Factors responsible for Yield Gap in Paddy farms:

The factors which are affecting the yield in major crops at farm level (Yield gap) was assessed by using the following production function model. The cobb ï douglas production function model was used. Age, education, experience, contact with extension officials or progressive farmers, knowledge level on technology, value on input use are identified as the major explanatory variables which areresponding for the yield variability at farm level. To differentiate the region the score values are given based on area under different irrigation sources (Well, Canal + Well, Rainfed tanks + Well). The determinants are estimated only for Paddy crop because it occupies significant area in sample farms of all sample districts.

$$Yi = ß_0 + ß_1 X_1 + ß_2 X_2 + ß_3 X_3 + ß_4 X_4 + ß_5 X_5 + ß_6 X_6 + ß_7 X_7 + U_i \quad \text{--------} (3)$$

i = 1, 2, é é n.

Y = Yield gap II (kg/ha)

X1 = Actual Farm Size in acres

X2 = Age in years

X3 =Education level (in number of schooling years)

X4 =Experience in farming (in years)

X5 = Contact level with experts (Scores are given if poor =1, Average =2, Good =3)

X6 = Knowledge level (Scores are given if poor =1, Average =2, Good =3)

X7= Value in input use (in RS.)

Ui = Error term.

5. Results and Discussions

The sample farms in the study area were distributed across five districts in Tamil Nadu representing the five agro climatic situation. The data collected from sample farms were analyzed with respect to each of the specific objectives with the methods of analysis as specified above. The results are presented and discussed in this chapter. Conclusions are drawn on the major constraints which hurdles the productivity at farm level in each agro climatic zone wise and factors which are responsible for yield gap at farm level and the strategies are drawn to reduce the yield gap at farm level towards increase in productivity of crops. The discussions are organized under the following topics.

5.1. General characteristics of sample households

5.2. Land holding pattern of sample farms

5.3. Area under crops in districts and sample farms

5.4. Yield gap in major crops grown in sample farms

5.5. Awareness and adoption level of technology in major crops in sample farms

5.6. Constraints on access to various resources at farm level

5.7. Infrastructural facilities development in study area

5.8. Factors responsible for yield gap in Paddy farms

5.1General characteristics of sample households

General (socio ï economic) household and farm particulars of the sample respondents provide a strong insight about the farm householdôs, which in turn help the policy makers to understand how the sample respondents allocate, their resources to attain maximum benefit. Hence the personal characteristics of the farm households like age, education, experience in farming, family particulars, land holding pattern, livestock position, and asset position were discussed in detail. These details provide a thorough understanding about the farm households.

5.1.1 Socio – economic particulars of sample households

Table 3. Socio –economic particulars of sample households

Sl. No.	Particulars	Study area				
		Villupuram	Salem	Dindigul	Tanjavur	Ramanatha-puram
1.	Age of sample farmer (in years)	50	44	49	51	52
2.	Education (in schooling years)	9	7	6	9	6
3.	**Average family size (in no's)**					
	Adults	3.75	3.7	3.5	3.22	3.48
	Children	0.66	1.1	0.45	0.92	0.56
	Average family size	4.41	4.8	3.95	4.14	4.04
	Earners	2.55	2.7	2.63	2.73	2.68
	Dependents	1.86	2.1	1.32	1.41	1.36
4.	Earner-Dependent ratio	1.37	1.29	1.99	1.94	1.97
5.	Number of family labours involved in Agriculture	2.21	2.06	2.08	2.28	2.04
6.	Family labours involvement in agriculture (%)	86.67	76.30	79.09	83.52	76.12
7.	Average asset (farm andhome) value(in lakhs)	5.38	3.33	4.18	4.18	3.04

From the above table it was understood that the middle age to old age group of farmers (40 ï 60 percent of sample farmers) are involving in agricultural activities which implies that the more productive age group of farmers are doing agricultural activities in study area. In Villupuram, Thanjavur and Ramanathapuram districts the sample farmers are comparatively higher aged group of farmers than the sample farmers in Dindigul and Salem districts. It implies that at this age group the farmers are more receptive for the productive technologies which enhance the crop productivity at farm level. The average schooling years of sample farmers also indicated that in all the districts the sample farmers are obtaining the education level upto secondary level. It was observed that the 10 -20 per cent sample farmers at Villupuram and Dindigul districts obtained education level upto collegiate level than other districts. It indicates that the sample farmers are in a position to understand the technology know - how if it reaches them.

It was also observed that in almost all the study districts, more than 85 per cent of sample farmers households are nuclear type with average family size of 4 noôs with more than 75 per cent of earning members are involving intensively in agriculture. The dependents also took the equal share in family size which implied they are demanding for more consumption expenditure in families for their education and health. The sample farmers in Villupuram district possessed higher asset position worth of Rs.5.38 lakhs followed by Dindigul and Thanjavur which implies that they are having capacity to investment in agriculture to certain extent compare to farmers in Salem and Ramanathapuram districts since their asset position was low. It shows that all the sample farmers are in need of financial support to invest more in agriculture.

5.2 Land holding pattern of sample households

Table 4. Land holding Pattern of sample households

Sl. no	Particulars	Villupuram	Salem	Dindigul	Tanjavur	Ramanatha-puram
1.	Average farm size (in ha.)	0.89	1.09	1.21	1.25	1.02
2.	Average Size of holding (in ha.)					
	Marginal farms	0.54	0.70	0.67	0.66	0.67
	Small farms	1.48	1.52	1.44	1.62	1.55
	Irrigated area(ac)	1.99	2.42	2.7	3.13	2.3
	Rainfed area (ac)	0.24	0.31	0.33	0	0.26
3.	Cropping intensity (%)	128	149	179	161	116
4.	Mean Annual Rainfall in districts					
5.	Employment Pattern(in man days)					
	On-farm	148	188	166	173	132
	Off ï farm	124	51	68	57	68
	Non ï farm	318	339	268	227	229
	Total days of employment (in mandays)	590	578	502	457	429
6.	Average number of employment days per earner per annum	231.4	214.1	190.9	167.4	160.1

It was understood from the table that, the average size of holding is lesser in Villupuram district i.e 0.89 ha. In all other districts the size of holding is comparatively

higher with good irrigation facility. More than 85 per cent of cultivated area is irrigated through wells in Villupuram, Salem, Dindigul districts, tanks and canals in Ramanathapuram and Thanjavur districts. It was also observed that in sample farms (both small and marginal) more number of crops are cultivated in all seasons without leaving any land as fallow which was indicated through the cropping intensity of sample farms in study area. Even the last three years period (2010 -11, 2011 -12 and 2012-13) received scanty rainfall and drought was occurred in the year 2012 -13 in almost all the districts the small and marginal farms in study area took efforts in crop cultivation which was indicated through cropping intensity. The cropping intensity is very high in Dindigul district followed by Thanjavur and Salem districts. It was low in Ramanathapuram and Villupuram districts since Ramanathapuram district is blessed with higher rainfall only in North east monsoon period which leads lesser water availability in wells. Through the study it was noted that the farmers are hiring water at the rate of amount ranging from Rs.1500 ï Rs.1800 for 5000 liters of water in Dindigul, Thanjavur and Salem districts to save the perennial crop. This is also a burden to the small and marginal farmers.

The employment pattern also indicated that the earning members in sample farms are getting more employment opportunities through non farm sector. Employment opportunities created through MGNREGP also helps to small and marginal holdings in sample study districts in getting more employment days which in turn helps them for their livelihood and to invest on agriculture. Hence efforts will be taken to increase the non ï farm employment opportunities in rural areas.

5.3. Area under crops in study districts and sample farms

Villupuram District

Table 5. Three Years Average of Area under Major Crops in Villupuram District

in ha.

S. No	Crops	2009-10	2010-11	2011-12	Three Years Average	% share in Dis. Net croppe d area	% Share of Irrigated area in total	% Share of unirrigated area in total
1	Paddy	148454	149929	129858	142747	42.61	98.6	1.40
2	Sugarcane	54139	64348	73460	63982	19.10	100.0	0.00
3	Groundnut	47957	39556	36224	41246	12.31	45.1	54.87
4	Pulses	19763	22201	24145	22036	6.58	10.8	89.17
5	Cumbu	11325	10727	12823	11625	3.47	3.4	96.62
6	Cotton	6519	5489	6220	6076	1.81	51.1	48.91
7	Maize	3811	3015	5706	4177	1.25	70.0	30.00
8	Gingelly	3974	2959	2004	2979	0.89	37.2	62.81
9	Sorghum	2110	1743	71	1308	0.39	41.7	58.31
10	Ragi	638	588	546	591	0.18	38.2	61.79
11	Sunflower	417	123	156	232	0.07	99.3	0.72
12	Castor	33	19	14	22	0.01	63.6	36.36
	Total Cropped area	333997	338764	332220	334994			

Source: Season and Crop Report for the period 2009 -10, 2010 -11 and 2011-12

From the table it could be understood that in Villupuram district paddy crop occupies (43 per cent) major share in net sown area followed by sugarcane (19.1 per cent) and ground nut (12.3 per cent). Pulses, cumbu, cotton and ragi crops cultivated in major areas in district. Recently casurina crop occupies major areas of east coast belt to minimize the risk in farming activities. The cropping pattern of the sample farms is discussed below. The yield gap for major crops was assessed and discussed below.

Table 6. Cropping Programme in Sample Farms of Villupuram District

in ha.

Sl. No	Crop Particulars	Area (ha.)	
		Rainfed	**Irrigated**
1.	Paddy		0.41
2.	Sugarcane(t/ha)		0.15
3.	Green gram		0.07
4.	Tapioca		0.06
5.	Gingelly	0.01	0.04
6.	Casurina	0.11	0.17
7.	Other crops (watermelon, ground nut and ragi)		0.13
	Total	0.12	1.03
	Total cropped area		1.15
	Net cropped area		0.89
	Cropping intensity		128.87

In sample farms, paddy occupies major area with the average productivity of 5461 kg/ ha. In paddy the varieties like ADT37 and BPT5204 preferred by the farmers since its market potential and consumptive uses. The yield gap in paddy was assessed as 2.04 t/ha in Villupuram district. In sugarcane, the variety Co86032 was cultivated by the farmers widely. The average yield of sugarcane was 125 t /ha. The yield gap in sugarcane was identified as 35t/ha. In green gram, a Co 2 variety was taken up widely. In tapioca Mulluvadi 2 is the variety mostly preferred by the farmers and in groundnut TMV 7 is the widely cultivated variety both in rainfed and irrigated situation in Villupuram district. The cropping intensity seems to be low in this district because non receipt of adequate rainfall in last three years and non availability of productive family labour for agriculture was observed as major reasons. Also the earning members of rural families moving to non- farm sector in seeking jobs in Pondicherry, Chennai and Thiruvallur district. To cope up this, farmers in the study area moving to casurina crop cultivation which occupies more area recently also it fetches good market price.

Salem District

Table 7. Three Years Average of Area under Major Crops in Salem District

in ha.

S.No	Crops	2009 - 10	2010-11	2011 - 12	Three years average	% share in Dis. Net cropped area	% Share of Irrigated area in total	% Share of unirrigated area in total
1	Maize	24632	24123	34666	27807	12.66	73.39	26.61
2	Tapioca	23057	19551	17084	19897	9.06	46.11	53.89
3	Groundnut	21939	14322	19773	18678	8.50	28.57	71.43
4	Cotton	13593	14322	16992	14969	6.81	58.83	41.17
5	Coconut	14312	14278	14590	14393	6.55	99.37	0.63
6	Sugarcane	11296	12339	12218	11951	5.44	100.00	0.00
7	Turmeric	7439	9465	13684	10196	4.64	100.00	0.00
8	Green gram	4288	12194	9154	8545	3.89	1.27	98.73
9	Black gram	3343	6084	4566	4664	2.12	19.34	80.66
10	Mango	3522	4352	4856	4243	1.93	40.46	59.54
11	Gingelly	3529	4041	2684	3418	1.56	37.81	62.19
12	Banana	3368	2591	2788	2915	1.33	93.27	1.62
13	Red gram	1169	2312	1451	1644	0.75	7.00	93.00
14	Bhendi	634	1230	1730	1198	0.55	100.00	0.00
15	Brinjal	626	936	1599	1053	0.48	99.97	0.03
16	Onion	537	934	1317	929	0.42	99.96	0.04
17	Sunflower	187	134	63	128	0.06	61.72	38.28
18	Bengal gram	156	100	24	9	0.04	13.57	86.43
	Total cropped area	208126	223370	227447	219647			

Source: Season and Crop Report for the period 2009 -10, 2010 -11 and 2011-12

From the table it was inferred that in Salem district the cropping pattern seems to be more diversified in nature without having major area under any single crop. Among the food crops paddy and maize occupies 16 and 13 per cent share of total net sown area followed by tapioca and ground nut which is mostly grown under rainfed situation. The high value crops like cotton, sugarcane, turmeric, coconut and mango occupies major net sown area in the district. In Pulses, green gram and black gram occupies the reasonable area in Salem district. The cropping pattern in sample farms also representing the same. The details are given below.

Table 8. Cropping Programme in Sample Farms of Salem District

in ha.

Sl.no	Crop Particulars	Area (ha)	
		Rainfed	Irrigated
1	Turmeric		0.46
2	Maize		0.31
3	Sorghum	0.08	0.20
4	Cotton	0.05	0.13
6	Paddy		0.11
7	Tapioca		0.08
8	groundnut		0.07
7	Other crops (sugarcane, vegetables, sesamum)		0.16
	Total cropped area	0.12	1.51
	Net cropped area	1.03	
	Cropping intensity (%)	146.6	

In sample farms, turmeric crop occupies major area (0.46 ha) under irrigated situation followed by maize crop (0.31ha). Hybrid varieties (NK 6240, NK6866 and Pioneer) are preferred by the farmers in maize. The sorghum crop was cultivated mainly for fodder purposes. For which Paiyur 2 was preferred by the farmers followed by cotton which is cultivated both in rainfed and irrigated situation. Paddy (ADT 45) and tapioca (Rose and MVD 1) are other major crops in sample farms. The small and marginal farmers in Salem district are shown their keen interest on vegetable (all types) crop cultivation which fetches higher prices and market suitability.

Dindigul District

Table 9. Three Years Average of Area under Major Crops in Dindigul District

in ha.

S.No	Crops	2009-10	2010-11	2011-12	Three years Average	% share in Dis. Net cropped area	% Share of Irrigated area in total	% Share of un irrigated area in total
1	Maize	39531	39629	40644	39934.67	17.3	50.0	50.0
2	Coconut	27113	28284	29478	28291.67	12.2	97.3	2.7
3	Sorghum	26591	28679	29156	28142	12.2	11.0	89.0
4	Paddy	16647	18349	19158	18051.33	7.8	100.0	0.0
5	Mango	14747	14992	15624	15121	6.5	17.1	82.9
6	Groundnut	8360	11173	12780	10771	4.7	64.9	35.1
7	Coffee	10437	10496	10223	10385.33	4.5	0.1	99.9
8	Banana	4680	4897	5307	4961.333	2.1	51.1	48.9
9	Tamarind	4323	4001	3987	4103.667	1.8	0.1	99.9
10	Onion	3043	2881	3803	3242.333	1.4	100.0	0.0
11	Potato	2796	2596	2320	2570.667	1.1	17.9	82.1
12	Lime	2373	2351	2348	2357.333	1.0	14.7	85.3
13	Tomato	2467	1969	1644	2026.667	0.9	100.0	0.0
14	Drumstick	1894	1841	1769	1834.667	0.8	99.9	0.1
	Total	220092	231494	241747	231111	100		

Source: Season and Crop Report for the period 2009 -10, 2010 -11 and 2011-12

From the triennium averages of area under crops in Dindigul district maize, coconut and sorghum crops were identified as major crops. Horticultural crops also took major share in cropped area in Dindigul district. It was observed that in small and

marginal farms of Dindigul district, fodder sorghum occupies major area both under irrigated and rainfed condition. Vegetables and medicinal crops took major area in its cultivation because of market suitability.

Table 10. Cropping Programme in Sample Farms of Dindigul District

in ha.

Sl. No	Crop Particulars	Area (ha)	
		Rainfed	**Irrigated**
1	Sorghum	0.16	0.26
2	Maize	0.06	0.33
3	Paddy		0.12
4	Ground nut		0.05
5	Pulses	0.07	0.00
6	Moringa		0.04
7	Other crops(sugarcane, moringa, vegetables and gloriosa)		0.22
	Total	0.29	1.02
	Total cropped area	1.32	
	Net Cropped area	0.73	
	Cropping intensity	179.1	

In Dindigul district, fodder sorghum occupies major area followed by maize in small and marginal farms. The cropping pattern in small farms revealed that the farmers are consistently following mixed cropping system which satisfies the food and fodder need and commercial crops to earn higher income to meet out their family expenditure. Vegetables and medicinal plants occupies major share in other crops since the second largest vegetable market is located in Ottanchattiram. To save the crops water hiring is practiced by the farmers at higher level in this district with a cost of Rs.1500 to 1800 for 5000 liters of water.

Thanjavur District

Table 11. Three Years Average of Area under Major Crops in Thanjavur District

in ha.

Sl. No	Crops	2009-10	2010-11	2011-12	Three years average	% share in Dis.Net cropped area	% Share of Irrigated area in total	% Share of unirrigated area in total
1	Paddy	162938	166209	180859	170002	85.68	100.00	0.00
2	Sugarcane	8564	8817	10665	9349	4.71	100.00	0.00
3	Groundnut	8156	7522	8262	7980	4.02	86.89	13.11
4	Pulses	22164	34042	32652	29619	14.93	41.77	58.23
5	Cumbu	6	0	2	3	0.00	75.00	37.50
6	Cotton	426	518	969	638	0.32	100.00	0.00
7	Maize	1496	1090	1291	1292	0.65	91.46	8.51
8	Gingelly	8046	4565	3868	5493	2.77	12.03	87.97
9	Cholam	3	2	6	4	0.00	109.09	0.00
10	Ragi	3	4	1	3	0.00	112.50	0.00
11	Sunflower	29	9	13	17	0.01	100.00	0.00
12	chillies	22	23	212	86	0.04	100.39	0.00
13	coriander	0	0	0	0	0.00	0.00	0.00
14	sugarcrops	8785	9026	10863	9558	4.82	97.81	2.19
15	Total.Fruits	4546	4426	4244	4405	2.22	79.52	20.48
16	Total.Veg	6810	607	799	2739	1.38	68.98	31.04
17	coconut	32077	33271	33742	33030	16.65	42.60	73.56
18	Total spices	244	217	462	308	0.16	38.03	62.08
19	T.Foodgrains	186610	201347	214812	200923	101.27	91.36	0.10
20	Total.Cereal	164446	167305	182160	171304	86.34	99.94	0.01
21	Castor	1	2	3	2	0.00	0.00	100.00
	TCA	**194911**	**200821**	**199488**	**198406.6667**			

Source: Season and Crop Report for the period 2009 -10, 2010 -11 and 2011-12

Table 12. Cropping Programme in Sample Farms of Thanjavur District

in ha.

Sl. No.	Crop Particulars	Area (ha)	
		Rainfed	**Irrigated**
1	Rice	0.00	1.17
2	Groundnut	0.00	0.29
3	Blackgram	0.00	0.44
4	Gingelly	0.00	0.09
5	Soya bean	0.00	0.01
6	Tapioca	0.00	0.01
7	sugarcane	0.00	0.01
		0.00	2.02
	Total cropped area in ha.	2.02	
	Net Cropped area	1.25	
	Cropping intensity	1.61	161

In Thanjavur district paddy and pulses (black gram) occupies major area of cultivation in small farms. In oilseed crops ground nut occupies major area in study district. The sample farms are in the tail end region of canal irrigated area. Hence investment made on borewells for irrigation purposes needs huge financial support for the farmers. The other crops like soya bean, gingelly, tapioca and sugarcane occupies reasonable share of cropped area in sample farms which has indicated about the diversified nature of cropping pattern in canal irrigated farms.

In total, the cropping intensity seems to be higher in small and marginal farms of all study districts in Tamil Nadu indicated that these groups of farmers using the resources potentially under so many constraints.

Ramanadhapuram District

Table 13. Three Years Average of Area under Major Crops in Ramanathapuram District

Sl. No	Crops	2009-10	2010-11	2011-12	Three years average	% share in Dis.Net cropped area	% Share of Irrigated area in total	% Share of unirrigated area in total
1	Paddy	133885	131397	128960	131414	69.73	41.27	58.73
2	Sugarcane	456	550	592	533	0.28	100.06	0.00
3	Groundnut	4860	3856	3705	4140	2.20	1.42	98.58
4	Pulses	3525	3899	4013	3812	2.02	1.36	98.65
5	Cumbu	581	464	496	514	0.27	0.58	99.48
6	Cotton	772	1167	2044	1328	0.70	12.00	88.00
7	Maize	152	216	391	253	0.13	4.35	95.65
8	Gingeely	1171	774	911	952	0.51	2.31	97.69
9	Cholam	1821	1771	1734	1775	0.94	1.75	98.29
10	Ragi	544	370	286	400	0.21	15.75	84.25
11	Sunflower	77	100	62	80	0.04	0.00	100.00
12	Chillies	20577	21569	21217	21121	11.21	16.53	83.47
13	coriander	1041	1151	1921	1371	0.73	1.24	98.69
14	Castor	98	67	3	56	0.03	4.17	0.00
15	sugarcrops	4276	4293	4362	4310	2.29	0.39	0.16
16	coconut	8454	8363	8567	8461	4.49	98.73	0.57
17	Total.Fruits	329	392	441	387	0.21	87.78	37.69
18	Total.Vege	690	230	332	417	0.22	65.18	34.98
19	Total.Spice	21777	22882	23290	22650	12.02	15.49	84.51
20	Total.Cereals	137524	135012	132566	135034	71.65	40.26	62.61
21	T.foodgrains	141049	138911	136579	138846	73.68	39.20	0.00
	TCA	**190973**	**187428**	**186954**	**188452**			

Source: Season and Crop Report for the period 2009 -10, 2010 -11 and 2011-12

Table 14. Cropping Programme in Sample Farms of Ramanadhapuram District

in ha.

Sl.no	Crop Particulars	Area (ha)	
		Rainfed	**Irrigated**
1	Paddy (Semi dry)	0	0.47
2	Cotton	0.04	0.13
3	Chillies	0	0.41
4	Sorghum	0.13	0.00
5	Others(gingelly, blackgram)		0.07
	Total cropped area	0.16	1.03
	Total cropped area in ha.		1.19
	Net Cropped area		1.02
	Cropping intensity (%)		116.00

Paddy, Chillies and cotton are the major crops grown in sample farms of Ramanathapuram district. Since the sources of irrigation are rainfed tanks the intensity of crop is lesser than other districts. Cotton and sorghum crops are other major crops grown in rainfed condition.

5.4 Yield gap in major crops grown in sample farms

Table 15. Varieties grown in Sample Farms of Study Districts

Crop	Villupuram	Salem	Dindigul	Thanjavur	Ramanathapuram
Paddy	ADT 37, BPT 5204	ADT 45	ADT45, CO43, white ponni	ADT 36, ADT 38, ADT 43	ADT 36, MDU 5
Maize	-	NK 6240, NK6866, Pioneer	Pioneer, ganga,naga, Co3, Gothavari, kanchan,	-	-
Cholam	-	Paiyur 2	Co(S)28, Co 30, Co 8	-	Fodder
Gnut	TMV 7	TMV 7	TMV7	VRI 2	-

Crop	Villupuram	Salem	Dindigul	Thanjavur	Ramanathapuram
Redgram	-	Vamban	-	-	-
Green gram	Co2	-	Co 6, Vamban	-	-
Blackgram	-	-	Vamban 2	Vamban2	-
Sugarcane	Co86032	Co92012	Co92012	Co86032	-
Sesamum	Local	SVPR 1	-	-	-
Turmeric	-	BSR 1, Co 2	-	-	-
Cotton	-	RCH 2, jackpart	-	-	MCU 7
Chillies	-	-	-	-	Mundu
Tapioca	-	Burma Rose , Mulluvadi 2	-	Mulluvadi 2	-
Watermelon	Apurva	-	-	-	--

From the table it could be understand that in all crops TNAU varieties released before 10 years back were cultivated by the farmers except maize, tapioca and cotton crops in study districts. In maize and cotton hybrid varieties were preferred by the farmers. In sugarcane varieties released by the Sugarcane Breeding Institution, Coimbatore was preferred by the farmers. The earlier varieties were still not replaced by the farmers. It indicated that most of the farmers were exchanging the seeds within them self in all crops in all districts. This might be one of the reasons for lower productivity in several crops.

Table 16. Average Productivity at Farm level in Sample Farms of Study Districts

in Kg/ha.

Crop	Villupuram	Salem	Dindigul	Thanjavur	Ramanathapuram
Paddy	5461	5192	5190	5247	4404
Maize	-	3942	3723	-	-
Cholam (fodder)	-	9297	8250	-	5640
Ground nut	2314	2280	2653	2619	-
Blackgram	-	-	-	2428	-
Sugarcane tonnes/ha	86	96	-	100	-
Sesamum	573	500	-	821	-
Chillies	-	-	-	-	1500
Cotton	-	1184	-	-	1189
Tapioca	-	31000	-	23500	-

From the collected data it was observed that in Paddy the farmers were obtained the yield in paddy ranging from 5.0 tonnes per ha to 8.5 t /ha with the highest productivity of 8500 kg per ha in Salem district and very lower productivity of 750 kg in Villupuram district. Likewise in maize the highest productivity was achieved by the farmers in salem and Dindigul districts. The yield was obtained ranging from 12.5 tonnes/ha to 7.5 tonnes/ha was achieved by the farmers in these districts. In Salem, Dindigul and Ramanathapuram districts the sorghum crop was grown only for fodder purposes rather than grain purposes. In ground nut the highest productivity was achieved by the farmers in Salem district followed by Dindigul district. In cotton the same yield potential was observed in Salem and Ramanathapuram districts. Sugarcane yield is maximum in Salem district i.e 190 tonnes/ha and minimum in Dindigul district as 100t/ha.

Table 17. Productivity in Progressive Farm in Selected Villages of Study Districts

in Kg/ha.

Crop	Villupuram	Salem	Dindigul	Thanjavur	Ramanathapuram
Paddy	7800	6320	6200	7320	5280
Maize	-	5269	5523	-	-
Cholam	-	10540	9800	-	6500
Ground nut	2400	2353	3270	4320	-
Blackgram	-	-	-	3710	-
Sugarcane	118	108	-	115	-
Sesamum	720	780	-	925	-
Chillies	-	-	-	-	1870
Cotton	-	2500	-	-	1350
Tapioca	-	38240	-	28500	-

To assess the yield gap, the yield difference between the progressive and actual farms was considered in this study. The results are discussed below.

Table18. Yield Gap Analysis in Crops Grown in Sample Farms of Selected Districts

Kg/ha

Crop	Villupuram	Salem	Dindigul	Thanjavur	Ramanathapuram
Paddy	2339	1128	1010	2073	876
Maize	-	1327	1800	-	-
Cholam	-	1243	1550	-	860
Ground nut	86	73	617	1701	-
Blackgram	-	-	-	1282	-
Sugarcane (tonnes /ha)	32	12	-	15	-
Sesamum	147	280	-	104	-
Chillies	-	-	-	-	370
Cotton	-	1316	-	-	161
Tapioca	-	7240	-	5000	

From the table it could be understand that, in Vilupuram and Thanjavur districts the highest yield gap was observed in paddy since the highest yield potential also observed in these districts. In maize the yield gap was higher in Dindigul district since the expected yield level could not be achieved in this district due to drought. Almost in all crops the highest yield gap was observed in Thanjavur district and lowest in Salem district. The yield gap in tapioca was higher in Salem district due to tapioca crop is grown under rainfed situation also. In Ramanathapuram district, the yield potential in the progressive farm itself found to be lower than other districts might be due to poor rain fall in the selected study period since the rainfed tanks are the major source of irrigation. In all the selected study districts the practice of water hiring was observed during the study period which is additional burden to the farmers.

5.5 Awareness and adoption level of technology in major crops in sample farms

Table19. Awareness and Adoption Level of Technologies in Crop Production of Sample Farms

N=60 (in each district)

Attributes	Awareness				
	Villupuram	Salem	Dindigul	Thanjavur	Ramanatha-puram
Suitable crop varieties	34 (56.7)	45(75.0)	50(83.3)	48(80.0)	4(6.7)
Soil Testing	21(35.0)	24(40.0)	16(26.7)	8(13.3)	12(20.0)
Water Testing	14 (23.3)	28(46.7)	12(20.0)	16(26.7)	8(13.3)
Water saving methods (Drip)	42(70.0)	38(63.0)	48(80.0)	43(71.7)	33(55.0)
Recommended doses of fertilizer	12(20.0)	33(55.0)	26(43.3)	10(16.7)	2(3.3)
Time and level of application of fertilizer	9(15.0)	58(96.7)	52(86.7)	22(36.7)	8(13.3)
Awareness on plant protection chemicals	17(28.3)	40(66.7)	42(70.0)	18(30.0)	6(10.0)
Mechanization of crop production	34(56.7)	39(65.0)	33(55.0)	42(70.0)	29(48.3)

Attributes	Adoption level				
	Villupuram	Salem	Dindigul	Thanjavur	Ramanatha-puram
Suitable crop varieties	20(33.3)	28(46.7)	32(53.3)	36(60.0)	4(6.7)
Soil Testing	6(10.0)	10(16.7)	4(6.7)	2(3.3)	3(5.0)
Water Testing	0(0.0)	0(0.0)	2(3.3)	0(0.0)	0(0.0)
Water Saving methods (Drip)	4(6.7)	5(8.4)	6(10.0)	0(0.0)	0(0.0)
Recommended doses of fertilizer	10(16.7)	24(40.0)	18(30.0)	2(3.3)	0(0.0)
Time and level of application of fertilizer	6(10.0)	32(53.3)	40(66.7)	18(30.0)	6(10.0)
Awareness on plant protection chemicals	4(6.7)	18(30.0)	20(33.3)	4(6.7)	2(3.3)
Mechanization of crop production	28(46.7)	30(50.0)	24(40.0)	38(63.3)	26(43.3)

(Figures in parenthesis indicate percentage to sample farms in each district)

From the table it could be understood that, the level of awareness seems to be higher in Salem and Dindigul districts followed by Villupuram district in all crop production technologies except soil and water quality assessment. In the study block of Salem district the concentration of seed producers in crops like cotton, vegetables are very high. Through them the farmers came to know about the crop production technologies widely. In all study districts, less than 50 per cent of sample farmers aware about soil and water quality assessment. It was observed that in sample farms of study districts small and marginal farmers came to know about the technologies only through large farms. The input dealers playing major role in transfer of technologies with respect to plant protection chemicals. In Thanjavur and Ramanathapuram districts the level of awareness about the technologies seems to be lower. In mechanization the sample farmers did not aware about the tools for intercultural operations but they aware about large machineries for ploughing, leveling and harvesting. If we look at the adoption level of technologies varietal adoption is higher but since the farmers are using the

varieties released in earlier period. They do not possess enough knowledge on recent varieties, fertilizer doses and suitable plant protection chemicals. Also it was opined that to follow the suitable technologies the water is the most crucial input. Because of insufficient water availability they could not able to follow the technologies. Most of the time they have received communication in late on seed availability in depot but when they approach they could not be able to receive the required quantity of seeds.

5.6. Constraints on access to various resources at farm level

Table 20. Constraints Faced by the Sample Farmers in Selected Study Districts on Resources

N=60(in each district)

Attributes	Rank				
	Villupuram	**Salem**	**Dindigul**	**Thanjavur**	**Ramanatha-puram**
1.**Soil**					
Non awareness on soil testing	1	1	1	1	3
Occurrence of problem soil	3	2	3	2	1
Higher cost for land improvement methods	2	3	2	3	2
2.Labour					
Non availability of hired labour during peak season	1	1	2	1	2
Higher cost of labour	2	2	1	2	1
Poor out turn	3	3	3	3	3
3. Seed					
Non awareness on suitable variety and source of seed material	2	2	3	3	1
Non availability of required seed quantity in time	1	1	1	1	2
Higher preference towards particular variety (due to good marketability /suitabilityfor consumption)	3	3	2	2	3

Attributes	Rank				
	Villupuram	Salem	Dindigul	Thanjavur	Ramanatha-puram
4.Water Resources					
Inadequate rainfall	1	2	1	1	1
Poor distribution of rainfall	2	1	3	2	2
Higher cost towards purchase of water	3	3	2	3	3
5.Knowledge					
Less frequency of contact with technical experts	1	3	1	1	1
Poor access to different sources	2	1	2	2	2
Non participation in trainings / exposure visits/ meetings conducted by Agrl.department	3	2	3	3	3
6. Plant Protection Chemicals					
Non awareness on right type of chemicals in right quantity	1	2	2	1	1
Non proper guidance of the extension officials based on proper assessment of samples in time	3	3	3	2	2
Recommendation followed as per the advice of input dealers due to easy access	2	1	1	3	3
7.Financial Support					
Non awareness on institutional agencies other than Co-op	2	3	3	1	1
Attitude of officials towards SF/ MF	1	1	1	2	2
Lengthy formalities to access credit	3	2	2	3	3

Attributes	Rank				
	Villupuram	Salem	Dindigul	Thanjavur	Ramanatha-puram
8. Mechanisation					
Non availability of machines, tools and equipments to various operations in small and marginal farms	1	1	2	1	1
Nonawareness of availability of machineries, tools and other equipments except tractor	3	2	3	3	2
Lacuna in technical knowledge to handle the machineries	4	3	1	4	4
Hiring in cost of machineries is very high.	2	4	4	2	3

The Garrettôs scoring technique was used to analyse the constraints faced by the farmers in selected study districts and mean score was arrived. Based on mean score value the ranks were given to different attributes. More than seven attributes were selected and the farmers were asked to rank them according to their priority in each item. Then the ranks were transformed into scores. Finally mean score value was arrived. Based on the mean score value the final ranks were given. In each item of resource level top three to four constraints were listed and discussed in Table 20.

It was observed from the table that in study districts of Villupuram, Salem, Dindigul and Thanjavur the most of the sample farmers are unaware about the soil testing. In Ramanathapuram district because of its locational disadvantage the problem soils are occurred. The farmers are aware about this. But they did not know about the reclamation measures. Hence the farmers could be taught with soil quality assessment and land reclamation measures towards improvement of crop productivity in all districts.

Almost in all study districts farmers felt that non availability of hired labour is the most important problem followed by higher cost which increases the cost of production.

During the study period the implementation of MGNREGP absorbs more labour in rural area and migration of rural labours also creates the labour scarcity problem in study districts. Hence measures will be taken to ensure the labour availability to agriculture in peak time.

It was observed that, among the study districts, in Ramanathapuram district most of the sample farmers were unaware about the suitable varieties of the crops grown in their location followed by non availability of seed material in required time and quantity. It was revealed by the sample farmers in all districts that the information on arrival of seed material was not reached them in time. Hence they followed the traditional practices in getting the seed material. Also the market suitability of particular variety in its quality aspects makes them to prefer the earlier variety. Necessary steps to be taken to produce and procure large quantity of seeds of suitable varieties in time to overcome this problem. Also it is needed to demonstrate the new varieties widely to get popularized among the farmers.

Inadequate rainfall during the past three years (2010 -11, 2011-12 and 2012 -13), Poor distribution of rainfall and non availability of water at required depth was identified as main constraints in all districts which makes them to hire water at higher rate which cost about Rs. 1500 to1800 per 5000 liters which increases the cost of production in irrigated crops of all study districts. To save the perennial crops the water hiring is practiced in Dindigul and Salem districts. It was observed that the farmers in most of the villages are not harvesting any rainfed crops during the study period.

It was observed that in sample farms of all study districts the farmers felt that it is more convenient for them to follow the recommendations given by the input dealers since they are more accessible for them. The less frequency of contact with the officials and field officers is also another major reason for non adoption of technologies due to unawareness. It was also observed that in sample districts only very few small farmers are having the opportunities to attend capacity building programmes like trainings, exposure visits, etc. to various institutions towards gaining knowledge in technologies.

The needy financial support to small and marginal farmers enhances the investment in agriculture which inturn breaks the vicious cycle of poverty. Hence more than ten attributes were listed and farmers were asked to rank them. Among them, non awareness of various sources of finance, poor response of officials towards marginal

farmers and difficulties in availing loan due to several procedures were identified as major constraints in access to institutional credit. These constraints are increases the transaction cost of credit. In Thanjavur and Ramanathapuram districts the marginal and small farmers are unaware about the other sources of credit except co-operatives. The repayment positions of loans by the sample farmers are at higher rate in these districts when compare to other districts. Also it was observed that more than 85 per cent of credit need of farmers was achieved only through the co - operatives. Hence the steps to be taken to ease the procedural steps in releasing the credit. Also strengthening the relationship with the marginal and small farmers creates promptness in repayment of loan

It could be inferred that the lack of awareness related to available machineries for crop production, information on its availability and its operation seems to be the major constraints in Salem, Dindigul and Ramanathapuram districts. In paddy growing areas like Thanjavur and Villupuram districts the farmers aware about the machineries and tools at higher level but they felt that the hiring in cost of the machineries are very high. Hence it is inferred that the machineries, tools and equipments may please be maintained at large scale level at co ï operatives and agro services depot to lease them to farmers in time which enhances the timely operations in agriculture in rural areas and helps to increase the level of crop productivity.

Table.21Constraints faced by the Sample Farmers in Marketing in Selected Study Districts

N=60(in each district)

Attributes	Rank				
	Villupuram	Salem	Dindigul	Thanjavur	Ramanatha-puram
Distance of markets (RM, co-op societies, etc.)	5	5	5	5	1
Not willing to store the produce in godowns	1	4	4	1	2
High cost involved in marketing	6	3	2	6	7

Attributes	Rank				
	Villupuram	Salem	Dindigul	Thanjavur	Ramanatha-puram
Non availability of thrashing floor and drying yards in shortest distance	4	2	7	4	3
More convenience in (Attitude towards) selling to village merchants	2	6	1	3	4
Delayed payments by the markets	7	1	6	7	6
Attitude (laborious) towards storage, processing and selling	3	7	6	2	5

It was observed that, the sample farmers at Villupuram, Thanjavur, Dindigul and Salem are selling their produce through the wholesale market, regulated market committee and Co ï op marketing societies. If the marketing facilities are available the famers are selling their produce through them immediately since the farmers knew the advantages about these facilities. But in Ramanathapuram district the farmers felt that the regulated market committee and societies are located in distance. The farmers in all sample districts felt that selling their produce through the village merchant is more convenient because of higher cost involved in marketing. Also insufficient storage capacity, drying yards and poor maintenance of godowns makes the farmers not to store their commodities in storage godowns. In the places where the farmers are selling vegetables through markets faced problems in getting their payment in time.

5.7 Infrastructural facilities development in study area

Table 22. Infrastructural Facilities Development in Selected Study Districts

Particulars	Villupuram	Salem	Dindigul	Thanjavur	Ramanatha puram
Irrigation intensity	107	129	102	124	100
Regulated Market Committee	17	9	6	13	4
Primary Agrl.Co ï operative credit societies	231	207	197	246	252
Commercial banks	167	187	195	190	120
Energized pumpsets	144677	149009	90979	57000	28500
Agrl machinaries and implements	66946	220000	165456	187560	21633
Mean annual rainfall (m.m)	1060	749	1013	1053	827

Source: Tamil Nadu an Economic Appraisal Report 2010-11 and District level Statistical Hand book for the Year 2012 -13

From the table it could be understood that the irrigation intensity is more in Salem followed by Thanjavur district. The increase in number of pumpsets revealed that the agriculture in Salem, Villupuram and Dindigul district solely dependent on wells which needs huge investment. Because of prevalence of good infrastructural facilities like roads, financial institutions, markets in Salem, Villupuram and Dindigul districts the cropping intensity is also more in these districts.

5.8 Factors responsible for yield gap in Paddy farms

Table 23. Determinants for yield gap in paddy farms

Particulars	*Coefficients*	*t Stat*
Intercept	6.748291	2.364595
Actual Farm size in ha	-0.34215	-1.53217
Age in years	0.330974	0.545529
Education level in schooling years	0.548191	0.759617
Experience in farming in years	0.662725	1.660083
Contact level with experts (in Scores)	-1.02122	-3.0572***
Knowledge level (in Scores)	-1.36663	-3.63813***
Value of inputs in Rs.	0.041564	0.065788
R^2 value	0.72	

*** indicates significance at one per cent level and * indicates significance at ten per cent level

The results of the analysis showed that R^2 was 0.72 which implied that the included variables in the function could explain only 67 per cent of the variation in yield gap. Remaining 28 per cent of the variation was due to other variables which are not included in the function. From the analysis it was understood that the determinants like knowledge level, contact with technical experts reduces the yield gap in sample farms of selected districts.

6. Conclusions

Indian Agriculture is characterized prominently with small holding agriculture. The future of sustainable agriculture growth and food security in India depends on the performance of small and marginal farmers since they occupies more than 85percent of the total cultivators and shared 44 per cent of total operated area. In Tamil Nadu we have experienced deceleration in agricultural growth since from 1990ôs onwards since the growth in agriculture face major constraints such as growing water scarcity, increasing land degradation, declining farm sizes and rise in cost of labour. More than

75 per cent of the holdings are ploughing less than 0.37 hectare only in Tamil Nadu. More over the land use, cropping pattern and crop diversification underwent significant changes in the last two decades in Tamil Nadu. The ways and means in reducing the vulnerabilities in small holder farms increases the growth in agricultural sector in Tamil Nadu. The results of this study revealed that small and marginal farms are having more crop mix and intensive cultivation practices. Food crops along with commercial crops took major share in crop cultivation. The sample farmers in all districts do not possess the knowledge on soil and water quality assessment and suitable crop varieties which are the foremost needed one to increase the productivity level. Inadequate rainfall, drought, cost of labour and non availability of seeds and labour in required time were the major constraints affected the yield potential in all crops. Input dealers are playing key role in providing technical guidance to the farmers. More than 85 per cent of the financial support was met through the co-op societies in study area. It was found that where the marketing facilities are good the farmers produced more and direct marketing took place. The functional analysis revealed that the contact with progressive farmers or extension officials, knowledge gain through trainings, exposure visits were the major determinants in reducing the yield gap in paddy crop.

7. Strategies to increase the productivity of major crops in Tamil Nadu

All the districts are categorized based on average yield performances in major crops, the problems were identified for the yield differences and the strategies are given to increase the productivity of major crops in Tamil Nadu as follows:

Table 24. Strategies to increase the productivity of major crops in Tamil Nadu

S. No.	Crop	Yield levels	Districts	Constraints to productivity growth	Strategies to increase yield
	Rice	Low (<2000kg/ ha)	Ramanathapuram, Sivagangai, Tiruvarur, Nagapattinam, Viruthunagar	Strategic location of the districts along the route of seasonal cyclones and storms and droughts is the major weaknesses of these districts Torrential rains during North East Monsoon, hindering both kuruvai harvest as well as thaladi transplanting. Monocrop of rice in the delta region coupled with unfavorable weather conditions lead to heavy incidence of pests/diseases. Labour shortage during peak season of harvesting or planting. Lodging of rice crop leads to field germination. Lack of means to preserve kuruvai grain. Lack of adequate drainage facility in the delta region. Low light intensity prevailing in samba season results in poor yield Predominance of semi-dry cultivation, poor soil, lack of drainage facilities. Low rainfall,	Short duration high yielding drought tolerant and tolerant varieties submergible condition in paddy is needed. Provision of supplementary sources of irrigation and improvement in drainage facilities and increasing fertilizer use and micro-nutrients (Ramanathapuram and Sivagangai) Improvement in drainage is needed, application of large quantities of organic matter coupled with less or slowly soluble nitrogenous fertilizer applied at frequent intervals has been found to be most suitable N strategy for the ill drained soil. Site Specific Nutrient Management approach is needed to increase the rice yield. Mechanization may be strengthened for transplanting and weeding also. PPFM spray will be promoted to save the crops from drought.

				Early drought and late water logging, Sandy soils with high infiltration rate, Sodic and alkaline soil and water, Intrusion of sea water even at 25-30 feet from the ground, Low investment power of the farmers, Lack of Knowledge on Production technologies, High labour cost, Non-availability of suitable crop varieties to meet the local situations, Lack of knowledge on mechanization (Ramanadhapuram) Rainfall deficiency, Low fertility status of soils, Problem soils like calcareous soils, Microbially inactive soils, Pest and disease problem in general stemborer and leaf blast in particular, Lack of availability of seeds of preferred varieties, Lack of suitable alternate varieties with high yield potential to ruling varieties are the major production constraints in Viruthunagar district.	

					Distribution of Green manure Seeds to improve the Organic Content of the Soil to be strengthened and distribution of certified seeds to improve the Yield potential by Quality Seeds is inevitable one to increase the productivity level. Application of enriched Farm Yard Manure, Bio fertilizer, MN mixture should be enhanced to improve the organic content and fertility status of the soil. Distribution of Soil Health Cards to Know the Soil Fertility Status by Soil Sampling is most essential to increase the productivity.
		Medium (2000 to 3000 kg/ha)	Thiruppur,Perambalur, Ariyalur, Pudukkottai, Thanjavur	Water availability is the major constrain in adopting the recommended (SRI) technology. The soil topography does not allow for laser leveling. (Tiruppur) Heavy clay soils hinders the use of paddy transplanter , problems in adoption of SRI technology and green manuring (Perambalur)	Mechanical transplanter is needed for paddy. (Tiruppur) Resistant varieties to problem soils and fallsmut / lakshmi disease may be popularized, suitable transplanted for heavy clay soil may be introduced Enhancing the green manure seed availability improves the productivity (Perambalur). Improvement in drainage is needed,

				Salinity and sodicity, waterlogged/ill drained, Rainfed rice, Uplands (single crop rice), Deep water area, Kullankar area (waterlogging) The soils of the old delta with heavy clay experience problems associated with illdrained conditions during rainy season. This is more so in low lying areas. As a result the thaladi and samba crops suffer resulting in poor yield. The possible causes for low yield could be reduced mineralisation, availability and uptake of nutrients induced by low temperature, inhibited decomposition of kuruvai stubbles and generation of toxic substances as decomposition products. Definite dates of opening and closing of Mettur Dam water for irrigation is not known. This	application of large quantities of organic matter coupled with less or slowly soluble nitrogenous fertilizer applied at frequent intervals has been found to be most suitable N strategy for the ill drained soil Application of 25 kg N/ha to hasten the decomposition of Kuruvai stubbles or application of lime at 500 kg/ha or application of 50 kg P2O5/ha as rock phosphate are some of the techniques developed to overcome this problem. The above mentioned strategies can be more appropriate for problem soils in terms of better nutrient management and increased fertilizer use efficiency. Also Standard price policy for the delta grown commodities especially rice, pulses, cotton, gingelly, groundnut sugarcane and coconut. Regulated market facilities are to be extended. Timely input supply in kind and cash is to be assured.

				reflects in planning of rice and rice based cropping system. Torrential rains during North East Monsoon, hindering both kuruvai harvest as well as thaladi transplanting. Monocrop of rice in the delta region coupled with unfavorable weather conditions lead to heavy incidence of pests/diseases. Labour shortage during peak season of harvesting or planting. Lodging of rice crop leads to field germination. Lack of means to preserve kuruvai grain. Lack of adequate drainage facility in the delta region. Low light intensity prevailing in samba season results in poor yield	
		High (3000 to 4000 kg/ha	Thiruvallur, Cuddalore, Villupuram, Thiruvannamalai, Namakkal, Coimbatore, Tiruchirapalli, Madurai, Dindigul, Thoothukudi and Nilgiris	Non-availability of location specific resistant varieties for blast and problem soils (saline and alkaline) reduces the productivity in paddy and lack of non availability of transplanters in peak time prolonged the time of planting reduces the productivity.(North eastern zone)	Popularisation of location specific resistant varieties for blast disease and problem soils (saline and alkaline) increases the productivity level in paddy and ensuring the availability of machineries at lower cost in peak time reduces the yield loss in paddy. For the management of diseases in ecofriendly manner the biocontrol agents viz., Pseudomonas fluorescens

				Degradation of soil fertility due to continuous cropping without adequate soil health management practices. Obstruction of natural drainage system, Incidence of flash floods, Infestation of weeds especially- *Phalaris minor* and *Parthinium spp. ,w*ater logging. (Tiruchirappalli) Low capacity and poor maintenance of Irrigation water system tank and increased cost of cultivation	and Trichoderma viride has been identified. Pseudomonas fluorescens (Pf1) is recommended for seed treatment @ 10g/kg of seed, root dipping @ 1.5kg/ha, soil application 30DAT @ 2.5kg/ha and foliar spray at boot leaf stage and 10 days later @ 1kg/ha is recommended for the management of rice diseases. Sorna Samba variety should be explored for flood resistance in Trichy. Short duration, drought tolerant and non- lodging variety with fine rice as like as BPT variety is to be evolved and popularised.
		(> 4000 Kg /ha)	Kancheepuram, Vellore, Salem, Dharmapuri, Krishnagiri, Erode, Karur, Theni, Thirunelveli and Kanyakumari	Lack of suitable crop varieties, to withstand the changing adverse weather conditions (Rain ï humidity ï temperature) and to manage with the available irrigation water. The Problem of yellow stem borer, leaf folder and earhead bug incidences in rice reduces the productivity. (Southern zone districts)	Popularisation of short duration location specific varieties suitable for climate variability and resistant varieties for pest and diseases increases the productivity level in paddy and ensuring the availability of machineries at lower cost in peak time reduces the yield loss in paddy.

				Non availability of better cold tolerant and short duration high yielding fine grained varieties for August and December sowing season. Low yield due to water scarcity in early stages of rice crop.(North western / Central zone)	
	Sorghum	Low (< 600kg)	Coimbatore, Tiruppur, Tiruchirapalli, Ramanathapuram	Non adoption of suitable variety and non availability of variety suitable for rainfed condition. Non-adoption of line sowing due to lack of suitable low cost seed drill. Non-application of fertilizers/plant protection measures against pests and diseases	TNAU Sorghum hybrid CO 5, CO(S) 28, K tall, TNAU sorghum variety CO 30 may be popularized and it gives a grain yield of about 2792 kg/ ha and dry fodder yield of 7743 kg/ha under rainfed conditions and 4355 kg/ ha of grain yield, 10886 kg/ha of dry fodder yield under irrigated conditions. Plant protection measures as detailed below may be followed to reduce the shoot fly incidences. Early sowing of sorghum immediately after the receipt of South West or North East monsoon to minimize the shootfly incidence. Use of pelleted with insecticides. In case of direct seeding, use increased seed rate upto 12.5 kg per hectare and remove the shootfly damaged seedlings

					at the time of thinning or raise nursery and transplant only healthy seedlings. Plough soon after harvest, remove and destroy the stubbles. Set up the TNAU low cost fish meal traps @ 12/ha till the crop is 30 days old. Arpocarb Fishmeal formulation is more effective in attracting the shootfly adults especially the females.
		Medium (600- 800 kg/ha)	Thoothukudi, Cuddalore, Villupuram, Thiruvannamalai, Namakkal, Krishnagiri, Perambalur, Pudukkottai, Thanjavur, Sivagangai, Thirunelveli	High incidences of pest and diseases (Thoothukudi). Lack of high yielding long duration varieties with good quality grain and straw. Non-adoption of line sowing due to lack of suitable low cost seed drill. Non-application of fertilizers/ plant protection measures against pests and diseases	Alternate variety to K8 to be popularized. Need short duration drought tolerant variety and farmers could be taught with plant population maintenance. Sowing sorghum during 39th Standard week (Last week of September) registered least shootfly incidence and higher yield. Sorghum shootfly can be controlled by pelleting the seeds with 4 ml of Chlorpyriphos 20 EC or Monocrotophos 35 EC WS or Phosalone 35 EC with 2.5% gram Solution in 230 ml of water/kg of seed. (Thoothukudi district).

					Raising cowpea, Paiyur 1 as intercrop in paired rows of sorghum is more remunerative. Proper manuring and Seed hardening of sorghum with neem cake extract (soaking neem cake one part with four parts of water overnight and decanting) recorded significantly higher grain yield and harvest index with a cost benefit ratio of 1: 2.3
		High (800-1000Kg)	Kancheepuram, Thiruvallur, Vellore, Salem, Dharmapuri, Karur, Nagapattinam, Viruthunagar	Traditional varieties like sambirani cholam, karun cholam and irungu cholam were grown by the farmers. Non availability of quality seeds is the major constraint. Poor soil health status and occurrence of more pest and disease incidence reduces the productivity level.	The high yielding varieties CSH 14 and Co 30 may be popularised towards increase in productivity. Also TNAU Sorghum hybrid CO 5, CO(S) 28, K tall may be promoted. The recommended plant protection practices for shoot fly incidences and other diseases may be demonstrated intensively.
		(>1000 kg)	Ariyalur, Madurai, Theni, Dindigul.	More than 80 percent of area under sorghum is covered either by local variety or conventional fodder sorghum with low grain yield and private hybrid varieties under irrigated condition	The high yielding varieties both for grain and fodder may be popularized.

	Maize	Low (< 2500kg)	Cuddalore, Perambalur, Thoothukudi, Thiruchirapalli, Ariyalur,Viruthunagar	Most of the maize hybrid seeds are from private and overseas seed companies. Spurious seeds are available. Non availability of labour during planting, weeding and harvesting operations leads low productivity.	Good performed TNAU Maize hybrid variety may be popularized. Enhancing the soil health through green manure, FYM, mulching, biofertilizers and micro nutrients. INM practices may be strengthened. Herbicide application may be promoted to mitigate the labour scarcity. Need to evolve the hybrid with the similar qualities of NK 6240 maize hybrid which performs well in all production centers.
		Medium (2500 ï 5000 kg)	Kancheepuram, Thiruvallur, Villupuram, Vellore, Thiruvannamalai, Namakkal Dharmapuri, Krishnagiri, Coimbatore, Erode, Karur, Thanjavur, Nagapattinam, Dindigul, Ramanadhapuram, Sivagangai, Thirunelveli		
		High(5000 - 6500 kg)	Thiruppur, Salem, Pudukkottai, Theni	Poor nutrient management and labour shortages during peak operations hinders the productivity.	High yielding variety, Better nutrient management practices and soil health management may be strengthened.

	Green gram	Low (< 250 kg)	Namakkal, Coimbatore, Thiruppur, Nagapattinam, Virudhunagar, Thoothukudi	Prevalence of problem soils, Erratic rainfall in rabi season, Pest and disease menace (YMV) and growing local varieties reduces the productivity level.	High yielding, short duration, pest and disease resistant varieties particularly for yellow mosaic virus may be evolved and popularized. Crop booster spray after 50% flowering stage and in initial pod formation stage is essential to increase the yield.
		Medium (250 ï 400 kg)	Kancheepuram, Villupuram, Vellore, Thiruvannamalai, Salem, Dharmapuri, Krishnagiri, Erode, Tiruchirapalli, Karur, Perambalur, Ariyalur, Pudukottai, Madurai,Theni, Dindigul, Ramanadhapuram , Sivagangai, Thirunelveli	Lack of knowledge in keeping the soil health and production technologies are the major constraint. Continuous erosion in rainfed areas removes the top soil and non-application of organic manures due to non availability reduces the crop productivity.	
		High (>400 ï 600 kg)	Thanjavur, Thiruvarur	Pest and disease menace (YMV), Lack of knowledge in keeping the soil health and production	

		>600 kg	Cuddalore, Thiruvallur	technologies are the major constraint.	
	Black gram	Low (< 350kg)	Nagapattinam, Dindigul, Ramanathapuram, Viruthunagar, Thoothukudi	Pest and disease menace (YMV), Lack of knowledge in keeping the soil health and production technologies are the major constraint. Continuous erosion in rainfed areas removes the top soil and non-application of organic manures due to non availability reduces the crop productivity	Short duration, Salt tolerant high yielding varieties for deep vertisol tracts and pest and disease resistant varieties particularly for yellow mosaic virus may be evolved and popularized. Crop booster spray after 50% flowering stage and in initial pod formation stage is essential to increase the yield.
		Medium (350 ï 500kg)	Kancheepuram, Thiruvallur, Villupuram, Salem, Namakkal, Tiruppur, Tiruchirapalli, Pudukottai, Nagapattinam , Thirunelveli, Kanyakumari		
		High (>500 kg)	Cuddalore, Vellore, Thiruvannamalai, Dharmapuri, Krishnagiri, Coimbatore, Erode, Karur, Perambalur, Ariyalur,		

			Thanjavur, Thiruvarur, Madurai,Theni, Sivagangai		
	Ground nut	Low (<2000 kg)	Salem, Namakkal, Coimbatore, Thiruppur, Erode, Pudukkottai, Ramanathapuram, Viruthunagar, Kanyakumari	Non-availability of adequate quantities of certified seeds in groundnut Low plant population due to non-adoption of recommended seed rate/seed treatment and sowing behind country plough due to non popularization of seed drill. Non adoption of recommended practices in pest and disease management and fertilizer application. Non adoption of high yielding, drought resistant, semi spreading and spreading varieties of groundnut. Lack of appropriate agronomic practices for spreading type groundnut variety.	Drought tolerant varieties (ICGV 00350) and TMV13 may be popularized since its performance is good in all regions. Crop booster spray after 50% flowering stage and in initial pod formation stage is essential to increase the yield. Nutrient management and gypsum application is essential towards increasing the productivity. Machineries for sowing and dehusking may be promoted. Farmers could be advised to maintain the optimum plant population.

		Medium (2000 ï 3000 Kg)	Thiruvannamalai, Villupuram, Vellore, Dharmapuri, Krishnagiri, Tiruchirapalli,Karur, Perambalur, Ariyalur, Nagapattinam, Madurai, Dindigul, Sivagangai, Tirunelveli, Thoothukudi		
		High(> 3000kg)	Kancheepuram, Tiruvallur, Cuddalore, Thanjavur, Thiruvarur, Theni		
	Sugarcane	Low (<80 tonnes/ha)	Namakkal, Tiruchirapalli, Dindigul, Tirunelveli	Non-availability of quality seed material (setts), High pest and disease incidences, Poor adoption SSI techniques due to labour shortage, Poor after-sales service by the dealers of drip irrigation pipes and Poor adoption of Precision Farming Techniques	Availability of high yielding high quality sugarcane varieties with red rot resistance may be strengthened. Adoption of SSI practices may be emphasized. Farmers may be updated with latest technologies through Capacity building programmes.
		Medium (80 ï 100 tonnes/ha)	Kancheepuram, Thiruvallur, Vellore, Salem, Dharmapuri,		

			Krishnagiri,Tirup pur, Erode, Karur, Perambalur, Ariyalur, Pudukkottai, Tiruvarur, Nagapattinam,, Madurai, Ramanathapuram, Viruthunagar, Sivagangai, Thoothukudi, Nilgiris, Kanyakumari	causes lower productivity	
		High (>100 tonnes/ha)	Cuddalore, Villupuram, Thiruvannamalai, Coimbatore, Thanjavur, Theni		

8. Policy options to increase the productivity in Small and Marginal farms of Tamil Nadu

The following policy options are given to increase the level of productivity in small and marginal farms

1. Small farms are having more crop mix and intensive cultivation practices. Hence the farmers could be taught with soil testing and land reclamation measures in detail. Recommendations based on soil test should be thoroughly explained to the farmers by the officials.
2. Large scale demonstrations to be conducted for major crops. High yielding varieties may be popularized in paddy, millets and maize crops. Efforts will be taken to demonstrate the crucial technologies to the farmers in major crops.
3. Enhancing the soil health through green manure, FYM, mulching, biofertilizers and micro nutrients application increases the productivity.
4. Integrated Pest and Disease Management would be adopted for pest and disease monitoring and Management and introducing superior crop varieties which are resistant to pest and diseases and introduction of farm machineries suitable for various crop operations increases the productivity of all crops.
5. Strengthening farmer capacity through establishment of networking systems and enabling them to access quality inputs for intensive agriculture production and to adopt best agricultural practices for enhanced productivity.
6. The small and marginal farmers are less capital intensive. Hence they are not in position to invest more in Agriculture which emphasized the need of financial support for them. Hence the procedural formalities in provision of credit may be relaxed for them where ever it is possible.
7. The non- farm employment opportunities provides more livelihood support for the small and marginal farmers. Hence efforts will be taken to increase the suitable non ï farm employment opportunities in rural areas.
8. To cope up the rainfall deficiency, efforts will be taken to intensify the implementation of water shed development activities towards construction of check dam and

creation of farm ponds. Also water conservation technologies like drip irrigation methods may be popularized among the small farms

9. To cope up labour scarcity in rural areas mechanization may be popularized through demonstration.
10. Different models for marketing collectively by the small and marginal farmers like self help group model, co-operative model, small producer co-operatives and contract farming may be practiced to overcome constraints in accessing inputs, credit, extension and marketing.
11. Proper maintenance and management of godowns built confidence among the farmers to store their commodity in godowns. Measures will be taken for proper management of godowns.

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Annexure 1

Agricultural Census in Tamil Nadu During 2010

Sl.No	Size class	NUMBER(000's)		AREA (000'ha)		Average Size of holding in ha.	
		India	Tamil Nadu	India	Tamil Nadu	India	Tamil Nadu
1.	**Marginal**	92356 (67.04)	6266 (77.19)	35410 (22.25)	2291 (35.33)	0.38	0.37
2.	**Small**	24705 (17.93)	1182 (14.56)	35136 (22.07)	1644 (25.34)	1.42	1.39
3.	**Semi medium**	13840 (10.05)	502 (6.19)	37547 (23.59)	1355 (20.89)	2.71	2.71
4.	**Medium**	5856 (4.25)	151 (1.85)	33709 (21.76)	847 (13.06)	5.76	5.65
5.	**Large**	1000 (0.73)	17 (0.21)	17379 (10.92)	350 (5.39)	17.37	19.98
	All size class	137757 (100.00)	8188 (100.00)	159180 (100.00)	6488 (100.00)	1.16	0.83

Source: Agricultural Census, 2010 -11 Dept.of Agriculture and Co ï operation, Ministry of Agriculture, GOI -2012.

Annexure 2

Net Cropped area and Different Sources of Irrigation in the Districts of Tamil Nadu during 2011-2012

(in ha)

S.No	Agro Climatic Zones	Districts	Geographical area in ha	Net area sown in ha / % share of net area sown in district geographical area / % share of net area sown in state geographical area	Total irrigated area in ha / % share of irrigated area in district net area sown / % share of irrigated area in state net sown area	Canals / Percent share of canal in district (Total irrigated area) / Percent share of canal in State(Total irrigated area)	Tanks / Percent share of tank in district (Total irrigated area) / Percent share of tank in State(Total irrigated area)	Well / Percent share of well in district (Total irrigated area) / Percent share of well in State(Total irrigated area)
1	North Eastern Zone	Kancheepuram	443210	116770 (26.35) [0.9]	104941 (33.58) [2.12]	216 (0.21) [0.01]	65514 (62) [2.2]	39212 (37) [1.3]
2		Thiruvallur	342243	106479 (31.11) [0.82]	86642 (66.97) [1.75]	861 (0.99) [0.03]	14470 (17) [0.5]	71311 (82) [2.4]

3		Cuddalore	367781	216008 (58.73) [1.66]	146655 (44.31) [2.96]	45896 (31.30) [1.52]	5053 (3) [0.2]	95705 (65) [3.2]
4		Villupuram	722203	334994 (46.39) [2.57]	236136 (52.98) [4.77]	1901 (0.81) [0.06]	56752 (24) [1.9]	177482 (75) [5.9]
5		Vellore	592018	175040 (29.57) [1.34]	89992 (49.94) [1.82]	21 (0.02) [0.00]	2548 (3) [0.1]	87423 (97) [2.9]
6		Thiruvannamalai	631205	202465 (32.08) [1.55]	147275 (59.28) [2.98]	638 (0.43) [0.02]	26623 (18) [0.9]	120014 (81) [4.0]
7	Northen Western Zone	Salem	520530	219648 (42.2) [1.69]	110519 (49.58) [2.23]	1517 (1.37) [0.05]	93 (0) [0]	108909 (99) [3.6]
8		Namakkal	336719	154583 (45.91) [1.19]	74260 (45.76) [1.50]	3447 (4.64) [0.11]	79 (0) [0]	70734 (95) [2.3]
9		Dharmapuri	449777	167697 (37.28) [1.29]	71313 (40.86) [1.44]	390 (0.55) [0.01]	2408 (3) [0.1]	68515 (96) [2.3]
10		Krishnagiri	514326	174550 (33.94) [1.34]	50561 (23.93) [1.02]	964 (1.91) [0.03]	7831 (15) [0.3]	41767 (83) [1.4]

11	Western Zone	Coimbatore	472322	176484 (37.37) [1.35]	113048 (51.49) [2.28]	22172 (19.61) [0.73]	0 (0) [0]	90876 (80) [3.0]
12		Thiruppur	519559	193699 (37.28) [1.49]	119424 (39.65) [2.41]	41255 (34.54) [1.36]	1377 (1) [0.0]	76792 (64) [2.5]
13		Erode	572264	193312 (33.78) [1.48]	125746 (29.68) [2.54]	68318 (54.33) [2.26]	59 (0) [0]	57369 (46) [1.9]
14		Theni	324230	114479 (35.31) [0.88]	63260 (44.59) [1.28]	10956 (17.32) [0.36]	1253 (2) [0.0]	51051 (81) [1.7]
15		Dindigul	626664	222111 (35.44) [1.70]	113222 (45.44) [2.29]	4149 (3.66) [0.14]	8148 (7) [0.3]	100926 (89) [3.3}
16		Karur	289557	93856 (32.41) [0.72]	57750 (45.68) [1.17]	14832 (25.68) [0.49]	46 (0) [0]	42872 (74) [1.4]
17		Perambalur	175739	98061 (55.80) [0.75]	30782 (28.46) [0.62]	0 (0.00) [0.00]	2870 (9) [0.1]	27912 (91) [0.9]
18		Ariyalur	193398	105330 (54.46) [0.81]	43173 (29.82) [0.87]	8116 (18.80) [0.27]	3644 (8) [0.1]	31413 (73) [1.0]

19	Cauvery Delta Zone	Pudukottai	466329	151215 (32.43) [1.16]	105728 (17.00) [2.14]	5683 (5.38) [0.19]	74334 (70) [2.5]	25711 (24) [0.9]
20		Tiruchirapalli	440383	165722 (37.63) [1.27]	98783 (32.09) [2.00]	40936 (41.44) [1.35]	4661 (5) [0.2]	53186 (54) [1.8]
21		Thanjavur	339657	198407 (58.41) [1.52]	195945 (29.02) [3.96]	138104 (70.48) [4.57]	267 (0) [0]	57574 (29) [1.9]
22		Thiruvarur	209709	154245 (73.55) [1.18]	199146 (32.67) [4.02]	148752 (74.69) [4.92]	0 (0) [0]	50394 (25) [1.7]
23		Nagapattinam	271583	154643 (56.95) [1.19]	149233 (16.80) [3.02]	123252 (82.59) [4.08]	0 (0) [0]	25981 (17) [0.9]
24	Southern Zone	Madurai	374173	131555 (35.16) [1.01]	87961 (29.74) [1.78]	24787 (28.18) [0.82]	24056 (27) [0.8]	39119 (44) [1.3]
25		Ramanathapuram	408957	188452 (46.08) [1.45]	67901 (7.33) [1.37]	0 (0.00) [0.00]	54093 (80) [1.8]	13808 (20) [0.5]
26		Virudhunagar	424323	121950 (28.74) [0.94]	54436 (24.79) [1.10]	0 (0.00) [0.00]	24203 (44) [0.8]	30233 (56) [1.0]

27		Sivagangai	418900	115328 (27.53) [0.88]	89638 (17.75) [1.81]	0 (0.00) [0.00]	69171 (77) [2.3]	20467 (23) [0.7]
28		Tirunelveli	675850	152223 (22.52) [1.17]	120968 (36.14) [2.44]	17911 (14.81) [0.59]	48039 (40) [1.6]	55017 (45) [1.8]
29		Thoothukudi	470724	80476 (38.34) [1.38}	40909 (10.40) [0.83]	14825 (36.24) [0.49]	7316 (18) [0.2]	18768 (46) [0.6]
		State	13033116	4943886	3024118	739899	504909	1750540

Annexure 3

Net Cropped Area and Different Sources of Irrigation in Study Districts during 2011-2012

(in ha)

Particulars	Villupuram	Salem	Dindugal	Thanjavur	Ramanathapuram	Tamil Nadu
Total Geographical Area (ha)	722203	520530	626664	339657	408957	13033116
Net Area Sown / % share of net area sown in district geographical area / % share of net area sown in state area (ha)	332220 (46.0) (6.7)	227447 (43.7) (4.6)	241747 (38.6) (4.9)	199488 (58.7) (4.0)	186954 (45.7) (3.8)	4985857 (38.3) (100.0)
Gross Cropped Area / % share of gross cropped area in district geographical area / % share of gross cropped area in state area (ha)	355081 (49.2) (6.0)	327068 (62.8) (5.6)	247627 (39.5) (4.2)	285305 (84.0) (4.8)	186954 (45.7) (3.2)	5889672 (45.2) (100.0)
Total Cropped Area (ha)	355081	327068	247627	285305	186954	5889672
Total Area Under Irrigation (ha)	253389	168815	125445	242359	66896	3518822
Well (open & Bore well) (ha)	175933	115725	106116	34186	12117	1682957
Tank (ha)	57732	0	9828	253	54779	527898
Canal (ha)	1980	1260	4229	140255	0	745835
Other sources (ha)	0	0	721	0	0	6835
Cropping Intensity (ha)	1.06	1.43	1.02	1.43	1.00	1.18
Percentage of area under irrigation in total cropped area (ha)	71.36	51.61	50.65	84.94	35.78	59.74

Source: Season and Crop Report in Tamil Nadu, 2012

Annexure 4

Districts with low rainfall (<850 mm) and high fallow lands

S.No.	District	% of Gross area irrigated to Gross area sown	Irrigation Intensity	Actual rainfall (2012-13)	Normal rainfall	% share of other fallow to district geog area	Cropping intensity (2012 -13)
1	Thoothukudi	16.72	1.04	426.2	656.3	17.0	1.007
2	Coimbatore	61.72	1.03	619.9	689.3	14.9	1.025
3	Erode	47.68	1.03	534.2	702.9	4.0	1.024
4	Tirunelveli	49.61	1.09	821.3	845.1	26.6	1.070
5	Karur	46.33	1.01	405.4	655.0	17.4	1.009
6	Tiruchirappalli	43.72	1.08	562.6	818.0	27.4	1.055
7	Namakkal	44.09	1.26	495.8	793.4	2.8	1.233
8	Ramanathapuram	33.96	1.00	656.5	807.8	11.7	1.000
9	Virudhunagar	36.03	1.07	476.0	820.1	40.4	1.032
10	Theni	57.82	1.12	680.1	720.0	8.8	1.077
11	Tiruppur	48.13	1.00	345.7	618.2	24.2	1.001
	Average	**44.16**	**1.07**	**547.61**	**738.74**	**17.75**	

Annexure 5

Districts with medium rainfall (850 to 1000 mm) and moderate extent of fallow lands

S.No.	District	% of Gross area irrigated to Gross area sown	Irrigation Intensity	Actual rainfall (2012-13)	Normal rainfall	% share of other fallow to district geog area	Cropping intensity
1	Dharmapuri	40.23	1.31	785.7	902.1	1.8	1.237
2	Krishnagiri	34.65	1.25	695.1	850.7	3.0	1.187
3	Sivagangai	67.02	1.00	722.5	872.8	29.0	1.003
4	Salem	53.36	1.29	799.3	997.9	3.1	1.346
5	Vellore	47.53	1.19	884.8	936.2	12.8	1.136
6	Pudukottai	68.80	1.02	708.5	887.4	21.7	1.026
7	Perambalur	28.39	1.08	493.4	861.9	7.5	1.053
8	Madurai	30.52	1.02	565.3	927.9	21.5	1.009
9	Dindigul	48.50	1.02	629.5	930.7	17.0	1.016
	Average	**46.56**	**1.13**	**698.23**	**907.51**	**13.04**	

Annexure 6

Districts with high rainfall (>1000 mm per annum) and low fallow lands

S.No.	District	% of Gross area irrigated to Gross area sown	Irrigation Intensity	Actual rainfall (2012- 13)	Normal rainfall	% share of other fallow to district geographical area	Cropping intensity
1	Kanyakumari	39.41	1.20	849.2	1302.5	0.3	1.084
2	Villupuram	65.58	1.07	923.5	1011.6	1.9	1.058
3	Thiruvannamalai	69.33	1.33	1080.0	1040.0	4.3	1.265
4	Thanjavur	75.88	1.24	757.0	1013.1	7.6	1.258
5	Thiruvarur	64.96	1.18	1090.2	1173.3	4.5	1.307
6	Thiruvallur	88.40	1.28	1114.2	1139.6	10.2	1.250
7	Cuddalore	58.44	1.20	914.0	1206.7	6.4	1.331
8	Kancheepuram	80.33	1.08	943.4	1227.7	17.2	1.077
9	Nagapattinam	44.90	1.13	1078.2	1393.3	5.5	1.472
10	Ariyalur	26.03	1.11	652.3	1071.8	7.7	1.043
	Average	**61.33**	**1.18**	**940.20**	**1157.96**	**6.56**	

Annexure 7

Area under major crops in Tamil Nadu during 1960 -2010

(in lakh ha)

Crops	1960-69	1970-79	1980-89	1990-99	2000-10	1960-2010
Paddy	25.7	26.41	21.73	21.52	18.52	22.69
Cholam	7.48	7.28	6.73	4.35	3.07	5.73
Ragi	3.25	2.83	1.86	1.36	1.02	2.04
Maize	0.07	0.17	0.22	0.49	1.83	0.58
Total pulses	4.21	5.68	6.17	6.82	5.86	5.75
Sugarcane	0.1	1.47	1.92	2.76	3	2.05
Cotton	3.43	2.89	2.29	2.39	1.17	2.41
Groundnut	9.29	10.03	9.11	9.8	5.47	8.68
Total Cropped area	72	74.57	66.77	67.29	58.05	67.74

Annexure 8

Land Utilization Pattern in Tamil Nadu during 1960 - 2011

(in lakh ha)

Category	1960-69	1970-79	1980-89	1990-99	2000-10	2010-2011
FOR	19.05	20.05	20.77	21.55	21.44	21.2
	(14.66)	(15.43)	(15.97)	(16.56)	(16.49)	(16.3)
BAUL	8.86	7.05	5.58	5.09	4.94	4.93
	(6.82)	(5.42)	(4.3)	(3.91)	(3.81)	(3.81)
LPNAU	13.57	15.99	17.95	18.2	19.07	21.12
	(10.4)	(12.27)	(13.81)	(13.99)	(14.67)	(16.22)
CW	6.61	4.15	3.09	2.9	3.25	3.58
	(5.05)	(3.19)	(2.36)	(2.23)	(2.5)	(2.75)
PP	3.34	1.98	1.44	1.24	1.23	1.13
	(2.58)	(1.54)	(1.1)	(0.95)	(0.94)	(0.85)
MTC	2.64	2.15	1.82	2.34	2.31	2.68
	(2.02)	(1.65)	(1.38)	(1.79)	(1.77)	(2.05)
CF	9.69	12.02	16.18	12.64	10.57	10.1
	(7.47)	(9.23)	(12.45)	(9.71)	(8.13)	(7.75)
FOTCF	6.1	5.31	7.03	10.44	10.93	15.3
	(4.69)	(4.07)	(5.4)	(8.02)	(8.39)	(11.73)
NAS	60.25	61.35	56.22	55.78	56.31	50.16
	(46.31)	(47.2)	(43.22)	(42.87)	(43.3)	(38.52)

Note: Figures in parentheses indicate percentage to total geographic area

Annexure 9

Percentage Share of Area under each Crop in Tamil Nadu from 1960-2010

Crops	1960-69	1970-79	1980-89	1990-99	2000-10	1960-2010
Paddy	35.69	35.42	32.54	31.98	31.92	33.5
Cholam	10.4	9.77	10.08	6.47	5.3	8.46
Ragi	4.5	3.8	2.79	2.03	1.75	3.02
Maize	0.1	0.25	0.34	0.72	3.15	0.86
Total pulses	5.85	7.61	9.24	10.14	10.09	8.49
Sugarcane	1.38	1.98	2.88	4.09	5.18	3.03
Cotton	4.76	3.87	3.42	3.55	2.01	3.55
Groundnut	12.9	13.45	13.64	14.58	14.95	12.81

Field Survey by Investigators