# A STUDY ON THE IMPACT OF E- AGRICULTURE IN A SELECTED AREA IN COIMBATORE DISTRICT

**BY**

**SUKANYA.A**

**(14PEC011)**

**A DISSERTATION SUBMITTED TO**

**AVINASHILINGAM INSTITUTE FOR HOME SCIENCE AND HIGHER EDUCATION FOR WOMEN**

**COIMBATORE-641043**

**IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE**

**DEGREE OF MASTER OF ARTS IN ECONOMICS**

**APRIL 2016**

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**CERTIFIED AS BONAFIDE RESEARCH WORK**

**SIGNATURE OF THE HEAD OF THE DEPARTMENT**

**SIGNATURE OF THE SUPERVISOR**

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# CHAPTER-I
# INTRODUCTION

Agriculture lies at the heart of many fundamental global challenges faced by humanity including food security, economic development, environmental degradation, and climate change. There is no humanitarian goal more crucial than feeding a world population projected to expand beyond nine billion by 2050. Meeting increases in food demands associated with growing population and income levels is likely to require increases in total food production of 50 percent or more by mid-century. Agriculture provides employment for 2.6 billion people worldwide and accounts for 20 to 60 per cent of the gross domestic product of many developing countries, forming the backbone of rural economies, contributing to local employment, and ensuring food security for poorer populations (California Environmental Associates, 2014). Global climate change is a change in the long-term weather patterns that characterize the regions of the world. The term "weather" refers to the short-term (daily) changes in temperature, wind, and/or precipitation of a region (Merritts et al. 1998). In the long run, the climatic change could affect agriculture in several ways such as quantity and quality of crops in terms of productivity, growth rates, photosynthesis and transpiration rates, moisture availability etc. Climate change is likely to directly impact food production across the globe. Increase in the mean seasonal temperature can reduce the duration of many crops and hence reduce the yield. In areas where temperatures are already close to the physiological maxima for crops, warming will impact yields more immediately (IPCC, 2007). Drivers of climate change through alterations in atmospheric composition can also influence food production directly by its impacts on plant physiology. The consequences climate change, and its negative impact on agriculture, is severe which is projected to have a great impact on food production and may threaten the food security and hence, require special agricultural measures to combat with (Mahato, 2014). It is a well known fact that at this moment also India is an agricultural country with over dependence of the people on agriculture as a means of lively hood, a major source of employment and a major population living in rural areas, whose prime economic activity is agriculture. It is therefore urgent need of the hour to examine the inter linkages and inter connections between Indian agriculture and climate as a crucial global environmental problem.

## CLIMATE CHANGE AND INDIA

The Inter-Governmental Panel on Climate Change (IPCC) was established by United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to provide the world with a clear view on the current state of Climate Change and its potential environmental and socio-economic consequences. IPCC defines climate change as ‘a change in the state of the climate that can be identified by changes in the mean and variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity’. The definition provided by United Nations Framework Conservation on Climate Change (UNFCC) defines as ‘a change that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods’.

## CLIMATE CHANGE AND INDIAN AGRICULTURE

Indian monsoon rains are the backbone of Indian economy as most of our agricultural activities; rivers and replenishment of ground water sources have a direct dependence on monsoon rains. Monsoon rains are a manifestation of the complex interactions between land, ocean and atmosphere. Rainfall data are collected by the India Meteorological Department (IMD) in respect of the meteorological subdivisions of the country on day-to-day basis. Observation of Intergovernmental Panel on Climate Change (IPCC) indicate that adverse impact of climate change due to rising temperatures and extreme weather events on food production system could impact agricultural growth. Consistent warming trends and more frequent and intense extreme weather events are being observed across India in recent decades. Several areas have been identified as risk prone due to impact of climate change like coastal areas, Indo- Gangetic plains and the drought and flood prone regions of the country. Besides production from crops and livestock, fresh water and marine ecosystem is also likely to be affected due to warming of sea surface temperatures. Such climatic fluctuations could adversely affect agricultural sustainability resulting in unforeseen situational shortages which could also impact other economic sectors. Climate change is likely to significantly alter the dynamics of extreme events such as tropical cyclones, associated storm surges and extreme rainfall events; possibly increasing their frequency and intensity. Low lying regions, including small islands, will face highest exposure to rising sea levels, which will increase risk of floods bringing more cultivable area under submergence and degradation. Vulnerability of India in the even to climate change is more pronounced due to its ever increasing dependency on agriculture, excessive pressure on natural resources and poor coping mechanisms. While in the short run impact might not be severe, most crops are likely to witness yield decline after 2020 when temperature threshold limit of many crops might get breached. A one degree Celsius rise in mean temperature is likely to affect wheat yield in the heartland of green revolution. There is already evidence of negative impacts on yield of wheat and paddy in parts of India due to increased temperatures, increasing water stress and reduction in number of rainy days. Irrigation requirements in arid and semiarid regions are estimated to increase by 10 per cent for every 10°C rise in temperature. Rise in sea level is likely to have adverse effects on the livelihoods of fisher and coastal communities (Government of India, 2013). With 60 per cent of total food grains and oilseeds produced being grown in the kharif season, and with just 35 per cent of total arable area being irrigated, Indian agriculture is still heavily dependent on rainfall. Significant warming of temperatures, lower mean rainfalls and higher rainfall variability has been recorded by the Indian Meteorological Department (IMD) over successive plan periods.

## PRESENT STATUS OF INDIAN AGRICULTURE

The impacts of climate change on agriculture and serious things of concerns of climate change for Indian agriculture, it is of vital importance to study the present state of Indian agriculture. It is therefore here it is endeavored to assess the present state of Indian agriculture by taking into account some important indicators of agricultural development for the latest period prominently and also considering the data availability. It has been clearly established that there are significant variations in climate change impact at the nation and regional levels across the globe, variations that will be significant in terms of policy and social actions (Parvathi,C. and Yajanthini,D.,2015). The following table-1 explains a details of Indian Agriculture sector scenario.

## TABLE-1

## INDIAN AGRICULTURE SECTOR SCENARIO

(per cent at 2011-12prices)

| S.No | Item | 2011-12 | 2012-13 | 2013-14 | 2014-15 |
|---|---|---|---|---|---|
| 1 | Growth in Agriculture GDP | 5.0 | 1.5 | 4.2 | -0.2 |
| | Share in total GVA | 18.5 | 18.2 | 18.3 | 17.4 |
| | Of which, Agriculture | 12.1 | 11.8 | 11.9 | 10.9 |
| 2 | Share in total GCF | 8.6 | 7.8 | 8.6 | 7.7 |
| | Of which, Agriculture | 7.3 | 6.6 | 7.3 | 6.4 |
| 3 | GCF as per cent of agriculture GDP | 20.8 | 21.2 | 18.3 | 14.3 |
| | Of which, GVA sector | 18.3 | 16.3 | 17.0 | 15.8 |
| | Agriculture exports | 10.1 | 11.8 | 11.9 | 12.0 |

**Source: Economic Survey, 2016**

It is observed that agriculture sector has shown a significant growth in the year 2011-12, and a considerable growth in 2013-14. But its growth in 2011 and 2014-15 was dismal only and hence the thing of serious concern. The thing to be noted is that the share of agriculture sector to GDP is continuously falling and also remained at lower level at less than 20 per cent during the period into consideration. Besides this and more importantly, the contribution of agriculture to GDP of India has remained at lower and also shows a declining trend, which was just 12 per cent only during the period under study. The share of agriculture sector and agriculture in capital formation was also lower and indicated a falling trend. The contribution of agriculture to the exports of India is even lower, it is increasing is a thing to be noted. This adequately reveals that the importance of agriculture and agriculture sector India is falling on various counts which require to be improved for which agricultural development is very much necessary and the need of the hour.

The present state of Indian agriculture can be examined by taking into consideration some important indicators of agriculture development such as growth in area, production and yield. The necessary data about it is depicted below table 2.

**TABLE-2**

**MAJOR CROPS IN INDIA 2014-15*, WITH PER CENT CHANGE OVER 2013-14**

(Area: Million ha; Prod: Million tonnes; Yield: kg/ha)

| **Group/Commodity** | **Area** | **Production** | **Yield** |
|---|---|---|---|
| **Food grains** | 122.1 (-3.1) | 252.7 (-4.6) | 2070 (-1.5) |
| Rice | 43.9 (-0.2) | 104.8 (-1.6) | 2390 (-1.4) |
| Wheat | 31.0 (-0.7) | 88.9 (-7.3) | 2872 (-6.6) |
| **Coarse cereals** | 5.3 (-9.0) | 5.1(-6.3) | 953 (3.0) |
| Maize | 9.3 (-1.8) | 23.7 (-2.8) | 2557 (-1.0) |
| Bajra | 7.1 (-9.7) | 9.1 (-1.4) | 1272 (9.3) |
| **Pulses** | 23.1 (-8.4) | 17.2 (-10.8) | 744 (-2.6) |
| Gram | 8.2 (-19.9) | 7.2 (-27.4) | 875 (-9.4) |
| Turmeric | 3.7 (-4.9) | 2.8 (-15.5) | 750 (-11.6) |
| **Oilseeds** | 25.7 (-9.8) | 26.7 (-18.9) | 1037 (-10.0) |
| Groundnut | 4.7 (-15.2) | 6.6 (-32.2) | 1400 (-20.0) |
| Rapeseed and mustard | 5.8 (-13.6) | 6.3 (-20.7) | 1089 (-8.3) |
| Cotton | 13.1 (11.8) | 35.5 (-3.3) | 461 (-13.3) |
| **Sugarcane** | 5.1 (2.0) | 359.3 (2.7) | 70 (0.00) |

**Source: Economic Survey, 2016**

It is revealed that in 2014-15 compared to 2013-14 not much increase area in agricultural commodities has taken place except a few items like gram, ground nut, Bajra, maize, pulses. The area under food grains have increased marginally only and same is the case of the agriculture. commodities like rice, wheat, coarse cereals. There are some commodities that shown either negative growth or stagnant position in the area under cultivation. So far as growth in production is concerned, the production of food grains, rice, wheat, rice and sugar cane have shown a marginal growth only , is a thing of concern which requires due attention. The agriculture Commodities namely groundnut, gram have shown a considerable growth is a thing of appreciation. As far as growth in yield is concerned, except ground nut, coarse cereals and cotton all others have registered negative growth is a thing of serious concern for food security in India, which requires necessary attempts for their positive change**.** Information and Communication Technology (ICTs) denote a wide range of services, applications and technologies, using various types of hardware and software, often running over telecom networks (Pradhan, L and Mohapatra, B.B.,2015). ICTs facilitate improvement in information management and dialogue between individuals, groups, communities etc. It consists of mainly three technologies. They are, Computer Technology, Communication

Technology and Information Management Technology. These technologies are applied for processing, exchanging and managing data, information and knowledge. The tools provided by ICTs include computer hardware, operating systems, application software, as well as networks and intranets, telephone and electricity lines, radio and satellite systems by which they operate. The information technologies that can be used in agriculture are Satellite Communication, Geographic Information System (GIS), computer network, video, radio and reprography. Teleconferencing, e-mail, fax and mobile phones are some other potential technologies that could be used in effective transfer and dissemination of agricultural information to the farmers.

**E-AGRICULTURE IN INDIA**

E-Agriculture Community is made up of individual stakeholders such as information and communication specialists, researchers, farmers, students, policy makers, business people, development practitioners, and others. More specifically, e-Agriculture involves the conceptualization, design, development, evaluation and application of innovative ways to use information and communication technologies (ICTs) in the rural domain, with a primary focus on agriculture. E-agriculture is the Internet platform of this global initiative aimed at promoting sustainable agricultural development and food security by improving the use of information, communication, and associated technologies in the sector. E-agriculture is a rising field for enhancing existing agriculture and food security through enhanced processes for knowledge access and switch using information and communication technologies. The World Summit on the Information Society (WSIS) Plan of Action comprises e-Agriculture as a region of function of information and communication technologies (ICTs). E-agriculture is a relatively recent term in the field of agriculture and rural development practices. An emerging field focusing on the enhancement of agricultural and rural development through improved information and communication processes. To enable Community members to exchange opinions, experiences, good practices and resources related to e-Agriculture, and to ensure that the knowledge created is effectively shared and used worldwide. Applications of e-Agriculture in intensive agricultural systems in developed countries are gearing towards using sophisticated technologies to improve the quantity and quality of production, in order to maximize profits. This is the case in precision agriculture in which farmers are harnessing computer and satellite technologies to cut costs, improve yields and protect the environment.

Precision agriculture is described as:"A system to manage farm resources better. Precision farming is an information technology based management system now possible because of several technologies currently available to agriculture. These include global positioning systems, geographic information systems, yield monitoring devices, soil, plant and pest sensors, remote sensing, and variable rate technologies for application of inputs. "Precision agriculture is an advanced e-agriculture application. It makes use of five major components of technology:

- Geographical Information Systems (GIS) for analysis and management of spatial data and mapping;
- Remote Sensing (RS) to identify and
- Global Positioning Systems (GPS) to locate and define spatial features or activities that contribute to the quality of site-specific practices;
- Variable Rate Technology (VRT) allowing targeted, site-specific input applications; and
- Yield monitoring for recording crop productivity as an historical database for crop management.

**ROLE OF ICTS IN E –AGRICULTURE**

ICTs is an term that includes any communication device or application, encompassing: radio, television, mobile and fixed phones, computer and network hardware and software, satellite systems and so on, (as well as the various services and applications associated with them, such as videoconferencing, distance learning, etc) necessary for the delivery of information in the form of audio, data, video, image, etc. ICTs consists of all technical means used to handle information and aid communication. Several reports underscore just how significant and extraordinary ICTs productivity gains are not only for individuals and businesses, but for a nation (Ghogare,A. and Monga, M. 2015).

**ROLE OF ICTS IN TAMIL NADU**

ICTs has been an integral part of our society since it plays an important role to our day to day life. The rise of population of India has been a major issue in India, i.e. around 121 crore, out of which Tamil Nadu 's population is around 7.21crores in 2011 census. ICTs can deliver useful information to farmers about agriculture like crop care and animal husbandry, fertilizer and feedstock inputs, pest control, seed sourcing and market prices(Singh 2016). There are many possibilities of integration of ICTs in agricultural, for the overall agricultural and rural development.

- The ICTs tools provide networking of Agriculture Sector globally, the Centre and State Government Departments will have reservoir of databases" and also "bring farmers, researchers, scientists and administrators together".
- ICTs plays an important role in enhancing the impact and performance of agriculture production and in direct poverty alleviation by enhancing activities of poor and increasing their productivity by way of new credit and financial services.
- Up-to-date information, supplied to farmers as early as possible, about subjects such as packages of practices, market information, weather forecasting, input supplies, credit availability, etc.
- Tele-education for farmers.

In the last few decades, information and communication technologies (ICTs) have provided immense opportunities for the social and economic development of rural people, and some technologies have surpassed others. Mobile telephony is one such technology that has developed significantly in the past few years, and the subscription rate in developing countries has gone up from 22 per 100 inhabitants in 2005 to 91.8 per 100 inhabitants in 2015. Mobile technology goes beyond geographic, socio-economic, and cultural barriers and this large increase in mobile subscriptions, along with the recent roll out of 3G and 4G technology, can play a big role in the development of rural people. Mobile phones are devices that can create, store, access, and share information anytime, anywhere (Saravanan and Suchiradipta,2015). But they are more than that. When teamed with extension and advisory services, they can help improve the livelihoods of rural people by getting much needed timely information to their fingertips at potentially low cost. So called mobile based extension and advisory enable value-added services, such as mobile agro-services and machine to machine services, which help farmers monitor their crops and farm machinery through mobile phones. While value added services are generally fairly accessible to all the farmers in rural areas, machine to machine services are more cost intensive and require infrastructure that is often not present in developing countries.

Access to Information and Communication Technologies (ICTs) implies access to channels and modes of communication that are not bound by the barriers. New forms of social organization and of productive activity emerge, which if nurtured, could become transformational factor as important as the technology itself. The new paradigm of agricultural development is emerging at a faster pace. The overall development of rural areas in developing countries is taking new avenues of expansion. Old ways of doing business in terms of delivery of important services to citizens are being challenged in both developing and developed countries. A complete transformation of traditional societies to the knowledge societies has been increasingly felt all over the world.

Rural communities and small-scale agricultural producers are deeply affected by global economic, environmental and political forces. Using the ICTs, knowledge can be harnessed by strong organization of small producers, which will lead to the overall development of the flow of information at various stages(Shaik,2005). It is an inexpensive way to communicate and access global information. Well-organized local user groups and farmers' organizations can easily manage local Internet services. Information and analyses can be tailored to local, regional and national knowledge and communication needs and realities.

Modern Information Technologies can be used for the community development applications as well. When systematically applied and adapted to conditions of rural communities, Information Technology can be used for rural communication to increase participation, disseminate information and share knowledge and skills for community development.

**E-VELANMAI (E-AGRICULTURE)**

It is an ICTs based demand driven and participatory technology transfer model in agriculture to provide timely agro advisory services by a multidisciplinary team of agricultural scientists to the farmers using ICTs tools (Digital camera, computer, internet, mobile phone etc.) through a Field Coordinator and farmer on need basis (Anbarasan 2016). It is a sustainable approach of technology transfer for enabling scientific farming and enhances farm productivity.

- Farmers pay a membership fee based on the farm size owned by them to avail the extension services under e-velanmai as an indicator of their participation in the system of technology transfer.
- Scientists attend the farmers queries based on their call (demand) or need and hence it is demand driven for technical advice or scientific farming.
- It is also believed to be sustainable approach of extension as it facilitates the farmers to adopt the ‘e-velanmai’ model for technology access in the long run even after the project period (2012). The membership fees collected will be utilized for managing the sustainability of the process.

The use of ICTs, such as mobile phones and the Internet, has increased significantly since the creation of the e-Agriculture Community. It is estimated that there are almost 6.8 billion mobile connections among a world population of a little over 7 billion. The most recent 1 billion connections have been predominantly activated by the largest, but poorest, socio-economic group – people living on less than USD a day. People involved in agriculture and allied fields form the majority of these rural poor, and the increased availability of mobile connections provides a phenomenal opportunity to deliver information services to them. Having access to the right information at the right time has an enormous bearing on the livelihoods of resource poor smallholder farmers by allowing them to make informed decisions. Multi stakeholder partnerships have been formed, and time and money have been invested in this effort. It is essential to reflect on those experiences and to strategize for the future.

**PARTICIPATORY COMMUNICATIONS**

Effective examples of ICTs for agriculture and development use combinations of technologies, and the way they are used is often determined by the rural communities themselves. Traditionally, radio has long been used in combination with traditional forms of communication and media. With the massive availability of mobile phones even in remote rural areas as well as the Internet, radio continues to be an effective technology in supporting community dialogue and information services, particularly when these are designed and provided by the community members. ICTs such as mobile phones, Internet and audio/video devices (e.g. digital cameras) can enhance the process and outcomes of agricultural development initiatives.

**USE OF ICTS IN AGRICULTURE**

ICTs innovation plays a key role in improving agricultural production and the value chain. Food traceability systems using ICTs have become very important risk-management tools that allow food business operators or authorities to contain food safety problems and promote consumer confidence. ICTs enabled marketing and access to markets plays a major role, especially for information on market prices and demand. ICTs enhanced marketing and certification also strengthens the capacity of small-scale producers to increase revenue by improving their position on local and international markets. GIS and agro meteorological technologies have been introduced into programmes from the very beginning for various purposes including land-use planning, crop forecasting and early warning systems, among others. In addition, use of mobile phones has become more common for exchanging information such as for disease surveillance and pest tracking. There is also growing prevalence of ICTs solutions for the later stages of the agricultural value chain (e.g. post-harvest, transport, storage).

Percepted of e-agriculture focused on information and tools. Subject areas mentioned included farming practices ,market information, training ,statistics and science or research benefits included both generally enhanced information and communication processes and specifically Agriculture related benefits such as market access and food security . E-Agriculture was also seen to contribute to broader development goals. Future priorities included developing virtual communities and networks ,capacity building in the application of ICTs, and defining and advocating e-agriculture initiatives (Riome, et.al.,2008).This theory brought out the need for applications the e- agriculture methods and its importance of the farm level. The present study tries to cover these gaps, the major objectives of the study is to analyze "A Study on the Impact of E- Agriculture in a Selected Area in Coimbatore District"

**The specific objectives of the study are**

1. To study the Socio economic background of the selected farm households.
2. To analyze the E-Agriculture Methods (EAMs) in selected farm households.

3. To assess impacts of E-Agriculture Methods in selected farm households.

4. To estimate crop diversification in selected farm households and

5. Find out the problems of E-Agriculture Methods.

**HYPOTHESIS**

The following null hypothesis were tested in the course of study

I. Application of E-Agriculture Methods had led to

1. Economic well being of the farmers are depended on agriculture production.

2. There is EAMs adopted in the selected study block during the period of the study.

3. The socio economic status of the farmers was affected due to climate change.

4. The impacts of NEAMs caused in agriculture production of the selected study block and

II. Changing crop production and crop diversification with the adoption of EAMs.

**CONCLUSION**

The current study is an attempt to find out how to overcome the problem of global warming due to climate change and adoption and the benefits of EAMs for agricultural production activities in agriculture development in selected study area.

# *Review of Literature*

# CHAPTER-II

# REVIEW OF LITERATURE

The review of literature relating to the present study on "**A Study on the Impact Of E-Agriculture in a Selected Area in Coimbatore District''** is discussed under the following heads:

2.1 Climate Change

2.2 Agriculture and Rural Development

2.3 Role of E-Agriculture

2.4 Importance of E-Agriculture

2.5 Problems of E-Agriculture and

2.6 Related Studies

## 2.1 Climate Change

Climate change is a serious global environmental concern, which is primarily caused by the building up of green house gases (GHG) in the atmosphere. Recent discourse on climate change has underscored the fact of climate change occupies a high priority on the environment agenda of international community. India is conscious of the challenges of climate change and has implemented several programs addressing the climate change variability concerns,

- Cyclone warning and protection
- Coastal protection
- Floods and drought control and relief
- Major and minor irrigation projects
- Control of malaria
- Food security measures
- Research on drought resistant crops, (Chandra shekhar prasad 2012).

**Mall, R. K. et.al (2006)** during the recent decade, with the growing recognition of the possibility of climate change and clear evidence of observed changes in climate during 20$^{th}$

century, an increasing emphasis on food security and its regional impacts had come to forefront of the scientific community. In recent times, the crop simulation models have been used extensively to study the impact of climate change on agricultural production and food security. The output provided by the simulation models can be used to make appropriate crop management decisions and to provide farmers and others with alternative options for their farming system. The study founded that state of the knowledge of possible effect of the climate variability and change on food grain production in India.

**Ninan and Bedamatta (2012)** assessed the impact of climate change on Indian agriculture covering a cross section of crops, seasons and regions based on existing literature. The study notes that the impact of climate change will vary across crops, regions and climate change scenarios. The evidences indicate a decrease in production of crops in different parts of India with an increase in temperature. A number of studies indicate a probability of 10 per cent to 40 per cent loss in crop production in India with increases in temperature by 2080-2100.In areas located above 27° N latitude yields of irrigated and rain fed wheat are projected to rise in response to climate change whereas in all other locations yields are projected to decline by -2.3 per cent to -23.9 per cent. Temperature rises of between 2° C to 3.5 ° C is projected to lead to a loss of 3 to 26 per cent in net agricultural revenues. Increasing climate sensitivity of Indian agriculture will lead to greater instability of India's food production which will also impact on poverty and livelihoods. How quickly Indian farmers were able to adjust their farming practices to adapt to climate change, and what policies or technologies will enable rapid adaptation to climate change were issues that merit attention.

**Haque, et.al (2012)** their analysed on World's climate was changing and it was predicted, by a significant number of scientific studies that changes in climate conditions will escalate in the later part of the century. As a consequence, urban water demand was likely to be affected. Changes in water demand will exert significant pressure on the water authorities to maintain the balance between water demand and supply. Therefore, assessment of climate change impacts on water demand was crucial to ensure water demand was met under changed climate conditions. Their discussed the outcomes of a critical review of literature on climate variables in water demand modeling. It also evaluated the impacts of climate change on future water demand in the Blue Mountains region, New South Wales, Australia, as a case study with the climate projections from a global climate model, CSIRO. It was found that temperature and rainfall were the mostly used climate variables in water demand modeling; however, their form (e.g. maximum temperature, total rainfall and number of rain days) and incorporation of other climate variables in modeling need to be investigated to develop a robust water demand model to identify the climate change impact more efficiently. Results of climate change impact assessment on urban water demand demonstrated that future water demand in the Blue Mountains region in Australia would not be significantly impacted by the changed climate conditions. The study provided important insights which could be useful in conducting a more rigorous climate change impact analysis on urban water demand in other cities and regions.

**Zou et.al (2013)** their study provided a cost-effectiveness analysis of four water-saving irrigation techniques that are widely implemented in China to address the impacts of climate change: sprinkler irrigation, micro-irrigation, low-pressure pipe irrigation and channel lining. The aim was to thoroughly understand the economic feasibility of water-saving irrigation as an approach to coping with climate change. Based on the cost-effectiveness analysis. The study founded that water-saving irrigation is cost-effective in coping with climate change, and has benefits for climate change mitigation and adaptation, and for sustainable economic development.

**Mahato (2014)** global climate change was a change in the long-term weather patterns that characterize the regions of the world. The term "weather" refers to the short-term (daily) changes in temperature, wind, and or precipitation of a region (Merritts et al. 1998). In the long run, the climatic change could affect agriculture in several ways such as quantity and quality of crops in terms of productivity, growth rates, photosynthesis and transpiration rates, moisture availability etc. Climate change was likely to directly impact food production across the globe. Increase in the mean seasonal temperature can reduce the duration of many crops and hence reduce the yield. In areas where temperatures are already close to the physiological maxima for crops, warming will impact yields more immediately (IPCC, 2007). The consequences of agriculture's contribution to climate change, and of climate change's negative impact on agriculture, were severe which was projected to have a great impact on food production and may threaten the food security and hence, require special agricultural measures to combat with.

**Iglesias and Garrote (2015)** made their study on Climate change was expected to intensify the existing risks, particularly in regions where water scarcity was already a concern, as well as create new opportunities in some areas. Efforts to develop adaptation strategies for agricultural water management can benefit from understanding the risks and adaptation strategies proposed to date. Developing priorities for the adaptation of water resources for irrigation. Based on that extensive database we characterised the effort and benefit of a number of agronomic and policy measures, aiming to develop concrete adaptation plans and responding to concrete regional challenges. The adaptation choices consider current technological perspectives and do not project future technological change; certain that technological change will shape some choices for adaptation in the coming decades. The greatest scope for action was in improving adaptive capacity and responding to changes in water demands, however the implementation requires revamping current water policy, adequate training to farmers and viable financial instruments. The study resulted aim to assist stakeholders as they take up the adaptation challenge and develop measures to reduce the vulnerability of the sector to climate change.

Climate change impacts on agriculture on agriculture are being witnessed all over the world, but countries like India are more vulnerable in view of higher demographic pressure of natural resources and poor coping up mechanisms. Models generally predict that rising temperature, increased climate variability and extreme weather events could significantly affect food production in the coming decades(Chandra shekhar prasad 2012).

**2.2 Agriculture and Rural Development**

ICTs in agriculture is an emerging field focusing on the enhancement of agricultural and rural development in India. It involves application of innovative ways to use Information & Communication Technologies (ICTs) in the rural domain. The advancements in ICTs can be utilised for providing accurate, timely, relevant information and services to the farmers, thereby facilitating an environment for more remunerative agriculture(Bhavesh Kataria 2015).E agriculture focused on the enhancement of agricultural and rural development through improved information and communication following processes.

- Set up Village Information Shops that enable rural families to access modern information and communication technologies.
- Train rural youth in the organisation and maintenance of a system that generates locally relevant information from generic information.
- Update and disseminate information on entitlements to rural families using a blend of modern and existing channels of communication.

- The impact of information shops and ICTs through surveys, participatory rural appraisal and other methods and
- Information dissemination and exchange in rural areas that use advanced information and communication technologies(Chauhan,2015).

**Meera, and Jhamtani et al., (2004)** their examined the performance of three ICTs projects in India. The projects have quite different origins and purposes, but all were concerned with improving the delivery of information to farmers and other rural dwellers. One project was managed by the government of Madhya Pradesh as part of an exploration of e governance. A second project was run by sugar cooperatives (with some government support) in Maharashtra and attempts to expand services to growers. The third project was an experiment by a large private agricultural input supplier to provide information to farmers in Andhra Pradesh. The study described the organisation of each project; discussed the types of farmers involved and assesses their utilisation of the services; and looks at the backgrounds and performance of the functionaries who manage the projects. The projects studied varied with respect to the type of services provided, but these included marketing information, extension advice, information about rural development programmes, and other information from government and private sources.

**Singh (2007)** examined several ongoing projects that aim to provide IT-based services to rural populations in India. These projects were distinguished by the goal of commercial sustainability, which supports scalability and, therefore, more widespread benefits. The analysis highlighted the common building blocks required for successful implementation, and the relative strengths and weaknesses of different approaches.

**Ahuja, (2011)** India, our great nation which was a vast pool of knowledge workers was competing in the global economic playfield. A large share of our national income comes from agriculture and that was why, India was still known as an agrarian economy. Indian agriculture is now in a post-green revolution era and a larger pie of developmental efforts was being constructed particularly for those who were in the rural areas. Developing the capacity of agro-based rural communities through cyber extension with the use of ICTs will create opportunities of growth and prosperity and give a chance to Indian Agricultural markets for creating a more efficient information and knowledge network. The study revealed the utilization of ICTs for building capacities of agricultural markets through cyber extension.

**Raj (2013)** the study detailed with the implementation methodology, innovations and lessons of the ICTs initiative in providing agricultural extension services to the rural tribal farming community of North-East India. The study documented the ICTs project implementation challenges, impact among farmers and briefly indicates lessons of the e-agriculture project. Findings: The e-agriculture prototype demonstrated that the Rs. 2,400 (USD 53) cost of the extension services to provide farm advisory services was saved per farmer per year, expenditure was reduced 3.6 times in comparison with the conventional extension system. Sixteen fold less time was required by the farmers for availing the services and threefold less time was required to deliver the services to the farmers compared with the conventional extension system. The study argued that in less developed areas, information through ICTs alone may not create expected development. Along with appropriate agricultural information and knowledge, field demonstrations and forward (farm machinery, manure, seeds) and backward linkages (post-harvest technology and market) need to be facilitated with appropriate public private partnership(PPP) between knowledge and other rural advisory service providers for agricultural development. The study also listed a number of practical lessons which will be useful for the successful planning and implementation of e-agriculture projects in developing countries. The article was a first case study on ICTs for agricultural extension initiatives among the tribal farmers who dominate the less developed North-East India.

**Muthiah et.al (2013)** their study described that the experiences gained in terms of challenges encountered and lessons learned in an exploratory initiative of mobile phone-based multimedia agricultural advisory System (MAAS), which helps in providing timely agricultural expert advice to farmers on their mobile phone. When a farmer was calling, a call-centre-like interface containing personalized information of that farmer pops up at the expert’s end. The expert views the farmer’s dashboard and analysed the situation and query based advisory was provided to the farmer. The agricultural advisory system formed part of a research study under National Agricultural Innovation Projects (NAIP), New Delhi. The MAAS was developed by Indian Institute of Technology Madras’s Rural Technology and Business Incubator and it was field tested with 1200 farmers in three districts of Tamil Nadu (Kancheepuram, Erode and Dharmapuri), India, during December 2010 to June 2012. The study described the experiences, highlighting a number of specific challenges and lessons associated with providing mobile based agricultural advisories to farmers in rural areas.

**Chatterjee and Nath (2015)** Information and Communication Technologies (ICTs) were changing every sphere of our lives. Due to tremendous progress in internet technologies, ICTs had a big impact on rural areas and rural lives. Especially in agricultural field there was significant role of ICTs in rural areas. It was also expected that the ICTs led extension systems are going to act as a key agent for farmers to access information and share knowledge. Hence, renewed enthusiasm to use new ICTs for agricultural advisory services led to mushrooming of e-initiative pilots in India. The innovators are experimenting innovative ICTs initiatives solely for agricultural information and knowledge delivery. Unlike other sectors, agriculture was a complex sector where most of the ICTs initiatives may not function well. It was time to move forward in integrating ICTs and Information and Communication Management (ICM) in agricultural extension. One of the main reasons for the inequitable distribution of economic gains between the urban and the rural population was the gap in access to information. ICTs can help to bridge that gap and hence lead to reduction in the level of poverty. Farmers can get access to knowledge to improve their production and even get better price for their produce using variety of ICTs systems. In the present paper the authors made a systematic review of the role which ICTs can play in the development of rural areas in India.

**Derso, and Ejiro, (2015)** Agricultural extension was an educational service which brings information and new technologies to farming communities to enable them improve their production, incomes and standards of living. With the problem that extension agents face in facilitating direct contact with farmer clients and with researchers due to the physical distances involved and lack of transportation needed for their mobility, the application of Information and Communication Technologies offers excellent possibilities, for strengthening research extension systems and beyond the urban focus. Thus, for effective and efficient service delivery, the extension services and research organizations need to be appropriately supported with the use of Information and Communication Technologies. In many countries the costs of maintaining full complement of extension agents were increasing progressively while the price of computers in the global market has decreased rapidly. Experts in public and private research and extension system could easily connect, collaborate and established working online and offline platform using the Information and Communication Technologies tools. The experience in Ethiopia rapid development of Information and Communication Technologies, which facilitates the flow of data and information, has tremendously enhanced the knowledge management practice in agriculture.

The study assessed the contribution of information and communication technologies to the Ethiopian agricultural extension system and review the recently developed agricultural knowledge systems in Ethiopia. The study was based on a systematic review of existing literature of agricultural knowledge management work in the country. Section II focused on contribution of Information and Communication Technologies to the Ethiopian agricultural extension system. The third section discussed the forms of Information and Communication Technologies for agricultural extension service provision in Ethiopia. The fourth section examined generation and use of agricultural information in Ethiopia. The study revealed that the various forms of Information and Communication technology have been used in agricultural service delivery and were more in tune with the circumstances and requirements of smallholder farmers.

ICT's for farmers and their groups, as seen in some of the ICTs driven initiatives, is the involvement of human interface at the last mile indicating that there is a human dependency in transmission of Information/Knowledge to farmers. ICTs initiatives try to provide locally relevant content to farmers while reducing the expert-farmer gap. ICTs can play a main role in support of transformation of rural areas and agriculture in order to respond to these challenges and reduce digital inequality and divide between rural and urban areas. Fast changes in ICTs domain enable development and dissemination of electronic services in agriculture (Bhavesh Kataria2015).

**2.3 Role of E-Agriculture.**

"E-Agriculture" is an emerging field in the intersection of agricultural informatics, agricultural development and entrepreneurship, referring to agricultural services, technology dissemination, and information delivered or enhanced through the Internet and related technologies. More specifically, it involves the conceptualization, design, development, evaluation and application of new (innovative) ways to use existing or emerging information and communication technologies (ICTs). E-Agriculture goes beyond technology, to promote the integration of technology with multimedia, knowledge and culture, with the aim of improving communication and learning processes between various actors in agriculture locally, regionally and worldwide.

**RamaRao, (2004)** rural e-Governance applications in the recent past have demonstrated the important role the Information and Communication Technologies (ICTs) play in the realm of rural development. Several e-Governance projects have attempted to improve the reach, enhance the base, minimize the processing costs, increase transparency, and reduce the cycle times. Several states have initiated the creation of State Wide Area Networks (SWAN) to facilitate electronic access of the state and district administration services to the citizens in villages. Studies and experiences of Center for Electronic Governance at Indian Institute of Management, Ahmadabad (CEG-IIMA) indicate that significant efforts were required to design, develop and internalize the ICTs solutions through well managed reengineering of back-end processes and capacity building efforts to ensure sustainability. Suitable public private partnership models have to be adopted to ensure rapid development and cost effective solutions. The study reviewed of the technologies, the rural ICTs projects and the issues associated with the use of ICTs for rural e-Governance applications.

**Riome, et.al., (2008)** Percepted of e-Agriculture focused on information and tools. Subject areas mentioned included farming practices ,market information, training ,statistics and science /research .benefits included both generally enhanced information and communication processes and specifically Agriculture related benefits such as market access and food security . E-Agriculture was also seen to contribute to broader development goals .Future priorities included developing virtual communities and networks ,capacity building in the application of ICTs, and defining and advocating e-Agriculture initiatives.

**Raj (2013)** the study detailed with the implementation methodology, innovations and lessons of the ICTs initiative in providing agricultural extension services to the rural tribal farming community of North-East India. The study documented the ICTs project implementation challenges, impact among farmers and briefly indicates lessons of the e-agriculture project. Findings: The e-agriculture prototype demonstrated that the Rs. 2,400 (USD 53) cost of the extension services to provide farm advisory services was saved per farmer per year, expenditure was reduced 3.6 times in comparison with the conventional extension system. Sixteen fold less time was required by the farmers for availing the services and threefold less time was required to deliver the services to the farmers compared with the conventional extension system. The study argued that in less developed areas, information through ICTs alone may not create expected development. Along with appropriate agricultural information and knowledge, field demonstrations and forward (farm machinery, manure, seeds) and backward linkages (post-harvest technology and market) need to be facilitated with appropriate public private partnership(PPP) between knowledge and other rural advisory service providers for agricultural development. The study also listed a number of practical lessons which will be useful for the successful planning and implementation of e-agriculture projects in developing countries. The article was a first case study on ICTs for agricultural extension initiatives among the tribal farmers who dominate the less developed North-East India.

**Mathur, and Goyal, (2014)** agriculture was the one of the most important sector in India and also it was a pillar of Indian economy. Now it demands second green revolution and it was possible only through the transfer of technologies from lab to land. The generation and application of agricultural knowledge was progressively important, particularly for small and marginal farmers, who require relevant information in order to improve, sustain, and diversify their farm enterprises. Information technology support new methods and ideas for precision and healthy agriculture like computerized farm, weather forecasting, use of pesticides, fertilizers, and kind of crops. The study founded that how information technology was useful for decision making, improve planning and better produce of agro products and study the key elements and basic issues of information technology in farm practice.

**Kamani, and Kathiriya, et al., (2014)** there was a time when farmers got together at the local panchayat and talked about the weather, crops or what was happening in the world of agriculture. Communicating with others was called socializing. It was done face to face and was generally local. Now people, farmers, ranchers included, spread the word whether personal or farming related people using social media tools such as Face book, Google+, Twitter, YouTube, Wikis, Whatsapp, LinkedIn and blogs. The study focused an AGROPEDIA; a new agricultural based advisory system or portal by combining these social media tools and going to prove a digital knowledge repository system for the people associate with agriculture or allied fields.

**Shukla, and Patel, et al., (2014)** stated the potential to improve the quality of agricultural products and production using information technology that requires efficiency and information in all sectors of agriculture. Emerging view of a non-regularity in agriculture, thanks to the World Trade Organization [WTO], to make a great need and urgency to bring in it's an integral part of decision making by the Indian Farming Community. Information Technology (IT) has a major role to play in all facets of India Agriculture. In addition to facilitating and improving the efficiency of farmers productivity in agriculture and allied activities, bringing the potential of IT about qualitative improvement in the overall quality of life by providing timely and data inputs for decision making. Who work for the welfare of employees Indian farmers such as extension workers, do not have access to the latest hinders their ability to serve the farming community information effective. This manuscript focuses on the opportunity for people living in the e-powering in India, as well as those peoples who work for their welfare. Latest developments changing patterns of IT in rural India that facilitate effective IT penetration information requirements and IT role, the post-WTO necessarily systems environment, with possible bottlenecks in rural India, e-powering solutions are examined.

**Thankachan and Kirubakaran, (2014)** reviewed that the technological importance has been a great support for making decisions in various fields especially in agriculture. The development of agriculture had been on under development for the past few years due to lack of Agriculture knowledge and environmental changes. The main aim of the study was to reach farmers for their awareness, usage and perception in E-Agriculture. The study used statistical survey design technique to collect data from farmers for their awareness in e-Commerce. The results obtained indicated the level of awareness was less such that there was a need for e-agriculture for their support. E-Agriculture was a platform for supporting marketing of agricultural products

**Rajkumar, and Chauhan, (2015)** e-agriculture focused on the enhancement of agricultural and rural development through improved information and communication processes. More specifically, e-Agriculture involves the conceptualization, design, development, evaluation and application of innovative ways to use information and communication technologies (IT) in the rural domain, with a primary focus on agriculture. E-Agriculture was a relatively new term and we fully expect its scope to change and evolve as our understanding of the area grows. Indian Agriculture contributes to 18.6 per cent of India's GDP, and approximately 59 per cent Indians derive their livelihood from the agricultural sector. Private sector initiatives like contract farming have commercialized the Indian agricultural sector. To enable Community members to exchange opinions, experiences, good practices and resources related to e-Agriculture, and to ensure that the knowledge created was effectively shared and used worldwide. But there was some advantages and drawback which reside in every technology.

**Bapurao, and Arjun, (2015) e**-agriculture was an emerging field focused on the enhancement of agricultural and rural development through improved information and communication processes. More specifically, e Agriculture involves the conceptualization, design, development, evaluation and application of innovative ways to use information and communication technologies (IT) in the rural domain, with a primary focus on agriculture. Farmers' suicides were a matter of significant concern and controversy in India. With the highest number of farmer suicides recorded in the year 2013, Maharashtra continues to paint a dismal picture on the agrarian front with over 3,000 farmers taking their lives. According to NCRB data, over 60,000 farmers have killed themselves in the state since 1995. Effective utilization of ICTs in agriculture can definitely change the current situation of farmers and also reduce the suicidal rate of farmer.

**Ghogare, and Monga, (2015),** in India, Agriculture was considered to be a primary occupation for a most segment of population. The study focused on key factors discovered for effective utilization of Information Communication Technology for agricultural boost up, at least on the surface, with supportive of evidence herein. E-Agriculture was a rising field focusing on the improvement of rural and agricultural development through advanced information and communication processes. Some excising issues discussed with agriculture and rural development. The development of agriculture had been on under development for the past few years due to lack of Agriculture knowledge and environmental changes. The main aim of this study is to reach farmers for their awareness, usage and perception in e-Agriculture. E-Agriculture was a platform for supporting marketing of agricultural products.

**Anbarasan, (2016)** e-velanmai was the enhanced version in satisfying the farmer agro technological information needs. The innovated technological boons like Computer, Internet, and Mobile will be helpful for the farmers to get consultancy for their farming issues from various eminent scientists. The e-velanmai was definitely a promising scheme for time shrinking in answering farm related queries. The study was conducted in Tamil Nadu State of India. Aliyar and Palarriver sub basins of Coimbatore and Tiruppur districts were selected for identifying the respondents. Case study methods were used for the data collection and numbers of 10 cases were identified for knowing the effectiveness of e-velanmai. E-velanmai was evaluated as an effective means to transfer agro technologies to farmers. This was considered to be an effective approach of technology transferred to farmers by agricultural experts.

E-agriculture conveys the information regarding agricultural details to farmers in SMS via SMS gateway and hereby propose to switch over e-agriculture. The details such as daily alert, seasonal alert and other additional details can be sent to farmers. The daily alert can be sent to all farmers in the database. Seasonal alert can be sent to farmers only for selected farmers based on clustering result. Finally the other or additional detail which is announced by agriculture can be sent to all farmers.

### 2.4 Importance of ICTs

Information and Communication Technology (ICTs) is seen as an important means of achieving such a transformation. When used as a broad tool for providing local farming communities with scientific knowledge, ICTs heralds the formation of knowledge societies in the rural areas of the developing world. ICTs can also play an important role in bringing about sustainable agricultural development when used to document both organic and traditional cultivation practices. Developing countries can create Traditional Knowledge Digital Libraries (TKDL) to collect and classify various types of local knowledge so that it can be shared more widely. These libraries could also integrate widely scattered references to Indigenous Technical Knowledge (ITK) systems in a retrievable form. Thus IT could act as a bridge between traditional and modern knowledge systems.

**Gopinath, (2007)** analysed that the field of development communication or Participatory communication had been recent though it remains to a few case studies. Though there were a number of researches carried out by eminent NGO's, International donors and implementers and the Government, they crave for communication when the objective was to gain visibility. The discussions in participatory communication have recently gained popularity in the past two decades. A lot of projects or case studies have not been reported due to language barriers and scarce international visibility of most of the grassroots experiences. Too many projects have failed because of vertical planning and implementation and funds where channeled to developing nations that never reached the intended "beneficiaries". The grassroots level felt the need to communicate but there had been little consciousness of change at the planning and implementation level as development projects were mostly in the hands of economists and technicians impeding the understanding of social and cultural issues that are key to communication strategy. The planners have also realized that the sense of ownership cannot be promoted if they do not involve the beneficiaries at the beginning of the project. He goes on to add that the increasing awareness of the concept of participatory development had lead to a greater level of understanding of the role of communication for development.

**Roy, (2008)** Information was crucial in agriculture, in addition to land and capital. Faster transmission of improved farm technologies can revolutionalise agriculture. Quick dissemination of technological information from the Agricultural Research System (ARS) to the farmers in the field and reporting farmers' feedback to the research system was one of the critical inputs in transfer of technology. Matching the speed of technology transfer with that of farmer's acceptance can bring prosperity among the farm families. Information and Communication Technologies (ICTs) can play a significant role in making information available to the farming community at a reasonable cost. Initiatives from public as well as private sector were taken for disseminating technology information through ICTs. The most important feedback of the farmers was for improving the quality, timeliness and reliability of Information. All districts and block level offices of agriculture and other line departments need to be connected for facilitating regular two-way flow of information between research and development wings of agriculture.

**Chauhan, (2010)** explained the role of Information Technology to develop agricultural research, education and extension to improve quality of life in rural area is well established. IT can help an average Indian farmer to get relevant information regarding agro-inputs, crop production technologies, agro processing, market support, agro-finance and management of farm agri-business.

**Ghosh, (2011)** analysed various initiatives in the recent past portrayed the significant role that the ICT plays in the realm of rural development. Several projects have reduced the costs, and it also had increased transparency. A large number of rural e-Governance applications, developed as pilot projects were aimed at offering easy access to citizen services and improved processing of government to citizen transactions. Information and communication technologies for rural development and how far it had contributed. The other aim was to ponder over the achievements and the failures of ICTs in the sustainable development march. The analysis also indicated communication related initiatives and projects for development before media liberalization and post media liberalization.

**Mahapatra, (2012)** analysed the role played by the information and technology in Odisha for agricultural development and find out that like other instrument of development of agriculture the provision of right information to the agricultural stakeholder has yet to designed. Access to right information and its proper utilisation can make agriculture more competitive.

**Kameswari, and Kishore, et al., (2012)** reported on the availability, use and information seeking behaviour of a farming community with specific reference to Information and Communication Technologies (ICTs). It fills a research gap by examining what people do with a medium when they have access to it, rather than looking at barriers surrounding the use of ICTs and digital divide issues arising due to differential access and capabilities. The study was conducted in a state in North India, and provides insights into intentions and factors surrounding the use of various media by farmers. It highlights the socio-cultural context within which information seeking and use occurs in rural India.

**Amit Mathur and Megha Goyal (2014)** pointed agricultural extension services and approaches have been pursued in east Africa with varying degrees of success. The study explored the extent to which agriculture extension services provided by both public and private sector have been translated into meaningful social and economic development of farmers. Several dynamics in the pursuit of extension programmes include shortage of extension staff and poor working facilities, leading to inadequate capacity of unbalanced technologies and low participation of private sector were noticed. The study outlined a number of recommendations including but not limited to strongly involve stakeholders in technology development and transfer. This will assist farmers identify their felt needs rather than the needs being determined by extension service providers.

**Kamani, and Kathiriya, et al., (2014)** there was a time when farmers got together at the local panchayat and talked about the weather, crops or what was happening in the world of agriculture. Communicating with others was called socializing. It was done face to face and was generally local. Now people, farmers, ranchers included, spread the word whether personal or farming related people using social media tools such as Face book, Google+, Twitter, YouTube, Wikis, Whatsapp, LinkedIn and blogs. The study focused an AGROPEDIA; a new agricultural based advisory system or portal by combining these social media tools and going to prove a digital knowledge repository system for the people associate with agriculture or allied fields.

**Patel, and Kapil, (2014)** depicted agriculture was different from industry and plays a significant role in the economic development of a nation. India's prosperity depends upon the agricultural prosperity. There were many kinds of agricultural products produced in India and the marketing of all these farm products generally tends to be a complex process. Agricultural marketing involves many operations and processes through which the food and raw materials move from the cultivated farm to the final consumers. The conventional approach of extension services have not been able to resolve the challenges posed by various factors in Indian Agriculture marketing. The study discussed about the challenges and the opportunities for ICTs mediated services for agricultural marketing.

**Mathur, and Goyal, (2014)** agriculture was the one of the most important sector in India and also it was a pillar of Indian economy. Now it demands second green revolution and it was possible only through the transfer of technologies from lab to land. The generation and application of agricultural knowledge was progressively important, particularly for small and marginal farmers, who require relevant information in order to improve, sustain, and diversify their farm enterprises. Information technology support new methods and ideas for precision and healthy agriculture like computerized farm, weather forecasting, use of pesticides, fertilizers, and kind of crops. The study founded that how information technology was useful for decision making, improve planning and better produce of agro products and study the key elements and basic issues of information technology in farm practice.

**Gandhi, and Armstrong, (2014)** described an assessment of attitudes of farmers from the Lanja tehsil of Ratnagiri district of Maharashtra in order to understand the information seeking behavior and reasons for the farmers seeking that agricultural information through different sources. To meet the objective of the study, a structured questionnaire and interviews were conducted to gather information on number of aspects related to the use of Information and Communication Technologies (ICTs) from 100 randomly selected framers. Additional semi-structured questionnaire and checklist was provided to the key stakeholders. The farmer based questionnaire sought demographic data, information requirement data and uses of ICTs data. Key stakeholders were also asked similar information and information related to their job position, their work experience and what further knowledge they would require to improve their work performance. The study analysed that demographic data, educational qualification, family background, income range, land ownership, use of ICTs, source of getting information, belief on the sources of getting the information and the information required by the farmer. The study provided an insight into information needs of the villagers and their attitudes to whether the information may facilitate better decision making about their agricultural activities

**Bhalekar, and Ingle, et al., (2015)** Information and communication technology (ICTs) was changing all the spheres of human lives. Hence it was popular. The application of Information and Communication Technology (ICTs) in agriculture sector was increasingly important. Agriculture was an important sector with the majority of the rural population in developing countries depending on it. The agriculture sector faced major challenges of enhancing production in a situation of declining natural resources necessary for production. The growing demand for agricultural products, however, also offers opportunities for producers to sustain and improve their livelihoods. Information and Communication Technologies (ICTs) act as a key agent in agriculture sector in addressed these challenges and enriching the livelihoods of the poor rural population which depends on agricultural produce.

**Abuja, (2015)** the factors influencing the use of Information and Communication Technologies (ICTs) and the effect on the efficiency of maize marketing in North-Central Nigeria were analyzed; based on profit margins, factor effects and log it regression model. Results showed that age of marketers, education, regulatory bodies, market channels, marketing cost and ICTs significantly affect maize marketing efficiency; and that maize marketing was price efficient but operationally inefficient (ranging from 194.83 to 399.46 percent). Sources of market information were: extension agents (53 percent), radio and television (53 percent), mobile phones (47 percent), video programs (30.5 percent), and internet (25 percent). Furthermore, the costs of mobile phones and air time, electricity, phone support services, internet services, radio and television network services, and literacy of marketers significantly influence the use of ICTs. The use of mobile phones should be promoted for disseminating market information and market infrastructure should be improved.

**Kataria, (2015)** the rapid advancement in Information and Communications Technologies (ICTs) had given rise to new applications that were impossible just few years ago. Agriculture was an important sector with the majority of the rural population in developing countries depending on it. ICTs or Information and Communications Technology in simple terms, can be defined as the basket of technologies, which assist or support in storage, processing of Data/Information, or in dissemination/ communication of Data/Information, or both. ICTs thus includes technologies such as desktop and laptop computers, software, peripherals and connection to the Internet that were intended to fulfill information processing and communication functions. The study analysed how ICTs used to evaluate scenarios of changing demographics, economic, and technological and agro climatic circumstances affecting agricultural production.

**Pradhan, and Mohapatra, (2015)** agriculture was an information intensive industry that was spatial in nature. To be successful, farmers must be generalists who were not only well versed in the latest farming technologies but also astute businessman who were technologically savvy. Further, the globalization had very adverse effects on Indian farmers, as they have to compete with the farmers of developed countries. To cope with challenges posed by the globalization of agriculture, the farmers have to produce quality product at par with world market at reasonable prices. Thus, the farmers need to be well informed and well trained in the management of natural resources and production of agricultural commodities. E-agriculture plays an important role in addressing these challenges and uplifting the livelihood of Indian farmers. The study explored the potential contribution so far been attempted under the aegis of e-agriculture or Information and Communication Technology (ICTs) to the livelihoods of farming community in India. Further, a general framework of the current state-of-the art wireless sensors network was given as a challenging technology for Indian farming community to monitor their crops from a remote place.

**Motilewa, and Deborah, (2016**)"The provision of citizen-centered services and development were critical indices in the measurement of performance of every government. In the era of Information Communication Technology (ICTs), government businesses can be conducted through the electronic governance (EGOV) platform. E-governance involves the development, deployment and enforcement of the policies, laws and regulations necessary to support the functioning of a knowledge society as well as the transformation of internal and external public sector relationship through ICTs in order to optimize government service delivery and citizen participations.

**Yadav et.al., (2016)"**Information and communication technologies (ICTs) were increasingly used for knowledge management (KM) currently. However the full potential of ICTs were yet to be realized due to several challenges. The study explored the challenges in using ICTs for KM using the case of Agropedia, an ICT mediated knowledge management platform for Indian agriculture. The study argued that KM was no longer a technical challenge but was rather constrained by social and organizational barriers. Without initiating institutional and policy changes to address these barriers, ICTs cannot contribute significantly to KM. By

March 2014, Agropedia had close to 8500 registered users and 33,062 published nodes solely dedicated to agriculture and 24 crop knowledge models. A total of 35 institutional Agropedias and a mother Agropedia were created for a better content management system. In conclusion, the deployment of ICTs in agriculture was found to be a socio-technical process, facing social and organisational challenges. Against this background, knowledge sharing needs to be incentivised."

The organisations and departments concerned with agricultural development need to realise the potential of ICTs for the speedy dissemination of information to farmers. • Government at national and state level in India has to reorient agricultural policies so that a fully-fledged strategy is formed to harness ICTs potential for assisting overall agricultural development.

**2.5 Problems of E-Agriculture**

The problems related to agriculture & farmers with the use of technology then its quite easy, fast and economical. So by using Information & Communication Technology we can deal the problem in a better manner and we have given new name to agriculture called e-Agriculture. Farmers don’t have sufficient knowledge to make land highly cultivable. They are not getting high yielding seeds and the seeds which can resist to common, illnesses & which can give good crop in less water. Farmers are not getting soil friendly fertilizers & pesticides. Farmers are not getting weather information or timely weather information ( Jai Vardhan Singh,2008).

**Patil, et.al (2008)** the past decade was characterized by major changes in the Information and Communication Technology (ICTs) environment in agriculture worldwide. It had changed from hand held calculators and batch processing of management data at central service centers to adoption of on-farm information management facilities, computer embedded process control devices, remote sensing with spatial data utilization, and more, with almost all of them endowed with communication capabilities. Adoption of ICTs was far from universal to the detriment of farmers and the agricultural sector. Accordingly current studies were evaluated what information farmers, extension personnel and researchers really need what were the main constraints for adopting ICTs. The Indian agricultural sector shares these concerns and was no exception in seeking answers. An evaluation of the Indian scene suggests that market information and weather updates were of prime interest; illiteracy, cost and lack of awareness were the major adoption constraints. Human capital enhancement was understood to be the main remedial factor to change the low rate of ICTs adoption and its effectiveness.

**Ramaraju, et.al (2011)** in their study on 'ICTs in Agriculture' was an emerging field focusing on the enhancement of agricultural and rural development in India. It involves innovative applications using Information & Communication Technologies (ICTs) in the rural domain. The advancements in ICTs can be utilized for providing accurate, timely, relevant information and services to the farmers, thereby facilitating an environment for more remunerative agriculture. The foremost issue yet to be addressed was the problem faced by farmers in using ICTs application's to collect information on agriculture. The problems faced were a lack of simplicity and acceptability of technology, with no relevant and in-time delivery of practical solutions area on location wise for all agricultural operations. The research paper focused on the key findings based on the study and analysed of major ICTs initiatives in agriculture in India vis a vis need for information by the Indian farmers.

**Kumar, and Sankarakumar, (2012)** stated that the outline the level of attitudes of the farmers on ICTs application in agriculture, impact of ICTs application in agriculture activities and problems in accessing the ICTs application in Ramanathapuram district.

**Bhavesh Kataria (2015)** The rapid advancement in Information and Communications Technologies (ICTs) had given rise to new applications that were impossible just few years ago. Agriculture was an important sector with the majority of the rural population in developing countries depending on it. ICTs or Information and Communications Technology in simple terms, can be defined as the basket of technologies, which assist or support in storage, processing of Data/Information, or in dissemination/ communication of Data/Information, or both. ICT thus includes technologies such as desktop and laptop computers, software, peripherals and connection to the Internet that were intended to fulfill information processing and communication functions. The study analysed how ICTs used to evaluate scenarios of changing demographics, economic, and technological and agro climatic circumstances affecting agricultural production.

E-Agriculture can solve the problems of farmers efficiently, timely and in a cost effective manner. This will increase the financial status of farmers which in turn change the economic condition of country. When our agricultural production will increase with the help of e-Agriculture then the food crisis of world will be solved and we can ensure food to everyone in sufficient quantity (Jai Vardhan Singh,2008).

### 2.6 Related Studies

ICTs is one of these solutions, and has recently unleashed incredible potential to improve agriculture in developing countries specifically. Technology has taken an enormous leap beyond the costly, bulky, energy-consuming equipment once available to the very few to store and analyze agricultural and scientific data. With the booming mobile, wireless, and Internet industries, ICTs has found a foothold even in poor smallholder farms and in their activities. The ability of ICTs to bring refreshed momentum to agriculture appears even more compelling in light of rising investments in agricultural research, the private sector's strong interest in the development and spread of ICTs, and the upsurge of organizations committed to the agricultural development agenda.

**Boris, et.al (1993)** the study reviewed and critiqued the frontier literature dealing with farm level efficiency in developing countries. A total of 30 studies from 14 different countries are examined. The country that had received most attention was India, while rice had been the most studied agricultural product. The average technical efficiency (TE) index from all the studies reviewed was 7270. The few studies reporting allocate and economic efficiency show an average of 68 per cent and 43 per cent, respectively. These results suggested that there was considerable room to increase agricultural output without additional inputs and given existing technology. Several of the studies reviewed have sought to explain farm level variation in TE. The variables most frequently used for this purpose have been farmer education and experience, contacts with extension, access to credit, and farm size. With the exception of farm size, the results reveal that these variables tend to have a positive and statistically significant impact on TE. The study showed that considerable effort had been devoted to measuring efficiency in developing country agriculture using a wide range of frontier models.

**Dethier, and Effenberger, (2012)** after 20 years of neglect by international donors, agriculture was now again in the headlines because high food prices are increasing food insecurity and poverty. In the coming years, it will be essential to increase food productivity and production in developing countries, especially in Sub-Saharan Africa and with smallholders. The study examined require finding viable solutions to a number of complex technical, institutional, and policy issues, including land markets, research on seeds and inputs, agricultural extension, credit, rural infrastructure, connection to markets, rural non-farm employment, trade policy and food price stabilization. The study reviewed what the economic literature had to say on these topics. It discusses in turn the role played by agriculture in the development process and the interactions between agriculture and other economic sectors, the determinants of the Green Revolution and the foundations of agricultural growth, issues of income diversification by farmers, approaches to rural development, and issues of international trade policy and food security, which have been at the root of the crisis in agricultural commodity volatility in recent years.

**Abubakari, F., and Abubakari, F., (2015)** climate change was a threat to agriculture and food security because of the loss in food production through crop failure and increase and mortality rate of livestock. One of the main elements of climate change for agriculture was the variability in rainfall and temperatures that directly impact soil moisture. This study addressed the effect of climate changing on food crop in Ghana between 2001 and 2010. Some of the crops grown by farmers in this study are cassava soybean, maize and millet. The effect climate on the yield of cassava was 13.80Mt/Ha and that of the achievable yield was 48.70Mt/Ha, average yield of soybean was 1.5Mt/Ha and its achievable yield 2.30Mt/Ha, maize average yield was 170 Mt/Ha and achievable yield 6 Mt/Ha and that of millet 1.3 Mt/Ha and achievable yield 2Mt/Ha. The highest rainfall in the regions was record in 2003 12,229mm and the least in 2004 9,928mm. The types of livestock from this study include cattle, sheep, goats and poultry. There was a positive co-variation between poultry population and the rainfall 30-year average under consideration, a perfect negative significant correlation between goat population and the rainfall 30-year average, a positive co-variation between cattle population and rainfall 30-year average.

Agricultural and Development is a complex endeavor. ICTs Extension can’t and should not be assumed to resolve the variety of agricultural and rural development problems, although it may serve in information coordination amongst relevant agencies. Enough ICTs initiatives have been pilot tested in Indian context, so far. There is a need to look beyond the pilot testing of ICTs to evolve the proper extension efforts that harness ICTs. For this, there is need to incorporate the ICTs into structural and functional components of the extension organizations (Anbarasan2016)

# *Methodology*

# CHAPTER-III

# METHODOLOGY

A systematic and careful analysis of information is of primary important in any research in order to obtain reliable results, it is essential to evolve scientific methods of data collection and employ appropriate and reliable techniques for the analysis information. The methodology adopted in the current study on "**A Study on the Impact of E- Agriculture in a Selected Area in Coimbatore District''** is presented and discussed under following heads.

3.1 Selection of the Problem

3.2 Selection of the Sample

3.2.1.(a) Selection of the Study Area

(b) Profile of Coimbatore District

3.2.2.(a) Selection of the Study Block

(b) Selection of the Farm House Holds

3.3. Sources and Collection of Data

3.4. Quantitative Tools

3.4.1 Cobb-Douglas Production Function

3.4.2 Crop Diversification Index

(a) Herfindhal Index

(b) Modified Entropy Index

3.4.3 Scaling Technique and

3.4.4 Average, Percentage and Graphs

3.5.Definitions and Terms Used in the Study and

3.6 Limitations of the Study

## 3.1 Selection of the Problem

The very important environmental problems before the World as a whole and India in particular is climate change, which is very closely associated with the global warming. They are very important on the ground that they have number of evil consequences on more or less all the spheres of the environment. It is not only India, but all the countries have been facing from the evil impacts of the climate change. It is adversely affecting the segments of the environments such as atmosphere, land, water and living things. Besides this the climate change is also adversely affecting the productive activities and sectors in the economies of the number of countries in the world as whole. It is therefore climate change has become at this moment a very importantly environmental problem of the globe as whole. And in the era of globalization and liberalization all countries of world are very closely interlinked and inter connected with the each other and India cannot be an exception to it. Hence India also has been severely affecting from the evil consequences of the climate change. It is a well known fact that at this moment also India is an agricultural country with over dependence of the people on agriculture as a means of lively hood, a major source of employment and a major population living in rural areas, whose prime economic activity is agriculture (Shabana Tabusum et al.,2014). This demands to discuss the interconnections and linkages between climate change and agriculture in the context of India. The prime objective of the present paper is identifying the things of serious concerns of climate change for the Indian agriculture. The study is exclusively relied on the secondary data concerning agriculture as well as climate change for the latest period prominently. The study concludes that the climate change has created severe adverse impacts on agriculture and thereby things of serious concerns, which are necessary to be tackled with the joint efforts of the government policy and active participation of the people and the society as a whole.

### 3.2.1 Selection of the Study Area

Tamil Nadu is situated in the southern-most part of the Indian peninsula. Agriculture, a predominant sector, contributes to about 10 percent of the state's Gross Domestic Product and provides employment for about 60 percent of the rural work force. Currently, gross cropped area is 6.3 million hectares, accounting for nearly 50 per cent of the total geographical area of the state. Food crops account for 70 per cent of the gross cropped area, of which nearly half is under rice (Government of Tamil Nadu, 2010).

Climate in Tamil Nadu is tropical with only slight variations in summer and winter temperatures. Rainfall is from the southwest and northeast monsoons in the last 25 years, the state has received nearly 80 percent of its annual rainfall during the northeast monsoon season. Additionally, depressions reaching the dimensions of a hurricane develop over the Bay of Bengal and the Arabian Sea, resulting in heavy wind and rainfall during the northeastern monsoonal months. Floods and cyclones can cause heavy damage to food crops during the northeast monsoon season. For instance, some 13 percent of agricultural crops were lost in 2008 as a result of the NISHA cyclone (Government of India, 2008). Since the state is entirely dependent on rains for recharging its water resources, monsoon failures also lead to acute water scarcity and severe drought. Tamil Nadu has India’s third longest coastline, which offers another set of challenges (Saravanakumar,V. 2015). Flooding of coastal areas as a result of sea-level rise and intrusion of salt water into coastal aquifers contributes to crop losses. Thus, climate change can impact agriculture in many different ways in Tamil Nadu, making this an important state to study.

**Profile of Coimbatore District**

Coimbatore District lies on north of Tamil Nadu. Coimbatore District situated at between 11$^{o}$00’58” and 11$^{o}$01’61”North latitude and 76$^{o}$58’16” and 76$^{o}$09’71”East longitude. Now Coimbatore District consists of 10 taluks viz., Coimbatore-North ,Coimbatore-South , Mettupalayam, Pollachi, Sulur, Valparai, Coimbatore Corporation, Pollachi Municipality, Mettupalayam Municipality. There are 3 Muncipalities in the District viz.,. Mettupalayam, Pollachi , Valparai. There are 37 Town Panchayats and 227 village Panchayats declared on 2011 census and 295 revenue villages. There are12 Community Blocks in the District. The District in generally is characterised with a pleasant and salubrious climate. The soils of the district are mostly red soil and black soil with moderate amount of sandy coastal alluvium.

**COIMBATORE DISTRICT MAP**


**FIGURE:1**

**Cultivable Area**

The total geographical area of the district is 3,97,883 hectares. Of these gross cropped area was 1,91,147 hectares. The area under forest accounted for 6,647 hectares and the net area sown accounts for 1,82,306 hectares.. The area sown more than once accounts for 8,841 hectares. The current fallow land was 56,219 hectors and other fallow land accounts for 30,630 hectares. The barren and uncultivable land accounts for 4,787 hectares. The cultivable waste accounts for 9,062 hectares. The permanent pastures and other grazing lands accounts for 76 hectares. The land put into non agriculture uses accounts for 74,202 hectares and miscellaneous tree, crops and grooves not included in the net area sown accounts for 3,168 hectares.

**Major Crops**

Pulses and cereals are much in cultivation in the selected district. Cholam which is raise in more than 32,107 hectares and Cumbu is about 131 hectares. Cultivation of Maize extends over 5,432 hectares and other cereals 700 hectares. Cultivation of Pulses is about 9,949 hectares are used for a raising pulses. The green gram are much in cultivation is about 1,832 hectares. Black gram cultivation is about 1,622 hectares and Bengal gram cultivation is about 1,622 hectares. The main sources of irrigations are the canals and wells. Canals under various irrigation projects together help to irrigated about 23,326 hectares of land while the wells irrigated19,314 hectares.

**TABLE-3**

**MAJOR CROPS CULTIVATED IN COIMBATORE DISTRICT**

| S. No | Major Crops | Area (in hectares) |
|---|---|---|
| **Cereals** | | |
| 1 | Cumbu | 131 |
| 2 | Cholam | 32107 |
| 3 | Maize | 5432 |
| 4 | Varagu | 100 |
| 5 | Other cereals | 700 |
| **Pulses** | | |
| 6 | Horse gram | 1592 |
| 7 | Green gram | 1832 |
| 8 | Black gram | 1622 |
| 9 | Bengal gram | 1622 |
| 10 | Red gram | 282 |
| 11 | Other pulses | 5571 |

**Source: CDP, 2015**

**Major crops cultivated in Coimbatore district**

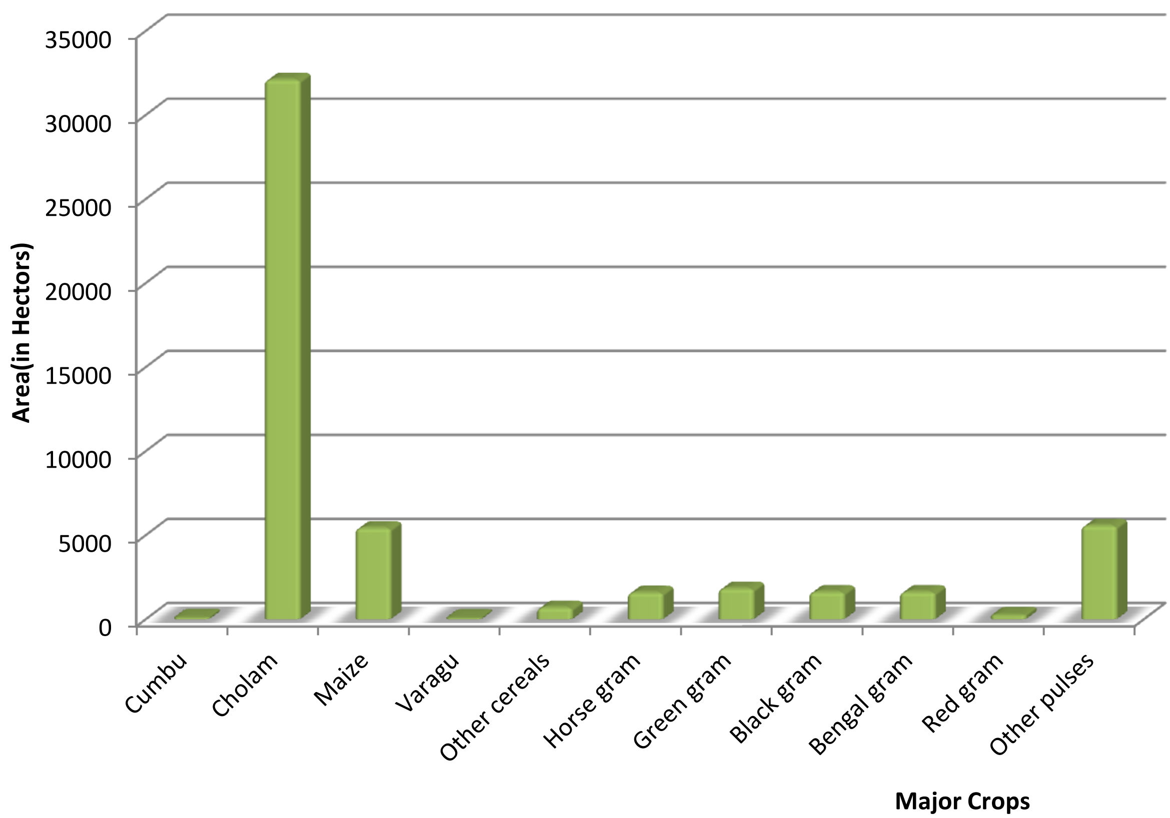


**FIGURE:2**

## Rainfall

Coimbatore is between the Western Ghats in the north and western side, the Nilgiri Biosphere Reserve, Annamalai range, Munnar range and the western pass Palghat. As such, this location gives Coimbatore a peculiar rainfall pattern. It receives an average rainfall of 61.22 cms annually, spreading over an average of 44.5 days in a year. The south-west monsoon contributes rain in the months from June to August. A humid September is followed by an October-November rain by the retreating North-eastern monsoon (CDP,2015).

## TABLE-4

## MONTHLY RAINFALL DATA SEASON-WISE IN COIMBATORE DISTRICT

| S.No | Month | Rainfall | | |
|---|---|---|---|---|
| | | Actual | Normal | Percentage deviation |
| 1 | April | 46.8 | 16.0 | +234.3 % |
| 2 | May | 14.8 | 9.2 | +60.9 % |
| 3 | June | 54.5 | 17.0 | +220.6 % |
| 4 | July | 21.9 | 52.7 | -58.4 % |
| 5 | August | 27.3 | 66.5 | -58.9 % |
| 6 | September | 46.5 | 42.8 | + 8.6 % |
| 7 | October | 141.2 | 68.5 | +106.3 % |
| 8 | November | 57.9 | 30.1 | + 92.4 % |
| 9 | December | 24.8 | 68.0 | -63.5 % |
| 10 | January | 1.6 | 146.0 | - 98.9% |
| 11 | February | 5.2 | 118.0 | -95.59% |
| 12 | March | 7.8 | 41.4 | -81.16% |

**Source: Coimbatore District Profile, 2015**

**Monthly Rainfall Data**

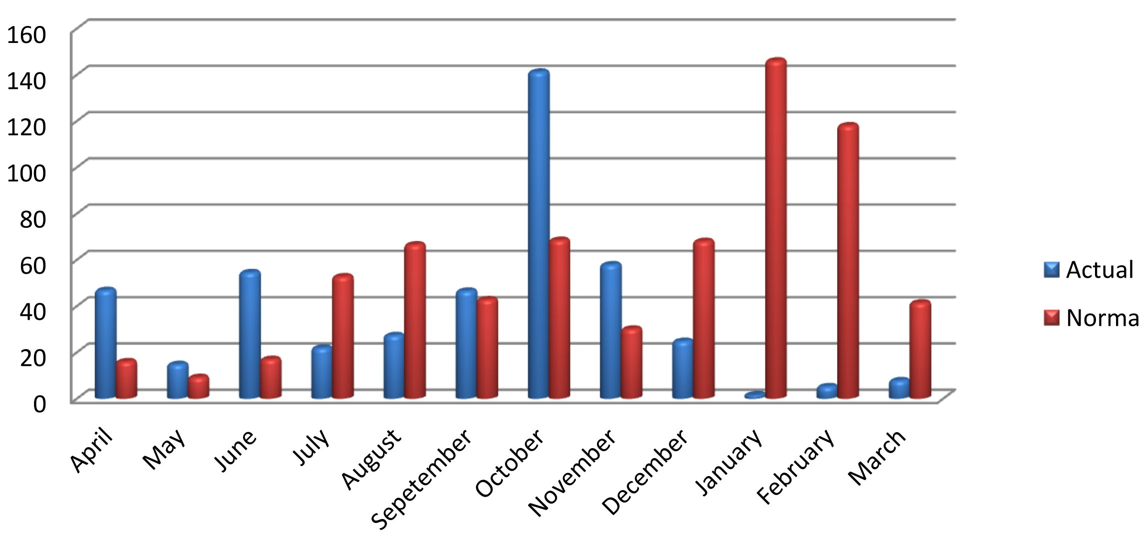


**FIGURE:3**

**Selection of the Farm House Holds**

Thondamuthur Block is one of the important block in Coimbatore District. Nearly 74,087 males and 72,338 females are living. In this people 2,11,056 were engaged in agricultural activities. Pulses and Cereals are the major crops to be cultivated in this block. The most commonly found soils are alluvial soil, gray soil, red soil and black soil. While seeing about cultivated area nearly hectares are cultivated and in that hectares are irrigated and remaining hectares are unirrigated. Canal, Bore wells and Open wells are commonly used for irrigation sources. The rainfall in this block is 635 mm-average. The farmer's using transplanted, combined harvester, and steamer as modern machinery for the cultivation and harvesting of crops.

**Selection of the Sample Units**

The present study was carried out in Thondamuthur block in Coimbatore district. From the selected block all the households having land were listed on the basis of farm size of holdings. Households were divided into small farmers (0-3 ha), medium farmers (3-5 ha) and large farmers (6 and above). For the study 16 small farmers, 20 medium farmers and 16 large farmers were selected based on their farm size holds. Totally 50 farmers who have adopted E-Agriculture Methods (EAMs) on their farms were selected purposively to study about the adoption of E-Agriculture Methods (EAMs). Another 50 farmers were selected from the study area by preparing the list of Non E-Agriculture Methods (NEAMs) and from those 18 small farmers, 22 medium farmers and 10 large farmers respectively. Thus total sample of 100 respondents were selected. The selected sample units of both E-Agriculture Methods (EAMs) and Non E-Agriculture Methods (NEAMs) are represents in figure 4.

**SELECTION OF FARM HOUSEHOLDS**

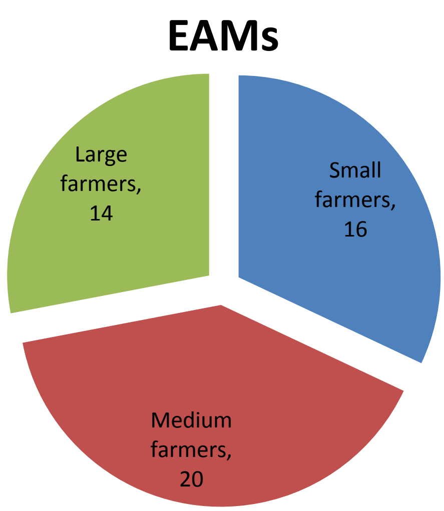


**FIGURE:4**

### 3.3.Sources and Collection of Data

Primary data was collected through personal interview method from the sample farm households. Interview schedules were used to collect details related to the study from the sample households. A pilot study was conducted to identify the gaps in the interview schedule. On the basis of observations during between November 2015 and February 2016. The data were collected from secondary sources like Coimbatore District Profile (CDP), Thondamuthur block profile and Agro Climate Research Centre, Tamil Nadu Agriculture University, Coimbatore, published materials like journals, magazine, books, government reports and newspapers, etc.

### 3.4 Quantitative Tools

The data was collected were arranged and tabulated for giving precise and concise information. Further, the following tools were applied to analyze the data.

The following tools were used for this analysis.

i) Cobb-Douglas Production Function

ii) Scaling Technique

iii) Crop diversification Index.

### 3.4.1 Cobb-Douglas Production Function

The cobb-Douglas production function is based on the empirical study of the American manufacturing industry made by Paul H. Douglas and C.W. Cobb. The production function expresses a functional relationship between quantities of inputs and outputs. Its shows how and to, what extent output changes with variations in inputs during a specified period of time. Basically, the production function is a technological "concept which can be expressed in the form of a table and equation showing the amount of output obtained from various combinations of inputs used in production, given the state of technology. Algebraically, it may be expressed in the form of an equation as

$$Q= f\,(L,M,N,C,\overline{T})$$

Where Q stands for the output of a good per unit of time, L for labour, M for management, N for land( or natural resources), C for capital and $\overline{T}$ for given technology and f refers to the functional relationship (Jhingan, M.L.,2008).

The adoption of new or improved method of production or cultivation can shift the production function. In other words, production can be increased with new technology by using same quantities of resources that were used in old technology or alternatively, the production level in old technology can be attained with new technology by using fewer quantities of inputs. The disembodied type of technical change is mainly due to improved management methods (Sankhayan, 1988). The resource use efficiency was assessed by comparing marginal value product (MVP) with factor cost of the resources (Basavaraja. H,etal, 2008). The marginal product (MP) was estimated from the parameters of Cobb-Douglas production function and the geometric mean levels of the output and input. Solow (1957) developed Decomposition Analysis to evaluate the effects of technological change on output growth in US agriculture.

### 3.4.3.Crop Diversification Index

#### Herfindhal Index

This index, by squaring the shares of a farm’s activities, gives particular weight to the farm’s principal activities. It means that a farm’s secondary activities are given only limited weight in calculating the index. This index is insensitive to minor secondary activities. This is desirable since it focuses attention on the major activities of the farm. This index takes the value of one, when a farm is completely specialized in its primary activity, and should approach zero as N gets large.

The Herfindhal Index is the sum of the squares of the acreage proportion of each crop in the total cropped area. That is,

$$HI = \sum_{i=1}^{i=N} pi^2$$

It can be shown that this index attains a minimum value equal to 1/N when pi = 1/N (i = 1,2,3,….N), and N is the total number of crops, that is, when maximum diversification occurs. It attains a maximum value of 1 when N = 1, that is, when there is a single crop or when complete specialization occurs.

**Modified Entropy Index (MEI)**

This index weights the shares of a farm's activity by a log term of the inverse of the respective shares. It takes then the value of zero when the farm is completely specialized, and it will approach its maximum when diversification is perfect. We consider eight micro level factors influencing farm diversification. The term diversification here is confined to both crop and animal production. The micro level factors are; farm size (area), farmer's experience (age), net worth (wealth) of the farmer, time devoted to farming (labor input), agricultural insurance, geographical or climatic and soil characteristics of the farm (location), organizational form of the farm (with regard to types of labor used), and access to forestry. We use reasonably balanced panel data-set in which only very few farmers have been less than two years in the analysis.

This index is defined as

$$MEI = - \sum_{i=1}^{i=N} = p_i \log_N (p_i)$$

Hence MEI is same as EI except that the base of the logarithm is N. It can be shown that at maximum diversification, this index takes a value of 1 and at maximum specialization it attains a value 0f 0. The MEI provides a uniform and fixed scale and hence it is used as a norm to compare and rank the extent of diversification spatially. Hence in the present study this index has been used to rank the different coastal indices.

### 3.4.2. Scaling Technique

**Garrett's Rating Scale**

To find out the strength of factors ranked by the selected sample groups in relation to the reasons for selecting expenditure pattern, Garrett's rating scale technique was used. From the ranks given for each factor, percent positions were calculated by using the formula.

$$\text{Percent position} = 100 * (R-0.5)/N$$

Where R is the rank assigned and N is the number of items ranked. The percent position was then converted into scores using Garrett's scores table (Garrett H, 2005).

Garret ranking scale technique was used in ranking the various reasons for selection of expenditure pattern in their order of priority.

**Likert's Summated Scale**

The Likert summated scaling technique was used to scale the opinion of the respondents on performance of ICTs, Providing timely information, Protecting production and productivity, Increasing the yield, Providing technology usage training, Expert guidance, Climate data, 24 x 7 services, Bridging the gap between technology generation and distribution, Ensures easy access, Cost effective, Eliminates the role of middleman. In the Likert scale, the respondent was asked to respond to each of the statements in terms of five degrees of agreement or disagreement.

Strongly Agree    Agree    Neutral    Disagree    StronglyDisagree

Each point on the scale carries a score. Response indicating the least favorable degree of satisfaction is given the least score (say 1) and the most favorable is given the highest score (say 5). These score values are normally not printed on the instrument but are shown here just to indicate the scoring pattern. The Likert scaling technique, thus, assigns a scale value to each of the five responses. The same procedure is repeated for each and every statement in the instrument. This way the instrument yields a total score for each respondent, which would then measure the respondent's favorableness toward the given point of view.

### 3.4.4 Average, Percentage and Graphs

Average, Percentage and Graphs were aiso used in the study. To carry out the calculation in SPSS 16.0 version software is used.

### 3.5.5 Definitions and Terms

**Climate Change**

Climate change is a change in the statistical distribution of weather patterns when that change lasts for an extended period of time. Climate change may refer to a change in average weather conditions, or in the time variation of weather around longer-term average conditions. Climate change is caused by factors such as biotic processes, variations in solar radiation received by Earth, plate tectonics, and volcanic eruptions. Certain human activities have also been identified as significant causes of recent climate change, often referred to as global warming.

**E-Agriculture**

E-agriculture is a relatively recent term in the field of agriculture and rural development practices. Consistency in the use of this term began to materialize with the dissemination of results from a global survey carried out by the United Nations (UN). This survey conducted in late 2006 by the Food and Agriculture Organization of the United Nations (FAO) found that half of those who replied identified "e agriculture" with information dissemination, access and exchange, communication and participation processes improvements around rural development.

**Global Warming**

Global warming and climate change are terms for the observed century-scale rise in the average temperature of the Earth's climate system and its related effects. Multiple lines of scientific evidence show that the climate system is warming.

**Cultivable Area**

Agricultural land is typically land devoted to agriculture, the systematic and controlled use of other forms of life particularly the rearing of livestock and production of crops to produce food for humans. It is generally synonymous with farmland or cropland.

**Land holding**

A farm is an area of land that is devoted primarily to agricultural processes with the primary objective of producing food and other crops; it is the basic facility in food production.

**Monsoon**

Monsoon is traditionally defined as a seasonal reversing wind accompanied by corresponding changes in precipitation, but is now used to describe seasonal changes in atmospheric circulation and precipitation associated with the asymmetric heating of land and sea.

**Land Use Pattern**

Land use pattern involves the management and modification of natural environment or wilderness into built environment such as settlements and semi-natural habitats such as arable fields, pastures, and managed woods. It also has been defined as "the total of arrangements, activities, and inputs that people undertake in a certain land cover type.

**Gross Farm Income**

Gross farm income refers to the monetary and non-monetary income received by farm operators. Its main components include cash receipts from the sale of farm products, government payments, other farm income , value of food and fuel produced and consumed on the same farm, rental value of farm dwellings, and change in value of year-end inventories of crops and livestock.

**Crop Diversification**

Crop diversification takes into account the economic returns from different value-added crops. It is different from the concept of multiple cropping or succession planting in which multiple crops are planted in succession over the course of a growing season

**Agriculture Production**

Agriculture Production includes growing of field crops, fruits, grapes, seeds, tree nurseries, vegetables and flowers, production of coffee, tea, cocoa, rubber, jute, oilseeds, fodder grass, etc.

**Net Area Sown**

Total area sown with crops and orchards counting area sown more than once in the same year only once.

**3.6 Limitations of the Study**

The following are the limitations of the study.

1. The primary data was based on "recall method". The farmers were not maintaining records on their farm inputs and outputs details.
2. It is a micro level study. Thus the findings of the study may not be applicable for the macro level, and
3. All the limitations pertaining to "Primary data" are applicable in this study

# *Results and Discussion*

# CHAPTER-IV

# RESULTS AND DISSCUSION

The result of the study "**A study on the Impact of E- Agriculture in a Selected Area in Coimbatore District''** is presented and discussed under the following heads.

4.1 General Characteristics of Selected Farm Households.

4.2 Land Use Pattern

4.2 (a) Type of Soil

4.2 (b) Input Usage

4.3 Cropping Pattern

4.4 E- Agriculture Methods

4.5 Problems

4.7 Benefits of E-Agriculture Methods

4.8 Scaling Techniques

4.9 Cobb-Douglas Production Function and

4.10 Crop Diversification Theory.

## 4.1 General Characteristics of Selected Farm Households

An important factor influencing the adoption of any new technology is an individual's perception about that technology, socio-economic characteristics are directly related to e-agriculture method use include level of education, farming technology, innovation method of cultivation farm size and level of income. The general characteristics viz., community, sex, education, marital status and annual income were expressed in the selected farm households are presented in table 5.

## TABLE-5
## SOCIO-ECONOMIC CHARACTERISTICS OF SELECTED FARM HOUSEHOLDS

| Particular | | EAMs | | | | NEAMs | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **SF** | **MF** | **LF** | **ALL** | **SF** | **MF** | **LF** | **ALL** |
| **Sex** | | | | | | | | | |
| **Male** | **N** | 12 | 16 | 12 | 40 | 14 | 17 | 6 | 37 |
| | **C** | (75.00) | (80.00) | (85.71) | (80.00) | (77.78) | (77.27) | (60.00) | (74.00) |
| **Female** | **N** | 4 | 4 | 2 | 10 | 4 | 5 | 4 | 13 |
| | **C** | (25.00) | (20.00) | (14.29) | (20.00) | (22.22) | (22.73) | (40.00) | (26.00) |
| **All** | **N** | **16** | **20** | **14** | **50** | **18** | **22** | **10** | **50** |
| | **C** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** |
| **Age** | | | | | | | | | |
| **20-30** | **N** | 8 | 10 | 6 | 24 | 10 | 9 | 6 | 25 |
| | **C** | (50.00) | (50.00) | (42.86) | (48.00) | (55.56) | (40.92) | (60.00) | (50.00) |
| **30-40** | **N** | 5 | 6 | 3 | 14 | 2 | 11 | 2 | 15 |
| | **C** | (31.25) | (30.00) | (21.43) | (28.00) | (11.11) | (50.00) | (20.00) | (30.00) |
| **40-50** | **N** | 2 | 2 | 3 | 7 | 4 | 1 | 1 | 6 |
| | **C** | (12.50) | (10.00) | (21.43) | (14.00) | (22.22) | (04.54) | (10.00) | (12.00) |
| **50 and above** | **N** | 1 | 2 | 2 | 5 | 2 | 1 | 1 | 4 |
| | **C** | (06.25) | (10.00) | (14.28) | (10.00) | (11.11) | (04.54) | (10.00) | (08.00) |
| **All** | **N** | **16** | **20** | **14** | **50** | **18** | **22** | **10** | **50** |
| | **C** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** |
| **Education** | | | | | | | | | |
| **Illiterate** | **N** | 1 | 1 | 0 | 2 | 1 | 0 | 0 | 1 |
| | **C** | (06.25) | (05.00) | (00.00) | (04.00) | (05.56) | (00.00) | (00.00) | (02.00) |
| **Primary (1-8)** | **N** | 6 | 8 | 4 | 18 | 12 | 7 | 2 | 21 |
| | **C** | (37.50) | (40.00) | (28.58) | (36.00) | (66.66) | (31.82) | (20.00) | (42.00) |
| **High School (9-12)** | **N** | 6 | 7 | 8 | 21 | 4 | 14 | 5 | 23 |
| | **C** | (37.50) | (35.00) | (57.14) | (42.00) | (22.22) | (63.63) | (50.00) | (46.00) |
| **HSC (DIPLLOMA)** | **N** | 2 | 2 | 0 | 4 | 0 | 0 | 1 | 1 |
| | **C** | (12.50) | (10.00) | (00.00) | (08.00) | (00.00) | (00.00) | (10.00) | (02.00) |
| **UG** | **N** | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 3 |
| | **C** | (06.25) | (05.00) | (07.14) | (06.00) | (05.56) | (04.55) | (10.00) | (06.00) |
| **PG and above** | **N** | 0 | 1 | 1 | 2 | 0 | 0 | 1 | 1 |
| | **C** | (00.00) | (05.00) | (07.14) | (04.00) | (00.00) | (00.00) | (10.00) | (02.00) |
| **All** | **N** | **16** | **20** | **14** | **50** | **18** | **22** | **10** | **50** |
| | **C** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** |
| **Annual Income** | | | | | | | | | |
| **Up to 50,000** | **N** | 8 | 1 | 0 | 9 | 6 | 4 | 1 | 11 |
| | **C** | (50.00) | (05.00) | (00.00) | (18.00) | (33.33) | (18.18) | (10.00) | (22.00) |
| **50,000 -1,00,000** | **N** | 6 | 6 | 1 | 13 | 8 | 7 | 1 | 16 |
| | **C** | (37.50) | (30.00) | (07.14) | (26.00) | (44.44) | (31.81) | (10.00) | (32.00) |
| **1,00,001-2,00,000** | **N** | 2 | 8 | 8 | 18 | 4 | 10 | 5 | 19 |
| | **C** | (12.50) | (40.00) | (57.14) | (36.00) | (22.22) | (45.45) | (60.00) | (38.00) |
| **2,00,001& above** | **N** | 0 | 5 | 5 | 10 | 0 | 1 | 3 | 4 |
| | **C** | (00.00) | (25.00) | (35.72) | (20.00) | (00.00) | (04.55) | (30.00) | (08.00) |
| **All** | **N** | **16** | **20** | **14** | **50** | **18** | **22** | **10** | **50** |
| | **C** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** |

**Source: Field survey, 2016.**

The selected farm households are mostly headed by males. The percentages are being 80 in the EAMs and 74 in the NEAMs. The data on the age of the selected farm households in both the farmer groups  reveal that about 42-50 in the age group of 20-30. But in NEAMs s range from 55-60 per cent medium farmers and large farmers belong to 51-55 age groups.

The percentages of farmers with no formal education were 4 in the EAMs and 2 in NEAMs. In both the farmer groups nearly 57-63 per cent head of the families had either high school or higher secondary education. In the EAMs farmer groups 7 per cent were completed UG and PG. In both the farmer group 57.14 per cent and 45.00 per cent of  large farmer in EAMs and medium farmer in NEAMs  earning annual income Rs. 1,00,000-2,00,000. In EAMs 25.00 per cent and 35.72 per cent of them are medium farmers and large farmers and in NEAMs 30.00 per cent of them are large farmers belong to Rs. 2, 00,000 and above

**4.2 Land Use Pattern**

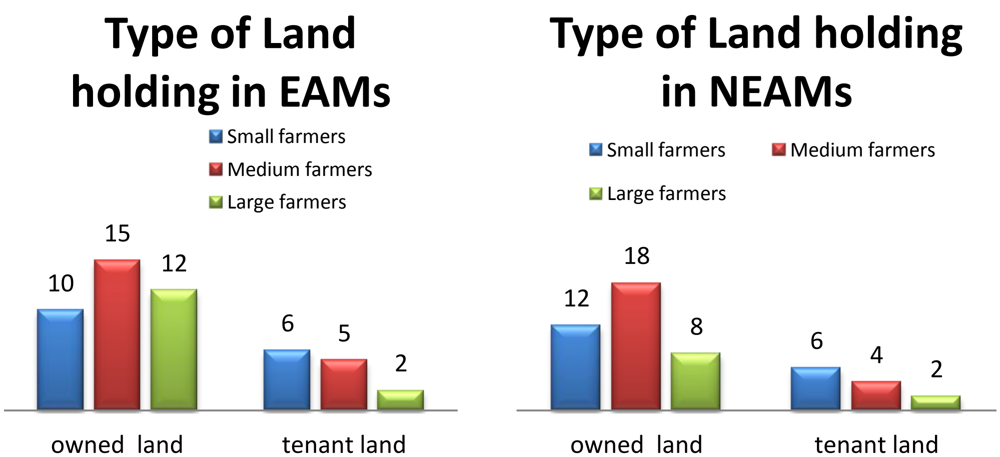


**FIGURE:5**

**Type Of Land**

The total geographical area of India is 328.73million hectors. Forest accounts for about 22.78 per cent and reporting area of land is about 100.0 per cent and Net area sown is about 46.24 per cent, Fallow lands were 30.98 per cent. The total cultivable area is area is about 75 per cent. The total geographical area of Tamil Nadu is 130 lakh hectors. Net area sown is about 37.5 per cent, and  Forest accounts for about 16.3 per cent . The total gross area sown is about 42.8 Fallow lands were 8.6 per cent. The total cultivable waste area is about 2.5 per cent respectively(Agriculture and sustainable development in India,2012). As land was the main factor in agriculture production most of the farmer have owned  land and some of the farmer tenant land for cultivation in selected study area is given in the following in the table-6.

**TABLE-6**

**DETAILS ABOUT THE TYPE OF LAND IN THE SELECTED STUDY AREA**

| **Particulars** | | **EAMs** | | | | **NEAMs** | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **SF** | **MF** | **LF** | **ALL** | **SF** | **MF** | **LF** | **ALL** |
| **Type of Land** | | | | | | | | | |
| **Own Land** | **N** | 10 | 15 | 12 | 37 | 12 | 18 | 8 | 38 |
| | **C** | (62.50) | (75.00) | (85.71) | (74.00) | (66.67) | (81.82) | (80.00) | (76.00) |
| **Tenant Land** | **N** | 6 | 5 | 2 | 13 | 6 | 4 | 2 | 12 |
| | **C** | (37.50) | (25.00) | (14.29) | (26.00) | (33.33) | (18.18) | (20.00) | (24.00) |
| **All** | **N** | **16** | **20** | **14** | **50** | **18** | **22** | **10** | **50** |
| | **C** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** |

**Source: Field survey, 2016.**

The percentage of farmer have their own land are 74 per cent in EAMs farmers and 76 per cent in NEAMs. Farmers have tenant lands are 26 per cent and 24 per cent respectively.

**4.2.(a)Type Of Soil**

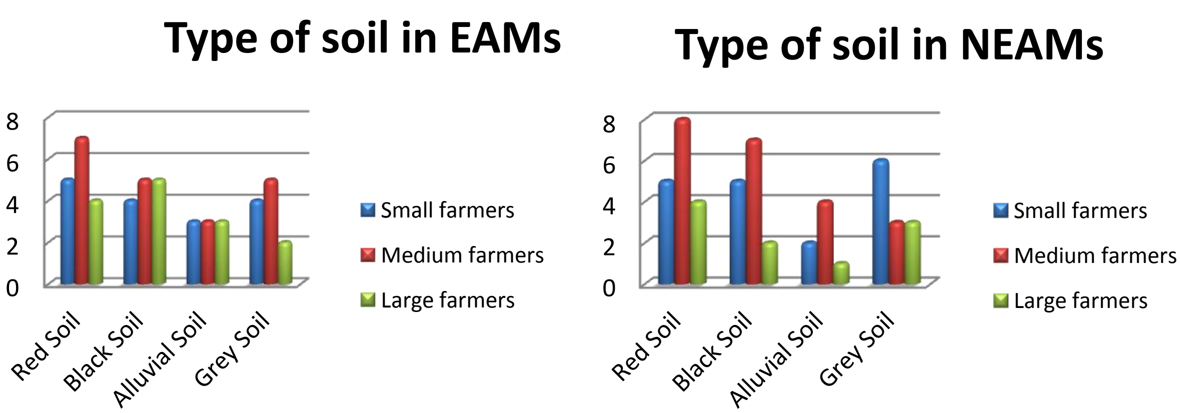


**FIGURE:6**

Soil in the main factor of agricultural production. The soil in India may be classified into alluvial soil is about 30.4 per cent ,black soil accounts for about 16.6 per cent , red soil accounts for about 26.8 per cent and laterial soil accounts about 5.5 per cent respectively. In Tamil Nadu the main types of soil are alluvial soil accounts for about 7 per cent, Laterial soil accounts for about 3 per cent .The higher range of black soil and red soil accounts for about 62 and 12 per cent (Tamil Nadu Agricultural University, Soil Management,2013). As soil was the main factor in agriculture production most of the area of the Thondamuthur block was covered by red soil and some parts covered by black soil and Alluvial soil in the selected study block is given in the following table-7

## TABLE-7

## DETAILS ABOUT THE TYPE OF SOIL IN THE SELECTED AREA

| Particulars | | EAMs | | | | NEAMs | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | SF | MF | LF | ALL | SF | MF | LF | ALL |
| **Type of Soil** | | | | | | | | | |
| **Red Soil** | **N** | 5 | 7 | 4 | 16 | 5 | 8 | 4 | 17 |
| | **C** | (31.25) | (35.00) | (28.57) | (32.00) | (27.78) | (36.36) | (40.00) | (34.00) |
| **Black Soil** | **N** | 4 | 5 | 5 | 14 | 5 | 7 | 2 | 14 |
| | **C** | (25.00) | (25.00) | (35.71) | (28.00) | (27.78) | (31.82) | (20.00) | (28.00) |
| **Alluvial Soil** | **N** | 3 | 3 | 3 | 9 | 2 | 4 | 1 | 7 |
| | **C** | (18.75) | (15.00) | (21.43) | (18.00) | (11.11) | (18.18) | (10.00) | (14.00) |
| **Grey Soil** | **N** | 4 | 5 | 2 | 11 | 6 | 3 | 3 | 12 |
| | **C** | (25.00) | (25.00) | (14.29) | (22.00) | (33.33) | (13.64) | (30.00) | (24.00) |
| **All** | **N** | **16** | **20** | **14** | **50** | **18** | **22** | **10** | **50** |
| | **C** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** |

**Source: Field survey, 2016.**

Soil is the main factor of agriculture production. Majority of the study area are covered with red loam soil 32 per cent of EAMs and NEAMs and 34 per cent of NEAMs have red soil.

### 4.2.(b) Input Dosage

The adaptation of new technology, mainly the HYV seeds requires intensive use of fertilisers and pesticides. Fertiliser are very important factor in increasing agricultural production. Tamil Nadu is one of the highest consumer of pesticides in India (Agriculture and sustainable development in India,2012). The agricultural sector is confronted with the major challenge of increasing production to feed a growing and increasing prosperous population in a situation of decreasing availability of natural resources.

**TABLE-8**

**DETAILS OF INPUT DOSAGE AND RECOMMENDATION OF SELECTED FARM HOUSEHOLDS**

| Particulars | | EAMs | | | | NEAMs | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **SF** | **MF** | **LF** | **ALL** | **SF** | **MF** | **LF** | **ALL** |
| **Input Dosage** | | | | | | | | | |
| **Organic fertilizer** | **N** | 7 | 7 | 5 | 19 | 5 | 6 | 2 | 13 |
| | **C** | (43.75) | (35.00) | (35.71) | (38.00) | (27.78) | (27.27) | (20.00) | (26.00) |
| **Inorganic fertilizer** | **N** | 2 | 4 | 4 | 10 | 4 | 7 | 3 | 14 |
| | **C** | (12.50) | (20.00) | (28.57) | (20.00) | (22.22) | (31.82) | (30.00) | (28.00) |
| **Organic pesticides** | **N** | 4 | 7 | 3 | 14 | 5 | 6 | 2 | 13 |
| | **C** | (25.00) | (35.00) | (21.43) | (28.00) | (27.78) | (27.27) | (20.00) | (26.00) |
| **Inorganic pesticides** | **N** | 3 | 2 | 2 | 7 | 4 | 3 | 3 | 10 |
| | **C** | (18.75) | (10.00) | (14.29) | (14.00) | (22.22) | (13.64) | (30.00) | (20.00) |
| **All** | **N** | **16** | **20** | **14** | **50** | **18** | **22** | **10** | **50** |
| | **C** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** |

**Source: Field survey, 2016.**

Use of technology is inadequate, hampered by ignorance, high costs and impracticality in the case of small land holdings. In India, farming practices are too haphazard and non scientific and need forethought before implementing new technology. Table 8 explains the input dosage and base on what recommendation farmers carry their farming practices. Majority of farmers under EAMs use recommended dosage fertilizer organically followed by organic pest management, the percentage being 38 per cent and 28 per cent respectively. NEAMs use fertilizer widely use non- recommended fertilizer chemically at 28 per cent.

## 4.3 Major Crops

Cropping pattern means the proportion of area under different crops at a particular point of time. In India large proportion of the area is occupied by cereals as 3.6 per cent and pulses as 5.9 per cent(economic survey2015). In Tamil Nadu total food grains is 62.4 per cent in that 1.0 per cent is cultivating pulses and 3.4 per cent of cereals(season and agricultural crop report, Tamil Nadu).

**TABLE-9**

**DETAILS OF MAJOR CROPS CULTIVATION IN THE SELECTED FARM HOUSEHOLDS**

| Particulars | | EAMs | | | | NEAMs | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | SF | MF | LF | ALL | SF | MF | LF | ALL |
| **LIST OF PULSES CULTIVATION** | | | | | | | | | |
| **Horse gram** | **N** | 2 | 3 | 2 | 7 | 2 | 3 | 2 | 7 |
| | **C** | (12.50) | (15.00) | (14.29) | (14.00) | (11.11) | (13.63) | (20.00) | (14.00) |
| **Green gram** | **N** | 2 | 3 | 4 | 9 | 4 | 3 | 1 | 8 |
| | **C** | (12.50) | (15.00) | (28.57) | (18.00) | (22.22) | (13.63) | (10.00) | (16.00) |
| **Black gram** | **N** | 3 | 5 | 2 | 10 | 3 | 4 | 5 | 12 |
| | **C** | (18.75) | (25.00) | (14.29) | (20.00) | (16.67) | (18.18) | (50.00) | (24.00) |
| **Bengal gram** | **N** | 4 | 5 | 2 | 11 | 4 | 6 | 0 | 10 |
| | **C** | (25.00) | (25.00) | (14.29) | (22.00) | (22.22) | (27.20) | (00.00) | (20.00) |
| **Red gram** | **N** | 2 | 1 | 1 | 4 | 2 | 3 | 0 | 5 |
| | **C** | (12.50) | (05.00) | (7.14) | (08.00) | (11.11) | (13.63) | (0.00) | (10.00) |
| **Peas** | **N** | 3 | 3 | 3 | 9 | 3 | 3 | 2 | 8 |
| | **C** | (18.75) | (15.00) | (21.42) | (18.00) | (16.67) | (13.63) | (20.00) | (16.00) |
| **All** | **N** | **16** | **20** | **14** | **50** | **18** | **22** | **10** | **50** |
| | **C** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** |
| **LIST OF CREALES CULTIVATION** | | | | | | | | | |
| **Cumbu** | **N** | 2 | 5 | 5 | 10 | 1 | 4 | 3 | 8 |
| | **C** | (12.50) | (25.00) | (35.71) | (22.00) | (05.56) | (18.18) | (30.00) | (16.00) |
| **Cholam** | **N** | 9 | 8 | 2 | 19 | 2 | 9 | 3 | 14 |
| | **C** | (56.25) | (40.00) | (14.29) | (38.00) | (11.11) | (40.90) | (30.00) | (28.00) |
| **Maize** | **N** | 2 | 2 | 6 | 9 | 5 | 3 | 1 | 9 |
| | **C** | (12.50) | (10.00) | (42.86) | (18.00) | (27.78) | (13.62) | (10.00) | (18.00) |
| **Varagu** | **N** | 0 | 2 | 2 | 4 | 7 | 4 | 2 | 13 |
| | **C** | (00.00) | (10.00) | (14.29) | (08.00) | (38.88) | (18.18) | (20.00) | (26.00) |
| **Samai** | **N** | 4 | 1 | 2 | 7 | 3 | 2 | 1 | 6 |
| | **C** | (25.00) | (05.00) | (14.29) | (14.00) | (16.67) | (09.09) | (10.00) | (12.00) |
| **All** | **N** | **16** | **20** | **14** | **50** | **18** | **22** | **10** | **50** |
| | **C** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** |

**Source: Field survey,2016.**

Table 9 explains the majority of the farmers in E-Farms cultivates pulses and cereals. Majority of E-Farm have cultivated cereals such cholam and maize as 38 per cent and 18 per cent. Cumbu cultivations under EAMs are 22 percent and N EAMs are16 per cent. 14 per cent of EAMs and 12 per cent of N EAMs are Samai cultivations. Majority of the farmers in E-Farms have cultivated pulses such as green gram as 18 per cent and Bengal gram as 22 per cent and 20 per cent.18 per cent of EAMs and 16 per cent of NEAMs are peas cultivations.

## 4.4. E-Agriculture Methods


**FIGURE:7**

E-Agriculture is a new area of knowledge emerging out of convergence of IT and farming techniques The e agriculture farmers were empowered with the right time and peace is essential for improving the efficiency and viability of small and marginal holdings. Mass media, particularly the radio, television and local language, news paper will be used to play an important role in this regard.

**TABLE-10**

**DETAILS ABOUT THE EAMs PROVIDED TO FARMERS IN SELECTED STUDY BLOCK**

| PARTICULARS | | EAMs | | | |
|---|---|---|---|---|---|
| | | SF | MF | LF | ALL |
| **EAMs Tools Provided** | | | | | |
| **Kisan Call Centers** | **N** | 2 | 3 | 2 | 7 |
| | **C** | (12.50) | (15.00) | (14.29) | (14.00) |
| **SMS** | **N** | 3 | 3 | 3 | 9 |
| | **C** | (18.75) | (15.00) | (21.43) | (18.00) |
| **Video Conferencing** | **N** | 2 | 2 | 1 | 5 |
| | **C** | (12.50) | (10.00) | (07.14) | (10.00) |
| **Television** | **N** | 1 | 4 | 3 | 8 |
| | **C** | (06.25) | (20.00) | (21.43) | (16.00) |
| **Radio** | **N** | 2 | 5 | 2 | 9 |
| | **C** | (12.50) | (25.00) | (14.29) | (18.00) |
| **News Paper** | **N** | 3 | 3 | 2 | 8 |
| | **C** | (18.75) | (15.00) | (14.29) | (16.00) |
| **Seminar** | **N** | 3 | 0 | 1 | 4 |
| | **C** | (18.75) | (0.00) | (07.14) | (8.00) |
| **All** | **N** | **16** | **20** | **14** | **50** |
| | **C** | **(100)** | **(100)** | **(100)** | **(100)** |

**Source: Field survey, 2016.**

Table 10 explains the EAMs tools provides and apt EAMs tools for farmers. Majority of the farmers under EAMs are provided with SMS and radio 18 per cent followed by television 16 per cent. Kisan call centers14 per cent and video conferencing 10 per cent. Farmers under EAMs stated that SMS service in the apt EAMs tools for them.

### 4.6 Problems

The farmers have facing problems in cultivation both in EAMs and N EAMs. The most of the problems are faced by the farmers in Non e-agriculture methods are Lack of up to date information, monsoon failure , low rainfall, lack of awareness and knowledge in using e-agriculture in farming.

## TABLE-11

## DETAILS ABOUT THE MOST PROBLEM OF FARMER'S CULTIVATION IN SELECTED STUDY BLOCK

| Particulars | | EAMs | | | | NEAMs | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | SF | MF | LF | ALL | SF | MF | LF | ALL |
| **PROBLEM OF FARMER'S CULTIVATION** | | | | | | | | | |
| **Failure of Monsoon** | **N** | 9 | 11 | 6 | 26 | 7 | 12 | 6 | 27 |
| | **C** | (56.25) | (55.00) | (42.86) | (52.00) | (38.89) | (54.54) | (60.00) | (54.00) |
| **Low Rainfall** | **N** | 7 | 9 | 8 | 24 | 11 | 10 | 4 | 23 |
| | **C** | (43.76) | (45.00) | (57.14) | (46.00) | (61.11) | (45.46) | (40.00) | (48.00) |
| **All** | **N** | **16** | **20** | **14** | **50** | **18** | **22** | **10** | **50** |
| | **C** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** |
| **PROBLEMS IN FARMING** | | | | | | | | | |
| **Unanticipated Climate** | **N** | 5 | 8 | 5 | 18 | 7 | 11 | 5 | 23 |
| | **C** | (31.25) | (40.00) | (35.71) | (36.00) | (38.89) | (50.00) | (50.00) | (46.00) |
| **Lack of Awareness** | **N** | 6 | 6 | 3 | 15 | 6 | 5 | 2 | 13 |
| | **C** | (37.50) | (30.00) | (21.43) | (30.00) | (33.33) | (22.73) | (20.00) | (26.00) |
| **Lack of ICT Knowledge** | **N** | 5 | 6 | 6 | 17 | 5 | 6 | 3 | 14 |
| | **C** | (31.25) | (30.00) | (42.86) | (34.00) | (27.78) | (27.27) | (30.00) | (28.00) |
| **All** | **N** | **16** | **20** | **14** | **50** | **18** | **22** | **10** | **50** |
| | **C** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** | **(100)** |

**Source: Field survey,2016.**

The above table 11 explains the problems faced by selected farmers are affected by selected farmers, majority of farmers are affected by failure of monsoon. The percentage are being 52 per cent in EAMs, 46 per cent of EAMs and 50 per cent of NEAMs are affected by low rainfall. Majority of farmers under EAMs face the problem of unanticipated climate with 36 percent and N EAMs face lack of technology with 28 per cent**.**

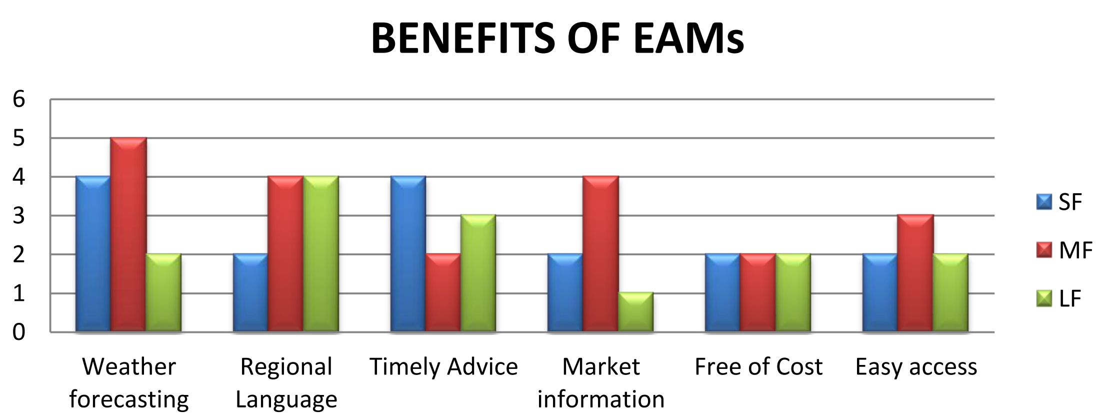


**FIGURE:8**

### 4.7. Benefits of E- Agriculture

The farmers are mostly benefited while using e-agriculture method in cultivation. The e-agriculture farmers are highly benefited in up to date information in weather forecasting and timely advice and market information has increase in agriculture production has resulted in increasing the standard of living of farmers.

**TABLE -12**

**DETAILS ABOUT BENEFITS OF EAMs IN SELECTED STUDY BLOCK**

| Particulars | | EAMs | | | |
|---|---|---|---|---|---|
| | | SF | MF | LF | ALL |
| **Benefits of EAMs** | | | | | |
| **Weather forecasting** | **N** | 4 | 5 | 2 | 11 |
| | **C** | (25.00) | (25.00) | (14.28) | (22.00) |
| **Regional Language** | **N** | 2 | 4 | 4 | 10 |
| | **C** | (12.50) | (20.00) | (28.57) | (20.00) |
| **Timely Advice** | **N** | 4 | 2 | 3 | 9 |
| | **C** | (25.00) | (10.00) | (21.43) | (18.00) |
| **Market information** | **N** | 2 | 4 | 1 | 7 |
| | **C** | (25.00) | (20.00) | (7.14) | (14.00) |
| **Free of Cost** | **N** | 2 | 2 | 2 | 6 |
| | **C** | (25.00) | (10.00) | (14.28) | (12.00) |
| **Easy access** | **N** | 2 | 3 | 2 | 7 |
| | **C** | (25.00) | (15.00) | (14.28) | (14.00) |
| **All** | **N** | **16** | **20** | **14** | **50** |
| | **C** | **(100)** | **(100)** | **(100)** | **(100)** |

**Source: Field survey,2016.**

Table 12 explains the benefits of EAMs by selected farmers, Majority of the farmers are benefited by Weather forecasting and regional language are being 22 percent and 20 per cent respectively. percentage of the farmers in EAMs benefits in timely advice by 18 per cent.

### Cobb Douglas Production Function

The adoption of new or improved method of production or cultivation can shift the production function. In other words, production can be increased with new technology by using same quantities of resources that were used in old technology or alternatively, the production level in old technology can be attained with new technology by using fewer quantities of inputs. The disembodied type of technical change is mainly due to improved management methods (Sankhayan, 1988). A few studies have treated E-Agriculture method as a new technology (Ratna Reddy et al., 2005). Application of certain management practices, which together provide better growing conditions for Pulses and Cereals, particularly ,than the Non E -Agriculture method. The reduced demand for water facilitates conservation of water and soil that is not kept saturated has greater biodiversity.

The costs, returns and profits in Non E- Agriculture and E Agriculture methods of Pulses and Cereals cultivation computed on per hectare basis were compared and contrasted. The cost of human labour including bullock and machine labour was estimated in terms of 8 man hours. The amount of capital, costs of technology, preparation of cultivation, ICTs tools and miscellaneous expenditure were calculated based on the actual expenditure incurred. The amount fixed by the government for irrigation and land revenue was considered for computation of these costs. The rental value of land was imputed based on the prevailing rents in the study area. The depreciation was calculated by the straight line method. The charges on account of minor repairs of implements and machinery during the year were added to the depreciation charges. The interest on fixed capital and depreciation were apportioned on the basis of area of land under pulses and cereals crops grown during the year. The gross returns were computed by multiplying the quantity of main product and by-products with respective prices received.

The resource use efficiency was assessed by comparing marginal value product (MVP) with factor cost of the resources. The marginal product (MP) was estimated from the parameters of Cobb-Douglas production function and the geometric mean levels of the output and input. Solow (1957) developed Decomposition Analysis to evaluate the effects of technological change on output growth in US agriculture. Bisaliah (1977) extended the framework of decomposition analysis to examine technological change in Indian agriculture (Basavaraja. H,etal, 2008). In this study, decomposition analysis was used to measure the contributions of technology and resource use differentials to the total productivity differences between Non E-Agriculture and E-Agriculture methods of Pulses and Cereals cultivation (Palanisami et al., 2002).The Cobb-Douglas production function of the following type was specified.

$$Y=AX_1^{b1}X_2^{b2}X_3^{b3}X_4^{b4}X_5^{b5}e^u$$

Where,

Y = Output in quintal (ha),
$X_1$ = labour,
$X_2$ =Seeds,
$X_3$ = land,
$X_4$ = capital,
$X_5$ =Preparatory of cultivation,
$X_6$=ICTs tools and Miscellaneous expenditure,
u = Error term.

The miscellaneous expenditure in the model included the expenditure on internet, mobile phone recharge.

By using the subscripts ‘s’ and ‘t’ respectively to represent production functions of E-Agriculture and Non E-Agriculture methods of Pulses and Cereals cultivation, the difference in the natural logarithms of Pulses and Cereals output between the E Agriculture and Non E Agriculture methods may be written as

$$[\text{InYs} - \text{InYt}] = [\text{InAs} - \text{InAt}] + \sum_{i=1}^{5}[\text{bsiInXsi} - \text{btiInXsi}]$$

Adding and subtracting $\sum_{i=1}^{5}[\text{ bsi ln Xti}]$ in the above equation and rearranging the terms yields the following decomposition model.

$$[\text{InYs} - \text{InYt}] = [\text{InAs} - \text{InAt}] + \sum_{i=o}^{5}[\text{bsi} - \text{bti}]\text{InXti} + \sum_{i=1}^{5}\text{bsi}[\text{InXsi} - \text{InXti}]$$

The above model involved decomposing the logarithm of ratio of per hectare productivity of E Agriculture and Non E Agriculture methods of Pulses and Cereals cultivation (LHS). This is approximately a measure of percentage change in per hectare output between the E Agriculture cultivation and Non E Agriculture cultivation. The summation of the first term (neutral technology) and the second term (non-neutral technology) on the right hand side of the decomposition model represents the productivity difference between the E Agriculture and Non E Agriculture method, which is attributable to the difference in technology (the cultural practices). The third term provides the productivity difference between the two methods, which is attributable to the differences in the input use between the two methods.

To examine whether the parameters of the production functions defining the two methods of Pulses and Cereals production were different, which was an essential component of decomposition analysis, intercept and slope dummies were introduced into the log linear production function, which was specified as follows.

$\text{In Y} = \text{InA} + b_1\text{InX}_1 + b_2\text{InX}_2 + b_3\text{InX}_3 + b_4\text{InX}_4 + b_5\text{InX}_5 + \text{cD} + d_1[D_1\text{InX}_1] +$

$d_2[D_2\text{InX}_2] + d_3[D_3\text{InX}_3] + d_4[D_4\text{InX}_4] + d_5[D_5\text{InX}_5] + u$

Where, Y, $X_1$, $X_2$, $X_3$, $X_4$, $X_5$, and u are as defined earlier and

D = Intercept dummy which takes value ‘1’, if it is E Agriculture method and value ‘0’otherwise, $D_1\ln X_1$, $D_2\ln X_2$, $D_3\ln X_3$, $D_4\ln X_4$, and $D_5\ln X_5$ are slope dummies of $X_1$, $X_2$, $X_3$, $X_4$, and $X_5$ respectively taking value '1' if it is E Agriculture method and value '0' otherwise. The results of the study are presented and discussed in the following sections.

## COST AND RETURNS IN E AGRICULTURE AND NON E AGRICULTURE

The profitability of E Agriculture method of Pulses and Cereals cultivation in the study area has been analysed by computing per hectare cost and returns and comparing them with those of the Non E Agriculture method. The pattern of inputs used in both the methods of Pulses and Cereals cultivation for sample farmers is presented in Table 13.

### TABLE-13

### PER HECTARE INPUT AND OUTPUT IN NEAMs AND EAMs METHODS

| SI.NO | Particulars | Units | NEAMS | | EAMS | |
|---|---|---|---|---|---|---|
| | | | Quantity | Values | Quantity | Values |
| **Variable cost** | | | | | | |
| 1 | Seeds | Kg | 69.78 | 918.58 (2.89) | 4.91 | 67.82 (0.20) |
| 2 | Preparatory of cultivation | Kg | 299.78 | 3679.62 (11.58) | 275.73 | 3245.54 (9.80) |
| 3 | Human labour | Man-days | 220.08 | 12004.62 (37.26) | 270.57 | 14811.17 (44.74) |
| 4 | ICTs Tools | Rs | 1829.62 | 2539.12 (7.99) | 781.15 | 1045.95 (3.16) |
| 5 | Capital | Rs | 3.54 | 1065.69 (3.35) | 8.02 | 2329.72 (7.03) |
| 6 | Interest on Working Capital | Rs | - | 1659.67 (5.22) | - | 1759.25 (5.31) |
| 7 | Irrigation Charges | Rs | - | 496.78 (1.56) | - | 239.65 (72.40) |
| 8 | Total Variable Cost | Rs | - | 22465.96 (70.71) | - | 23792.54 (71.88) |
| **Fixed Costs** | | | | | | |
| 1 | Land Revenue | Rs | - | 11.69 (0.03) | - | 10.69 (0.03) |
| 2 | Rental Value of Land | Rs | - | 8496.69 (26.74) | - | 8376.52 (25.30) |
| 3 | Depreciation | Rs | - | 289.91 (0.91) | - | 369.62 (1.11) |
| 4 | Interest on fixed capital | Rs | - | 378.69 (1.19) | - | 367.91 (1.11) |
| 5 | Total fixed cost | Rs | - | 9252.93 (29.12) | - | 9249.74 (27.94) |
| **Total cost** | | | | | | |
| 1 | Total cost | Rs | - | 31769.28 (100.00) | - | 33096.96 (100.00) |
| 2 | Main product | Tonnes | 5.69 | - | 7.98 | - |
| 3 | By product | Tonnes | 3.96 | - | 4.69 | - |
| 4 | Gross returns | Rs | - | 41489.68 | | 56687.79 |
| 5 | Net returns | Rs | - | 9698.98 | | 23583.61 |

**Source: Field Survey, 2016.**

The quantities of seed, preparatory of cultivation and ICTs tools used in Non E Agriculture method of Pulses and Cereals cultivation were 69.78 kg, 299.78 kg and 1829.62 ml respectively which were larger than the quantities of 4.91 kg, 275.73 kg and 781.15 ml correspondingly in E Agriculture method. However, slightly higher amounts of labour and capital were used in E Agriculture method when compared to those in Non E Agriculture method were man-days 270.57against of 220.08 human labour. Use of slightly higher quantities of labour was the major contributor for higher per hectare cost in E- Agriculture method. It may be noted that E Agriculture method involves careful transplanting of single seedlings and frequent inter cultivation and thus utilises more labour than Non E- Agriculture method. The higher expenditure on labour in E Agriculture method was on account of more number of land leveling operations required for transplanting and to avoid water stagnation on the fields.

The per hectare cost of cultivation in E Agriculture method (Rs. 33096.96) was more when compared to that in Non E Agriculture method (Rs. 31769.28 ). The share of human labour cost in total cost was 37.26 per cent in Non E Agriculture method and 44.74 per cent in E Agriculture method. Preparatory of cultivation was the next important item of expenditure in both the methods of Pulses and Cereals cultivation which worked out to be 11.58 per cent and 9.80 per cent of total cost, respectively in Non E Agriculture and E Agriculture methods. The amount of capital (Rs. 2,329) was higher in the case of E Agriculture Pulses and Cereals compared to that in Non E Agriculture Pulses and Cereals (Rs. 1,065 ) as more e-agriculture technology is applied in E Agriculture method. However, expenditure incurred on preparatory of cultivation in E Agriculture method was less (Rs. 3,245) when compared to that in the Non E Agriculture method (Rs. 3,679 ). There was a glaring difference in the costs incurred on seeds between the two methods mainly due to smaller quantity of seeds used in E Agriculture method. The considerable difference in ICTs tools and miscellaneous expenses between Non E Agriculture method (Rs. 2,539 ) and E Agriculture method (Rs. 1,045 ) was in Pulses and Cereals cultivation in the study area . It may be noted that the irrigation charges in E Agriculture method (Rs. 239) were less than that in the Non E Agriculture method (Rs. 496) as the number of irrigations was lower and quantity of water required was less in E Agriculture method. The rental value of land was also a major item of expenditure contributing to the fixed cost (26 per cent and 25 per cent, respectively in Non E Agriculture and E Agriculture methods). The share of variable cost in the total cost was 70.71 per cent (Rs. 22,465) in Non E Agriculture method and 71.88 per cent (Rs.23,792) in E

Agriculture method. As such, variable cost was found to be less by about Rs.1,326 in Non E Agriculture method, when compared to that in E Agriculture method.

The yield realized in Non E Agriculture method was 5.69 tonnes per hectare, while it was 7.98 tonnes per hectare in E Agriculture method. The yield difference was mainly because of more number of productive tillers per $m^2$ in E Agriculture. The straw yield in Non E Agriculture and E Agriculture methods was 3.96 tonnes and 4.69 tonnes per hectare. Though the cost of cultivation per hectare was higher in E Agriculture method (Rs. 33,096) compared to that of Non E Agriculture method (Rs. 31,769), the net returns realized was much higher in the former (Rs. 23,583) than in the latter (Rs. 9,698). This was mainly due to higher gross returns (Rs. 56,687) in E Agriculture method, where Pulses and Cereals yield harvested was more. The returns per rupee spent in Non E Agriculture method were Rs. 1.10 against Rs. 1.27 in E Agriculture method. These findings clearly indicated that E Agriculture is a better yielding technology though it involves slightly higher costs. The differences in the use of most of the inputs between the two methods are evident. E Agriculture demands more inputs like capital and labour. On the other hand, it required less seeds, preparatory of cultivation and expenditure on irrigation. Therefore promotion of E Agriculture could result in substantial yield gain and efficient use of scarce water resource.

## DECOMPOSITION OF FACTORS CONTRIBUTING TO PRODUCTIVITY DIFFERENCE BETWEEN EAMs AND NEAMs

In order to test the difference in the structural relationship in the parameters defining the production functions for the two methods, the log-linear production function with both intercept and slope dummies was estimated. The estimated production parameters are presented in Table 14.

**TABLE-14**
**ESTIMATED PRODUCTION FUNCTIONS WITH INTERCEPT AND SLOPE DUMMIES**

| S. No | Particulars | Production elasticity | | |
|---|---|---|---|---|
| | | Pooled | NEAMs | EAMs |
| 1 | Intercept | 0.2044 (0.1019) | 0.2489 | 0.3176 |
| 2 | Seeds | **0.0596* (0.0339)** | **0.0597* (0.0369)** | **0.3389** (0.0889)** |
| 3 | Human labour | **0.2675** (0.0567)** | **0.2785** (0.0596)** | **0.1489** (0.0298)** |
| 4 | Preparatory of cultivation | **0.1179* (0.543)** | **0.1189* (0.0498)** | **0.2219** (0.0689)** |
| 5 | Capital | **0.2019** (0.0489)** | **0.2019** (0.0499)** | **0.0286* (0.0099)** |
| 6 | ICTs+ miscellaneous expenditure | 0.1796 (0.0393) | 0.1796 (0.0399) | 0.0691 (0.0297) |
| Dummy | | | | |
| a | Intercept | **0.2601** (0.0765)** | - | - |
| b | Seeds | **0.2290** (0.0498)** | - | - |
| c | Human labour | **0.1097* (0.0491)** | - | - |
| d | Preparatory of cultivation | **0.0326** (0.0099)** | - | - |
| e | Capital | **0.1279** (0.0384)** | - | - |
| f | ICTs + miscellaneous expenditure | **0.0324** (0.0113)** | - | - |
| | $R^2$ | 0.865 | 0.749 | 0.724 |
| | F-Value | **70.92**** | **32.90**** | **27.69**** |

**Source: Field Survey, 2016.**

The estimated production function explained 86.50 per cent variation in Pulses and Cereals output due to variation in all the resources put together showing a good fit of the model.

The coefficients of the intercept dummy and slope dummies were significantly different from zero. This result facilitated the rejection of the hypothesis that production parameters defining the E Agriculture method and Non E Agriculture method are same. The positive estimates of intercept and slope dummy coefficients for all resources implied that the output in E Agriculture method. Is significantly higher than that in the Non E Agriculture method for a given level of resources. They also implied larger elasticity coefficients of production with respect to each input under E Agriculture method compared to Non E Agriculture method. This result as such offered the required justification for decomposing the factors contributing to productivity difference between E Agriculture and Non E Agriculture methods of Pulses and Cereals cultivation.

As much as 74.9 per cent and 72.40 per cent of variation in Pulses and Cereals output, respectively, in Non E Agriculture and E Agriculture methods was explained by the independent variables. The constant term (intercept) in the case of E Agriculture method was higher than that for the Non E Agriculture method. This virtually signified that there was an upward shift in production function due to technological change associated with E Agriculture. The production elasticity coefficients of seeds, labour, preparatory of cultivation, capital and expenditure made on Information and communication technology (ICTs) and miscellaneous expenditure were positive and significant in Non E Agriculture and E Agriculture methods. The output elasticity coefficients of labour, capital and expenditure made on ICTs and miscellaneous items in the case of Non E Agriculture method were relatively greater as compared to those for E Agriculture method. The Pulses and Cereals output in Non E Agriculture method would increase by 0.2785 per cent and 0.2019 per cent for every one per cent increase in the use of labour and capital. Thus, the major contribution to output in Non E Agriculture method came from labour and capital. In the case of E Agriculture method, the Pulses and Cereals output would increase by 0.3389 per cent and 0.2219 per cent for every one per cent increase in the use of seeds and preparatory of cultivation. Thus, the major contribution to output in E Agriculture method came from seeds and preparatory of cultivation.

To analyze the scope for intensification of resources in both methods, the marginal value product (MVP) of the resources was compared with the respective marginal factor costs (MFC). The MVP and MFC ratios for different resources for both the methods are given in Table 15.

**TABLE-15**

**MVP AND MFC OF RESOURCES IN NEAMs AND EAMs METHODS**

| **Inputs** | **NEAMs** | | | **EAMs** | | |
|---|---|---|---|---|---|---|
| | **MVP** | **MFC** | **Ratio** | **MVP** | **MFC** | **Ratio** |
| Seeds (Kg) | 156.25 | 11.92 | 13.10 | 1059.32 | 12.76 | 83.01 |
| Labour (man-days) | 32.96 | 50.00 | 0.66 | 75.82 | 50.00 | 1.51 |
| Preparatory of cultivation | 32.84 | 10.98 | 2.99 | 36.93 | 10.90 | 3.38 |
| Capital | 269.42 | 236.72 | 1.13 | 1027.68 | 235.25 | 4.36 |
| ICTs +miscellaneous Expenditure | 0.726 | 1.00 | 0.726 | 1.23 | 1.00 | 1.23 |

**Source: Field Survey, 2016.**

The MVP-MFC ratios in Non E Agriculture methods indicated that there was a scope for increased use of seeds in the short-run keeping the use of other resources at a constant level. This was also true for preparatory of cultivation and capital as MVP-MFC ratio for these resources was also more than one. Nevertheless, MVP-MFC ratio for labour and expenditure made on ICTs and miscellaneous items were less than one and positive indicating that profit could be maximised in the short run by using less quantity of these resources. On the other hand, the farmers under the E Agriculture method could maximize their profit by using more quantities of seeds, labour, preparatory of cultivation, capital and ICTs including miscellaneous items as the MVP-MFC ratio for all these resources was more than one.

Using the decomposition model, the productivity difference between the E Agriculture and Non E Agriculture method was decomposed into its constituent sources and the results are presented in Table 16.

**TABLE-16**

**DECOMPOSITION OF OUTPUT DIFFERENCE BETWEEN THE EAMs AND THE NEAMs METHODS**

| S. No | Source of output difference | Per cent contribution |
|---|---|---|
| I | Observed difference in output [lnYs - lnYt] | 31.69 |
| II | Source of contribution | |
| 1 | Due to difference in input use [ln As – lnAt]+ $\sum_{i=1}^{5}$ bsi[InXsi − InXti] | 29.49 |
| 1. | Due to difference in input use Σ=bsi [lnXsi – lnXti] | |
| a | Seeds | -15.74 |
| b | Human labour | 6.29 |
| c | Preparatory of cultivation | -0.86 |
| d | Capital | 13.91 |
| e | Expenditure on ICTs and miscellaneous items | 1.94 |
| | Due to all inputs | 1.98 |
| 3 | Estimated difference in output | 31.67 |

**Source: Field Survey, 2016.**

A perusal of the results of decomposition analysis revealed that there was not much discrepancy between the observed difference (31.69 per cent) and the estimated difference (31.67 per cent) in the productivity of E Agriculture method and Non E Agriculture method. It can further be inferred that between technological and input use differentials, which together contributed to the total productivity difference of the order of 31.69 per cent, the former alone accounted for 29.49 per cent. This implied that Pulses and Cereals productivity could be increased by about 29.49 per cent if the farmers could switch over from Non E Agriculture method to E Agriculture method with the same level of resource use as in Non E Agriculture method. An increase in productivity exclusively from technological improvement is brought about through a shift in the scale and or slope parameters of the production function.

The contribution of differences in input use between the E Agriculture method and Non E Agriculture method of Pulses and Cereals cultivation to the productivity difference was meager at 1.98 per cent. The larger quantity of seeds used in Non E Agriculture method of cultivation has helped to increase yield of Pulses and Cereals by -15.74 per cent in that method. Similarly, larger quantity of resources like capital and human labour used in E Agriculture method caused yield increase of 13.91 per cent and 6.29 per cent respectively.

The average net returns were Rs. 9,698 per ha and Rs. 23,583 per ha in Non E Agriculture and E Agriculture methods of Pulses and Cereals cultivation. The yield realized in

Non E Agriculture method was 5.69 tonnes per hectare and it was 7.98 tonnes per hectare in E Agriculture method. The expenditure on human labour accounted for the highest share (37.26 per cent) in the total cost of cultivation of Rs. 3,1769 per ha in Non E Agriculture method. The cost of cultivation in E Agriculture method worked out to be Rs. 3,3096 per ha in which the share of human labour was 44 per cent respectively. The estimated production functions were significant with high $R^2$ for both the E Agriculture method and Non E Agriculture methods. The output elasticity coefficients for seeds, labour, preparatory of cultivation and capital were positive and statistically significant in both the methods. The MVP-MFC ratio analysis indicated that in the short run there was a scope for intensification of use of resources like seeds, preparatory of cultivation in Non E Agriculture method and for seeds, preparatory of cultivation and capital in E Agriculture method. The technological change in of Pulses and Cereals production has brought about 31.69 per cent productivity difference between the two methods. The major component of this productivity difference was due to the difference in method of cultivation, which contributed to 29.49 per cent. The remaining two per cent difference in output was due to difference in quantities of inputs used. However it is worth mentioning here that the actual adoption rate of E Agriculture among of Pulses and Cereals growers is very low, which appears to be a puzzle given the encouraging performance of the new technology. First, the farmers, particularly in the head reaches of command areas, where of Pulses and Cereals is grown extensively, have not fully realized the importance of water in view of market and policy failure in pricing the resource appropriately; second, intensive care particularly during transplanting of seedlings and higher weed infestation demands more labour and hence farmers in labour scarce areas are hesitant to adopt E Agriculture; third, only soils with good drainage facility and low clay content are suitable for E Agriculture cultivation and finally, there is not enough awareness among farmers about its superiority. The timely guidance to the farmers from the extension agencies and to the persons involved in the transfer of technology to the farmers' fields would be of immense help in this direction.

**CONCEPT OF CROP DIVERSIFICATION**

While uncertainty and risk to varying degrees surround all forms of activity, it is considered more of a problem for agricultural production than for industrial production due to the influence of climate and other natural factors on the agricultural output and the length of agricultural production cycle. Typically, the different types of uncertainties most farmers face are climatic factors, pests and diseases, price uncertainties and polices related to agricultural production, marketing and trade. In this respect, farm diversification may be considered as a spontaneous response to avoid many of these uncertainties.

There are several reasons why diversification is an option for managing these uncertainties. First, the relationship between diversification and farm size is an indication of trade-off between risk reduction and return in a farming activity. A farmer may give up a large expected return by specialization in order to insure against risk through diversification. Second, aside from farm size, there are a number of potentially interesting micro level variables which may affect diversification choices in a risk-preference (as well as alternative models of) behavior. These variables may include form of farm organization, technological and policy changes, geographical location, labor, experience of farmers, wealth of farmers, agricultural insurance, etc. Third, there is policy instruments designed to increase food security and to manage the environment and other resources in a sustainable manner rather than to maximize short-term farm profit.

There is a rich agricultural economics literature on farm diversification since the early 1950s. Following the work of Heady (1952) and Markowitz (1959), attention has focused mainly on mean variance portfolio approaches (Stovall, 1966; Johnson, 1967). First, farm plans to maximize expected return will often be reasonably diversified before risk aversion is considered. Second, the mixture of activities will typically make best use of available resources, risk aside. Third, the mixed cropping allows more productive and sustainable crop rotations which again favoring some system diversification. Finally, if the majority of the risk reducing benefits from diversification can be captured by having only two or three enterprises (although, it is an empirical matter), the returns from different strongly positively correlated activities will limit the gains from diversification on farm (Hardaker et al 1997).

**Theoretical Frame Work**

Patterns of production at early stages of development which are partly induced by geographic endowments can affect long-run growth. The importance of history for economic development is underlined by a burgeoning literature that uncovers the persistent effects of deep-rooted factors. Nunn et.al, (2013). Geographic factors have significant effects on contemporary outcomes by shaping historical paths of economic, social and political development (Diamond, 1997; Acemoglu and Robinson, 2001). The empirical analysis takes into account land productivity and the dominance of specific agricultural products as well as other environmental conditions, distances to the coastline and main cities, and an extensive set of socio-economic variables. The results complement recent quantitative studies of US history showing persistent effects of geographical features that are not longer directly relevant (Bleakley and Lin, 2012; Hornbeck, 2012; Glaeser et al., 2012). The focus on diversification offers a distinct addition to the literature on the role of agriculture on industrialization and long-run development. The results also complement the literature on diversification and growth, providing an analysis of different channels in historical perspective and a focus on the agricultural sector that permits a novel identification strategy.

**Diversification and Growth: Theories and Evidence**

The relationship between diversification and development has been addressed by a number of theories with different implications about the sign and direction of causality. While this paper focuses on the effect of agricultural diversification, the ideas discussed in this section address the relationship between diversification and development for the economy as a whole. These theories remain relevant notwithstanding the particular sectoral focus of the links identified in the empirical analysis, in some cases calling for additional considerations that are introduced in the section on mechanisms. Among theories that predict a positive relationship between diversification and income levels, a well-known group emphasizes the role of risk and volatility. In Acemoglu and Zilibotti (1997), risky projects with high returns are only carried out when economies have the possibility of entering a wide array of projects (sectors); thus, higher diversification goes hand in hand with a higher expected rate of return. Another theory is that higher levels of diversification reflect a wider availability of productive capabilities, implying under the assumption that capabilities are complementary a positive effect of diversification on income and subsequent growth (Hausmann and Hidalgo, 2011). A somewhat related idea connected with urbanization economies, in particular that operating through increased flows of knowledge goes under the name of Jacobs externalities: diversity can foster technological dynamism, i.e. innovation and adoption of new technologies (Paci and Usai,1999). The different theories reviewed above can be seen as complementary, insofar as they predict a positive relationship between diversity and development. Farm risk management strategies may incorporate a combination of production, marketing, financial and environmental responses. Therefore, a measure of diversification, i.e. an index, can be assumed to incorporate the management of farm risk as a combination of the production, marketing, financial and adaptive environmental responses. We consider two different types of measures of diversification, i.e. Herfindhal index and Modified Entropy Index.

**Herfindhal Index**

This index, by squaring the shares of a farm's activities, gives particular weight to the farm's principal activities. It means that a farm's secondary activities are given only limited weight in calculating the index. This index is insensitive to minor secondary activities. This is desirable since it focuses attention on the major activities of the farm. This index takes the value of one, when a farm is completely specialized in its primary activity, and should approach zero as N gets large. Thus, for increasing diversification should decrease. Socio ecological system of arid and semi arid areas are usually fragile and sensitive to vagaries of weather. They are more vulnerable to the impact of climatic changes. For such a society faced with diminishing natural resources and ever increasing demand for food consumption and food security due to increase in population growth. Agricultural intensification is the only course of action for future growth of agriculture. Agriculture intensification can be achieved by changes in the cropping pattern or crop diversification. It is certainly an important component of the overall strategy for small farm development. It is usually viewed as a risk management strategy (Palanisami, 2008).

Agricultural diversification really started in the early eighties in India and it has picked up momentum over the recent past. Farmers are always quick to diversify into higher value crops as market opportunities developed. In this section, it is shown that there exist wide spatio – temporal disparity in the diversification of crops in Thondamuthur block. This is done by constructing a crop diversification index which provides a basis for ranking the different farmers groups. EAMs can be achieved by changes in cropping pattern or crop diversification. It is certainly an important component of the overall strategy for small farm development. Crop diversification has lot of benefits such as food and nutrition security, income growth, poverty alleviation, employment generation, judicious use of land and water resources, sustainable agricultural development and environmental improvements.  This happens when the pattern of diversification in such as to accommodate more and more important for the farmers who strive to make their farm viable (Saleth,1995).

Crop diversification during the pre and post EAMs was measured using the Hirschman-Herfindhal diversification index. The diversification index was calculated as D1=1-H; where H in the Hirschman-Herfindhal diversification index is measured as,

$$\mathbf{H=\sum [(CP_{ij}/\sum P_{ij})]^2}$$

$P_{ji}$ being the value of production of the $i^{th}$ crop for the $j^{th}$ farmer. The higher diversity index indicates greatest crop diversity in production pattern. This is a mean to reduce risk in terms of individual farm income risk. With only one or two food crops, farm income in much riser to natural hazards than with a more diversified cropping system (Healey,1987). Timmer (1990) has identified three reasons for policy makers to pay more attention to agricultural diversification:

i) When output prices are highly unstable, a well diversified and flexible agriculture provides more stable farm income.

ii) Diversification of rural economy is a significant source of income growth for rural people, it provides better living standards and reducing rural to urban migration.

iii) in the long run, a diversified cropping pattern is more sustainable than the intensive Cultivation of a single crop. The crop diversification index for the different crops cultivated in the selected block were calculated using the Hirschman-Herfindhal index and are shown in the following table-17.

**TABLE - 17**
**DETAILS ON CROP DIVERSIFICATION INDEX IN THE SELECTED FARM HOUSEHOLDS**

| Farmers / Crops | EAMs | | | | NEAMs | | | |
|---|---|---|---|---|---|---|---|---|
| | **SF** | **MF** | **LF** | **All** | **SF** | **MF** | **LF** | **All** |
| Cumbu | 0.998 | 0.992 | 0.994 | **0.994*****| 0.912 | 0.920 | 0.932 | 0.921 |
| Maize | 0.996 | 0.994 | 0.996 | **0.995**** | 0.942 | 0.931 | 0.912 | 0.928 |
| Bengal gram | 0.993 | 0.992 | 0.989 | 0.991 | 0.914 | 0.918 | 0.926 | 0.919 |
| Black gram | 0.989 | 0.994 | 0.996 | 0.993 | 0.913 | 0.926 | 0.918 | 0.919 |
| Cholam | 0.999 | 0.997 | 0.995 | **0.997*** | 0.924 | 0.926 | 0.923 | 0.924 |

**Source: Field Survey,2016.**

The table-17 explains the crop diversification using Herfindhal Index and it had compared the indices of both EAMs and NEAMs. The Herfindhal Index attains significance level when the result is nearest to 1. The diversification index calculation clearly explains that EAMs adopters have more diversification comparatively to NEAMs. EAMs have 0.997diversification index for Cholam wherein NEAMs have 0.924. In Maize EAMs had 0.995

diversification and NEAMs attained only 0.928. In the selected block, among the farm households small farmers had maximum crop diversification mainly in Cholam (0.999), Cumbu (0.992), Maize (0.996) and Bengal gram(0.993). In Cumbu EAMs had 0.994 diversification index wherein NEAMs had 0.921. Through this analysis we clearly demonstrate that crop diversification favors to EAMs adopters rather than NEAMs adopters, so EAMs are more important in enhancing crop production.

**Modified Entropy Index**

This index weights the shares of a farm's activity by a log term of the inverse of the respective shares. It takes then the value of zero when the farm is completely specialized, and it will approach its maximum when diversification is perfect. Thus, for increasing diversification M4 should increase. This index gives less weight to larger activities than the Herfindhal index. We consider eight micro level factors influencing farm diversification. The term diversification here is confined to crop production. The micro level factors are farm size (area), farmer's experience (age), net worth (wealth) of the farmer, time devoted to farming (labor input), agricultural insurance, geographical or climatic and soil characteristics of the farm (location), innovation methods (with regard to types of labor used), and adoption of new technology.

To find out the extent of dispersion and concentration of different crops at a given point of time and space, Modified Entropy Index (MEI) was calculated. This index is defined as,

$$\mathbf{MEI} = -\sum_{I=1}^{I=n} \mathbf{Pi \log N (Pi)}$$

Modified entropy index take a value of 1 and at maximum specialization it attains a value of 0. Hence in the present study this index has been used to rank the different crop indices. For calculating MEI major crops grown in the selected study area were chosen. Following table gives the calculated crop diversification indices in the selected study area.

**TABLE – 18**

**MODIFIED ENTROPY INDEX IN SELECTED FARM HOUSEHOLDS**

| Crops \ Farmer | EAMs | | | | NEAMs | | | |
|---|---|---|---|---|---|---|---|---|
| | **SF** | **MF** | **LF** | **All** | **SF** | **MF** | **LF** | **All** |
| Cumbu | 0.001 | 0.009 | 0.003 | **0.004**** | 0.019 | 0.022 | 0.013 | 0.018 |
| Maize | 0.002 | 0.004 | 0.006 | **0.004**** | 0.021 | 0.017 | 0.005 | 0.014 |
| Bengal gram | 0.006 | 0.003 | 0.007 | **0.005***** | 0.013 | 0.018 | 0.024 | 0.018 |
| Black gram | 0.004 | 0.005 | 0.002 | 0.011 | 0.021 | 0.026 | 0.023 | 0.023 |
| Cholam | 0.003 | 0.002 | 0.006 | **0.003*** | 0.021 | 0.018 | 0.016 | 0.066 |

**Source: Field Survey, 2016.**

The table-18 explains the crop diversification using Modified Entropy Index and it had compared the indices of both EAMs and NEAMs. The Modified Entropy Index attains significance level when the result is nearest to 0. The Modified Entropy Index calculation clearly ranked that EAMs adopters have more diversification comparatively to NEAMs. EAMs have 0.003 diversification index for Cholam ranking 1$^{st}$ wherein NEAMs have 0.066. In Cumbu and Maize EAMs had 0.004 and 0.004 diversification ranking 2$^{nd}$ and NEAMs attained 0.018 and 0.014. In the selected block, among the farm households small farmers had maximum crop diversification mainly Maize (0.004) and Bengal gram (0.003), Black gram (0.002).In Bengal gram EAMs had 0.005 diversification index ranking 3$^{rd}$ wherein NEAMs had 0.018. Through Modified Entropy Index among the selected farm households we found that crop diversification favors more to EAMs adopters with special reference to small farmers. The above explanation clearly indicated that EAMs play vital role in improving farming practices.

## SCALING TECHNIQUE

### Opinion of the users about the performance of EAMs

Most farmers by their nature will possess resistance to foreseeing for future. Mostly, the negative things about framers are day-dreaming for their future by being negligent, wasting resources unnecessarily without any thought for recycling of water resource, resistance to implement new ideas and technology etc. This resistance can be overcome positively by systematically following an optimistic approach. The excellent outcomes resulting from EAMs usage in agriculture shall be exhibited and farmers shall be encouraged to use more and more of EAMs. The success of EAMs in agriculture is very much possible and can be achieved by implementing it in the present situations carefully and thoughtfully.

In the present study, the users of the EAMs were asked to rank the various opinions regarding the performance of EAMs on the basis of expectation and realization in their order of priority. The ranks were then converted into percent position and from the percent position the individual scores were determined on a scale of 100 points by using Garrett's rating scale. The average scores and the ranks corresponding to each purpose are shown in table 19.

**TABLE-19**

**DETAILS ON OPINION OF THE USER AMONG THE PERFORMANCE OF EAMs IN SELECTED FARM HOUSEHOLDS**

| Factors | Expectation | | Realization | |
|---|---|---|---|---|
| | Scores | Rank | Scores | Rank |
| Providing timely information | 39.6 | 2 | 31.3 | 4 |
| Protecting production and productivity | 22.3 | 11 | 40.6 | 1 |
| Increasing the yield | 28.5 | 7 | 23.5 | 9 |
| Providing technology usage training | 24.7 | 10 | 25.9 | 7 |
| Expert guidance | 37.4 | 3 | 36.7 | 3 |
| 24 x 7 services | 35.3 | 4 | 39.1 | 2 |
| Climate data | 41.9 | 1 | 28.1 | 6 |
| Bridging the gap between technology generation and distribution | 32.1 | 6 | 22.3 | 10 |
| Ensures easy access | 33.8 | 5 | 29.0 | 5 |
| Cost effective | 26.1 | 8 | 24.7 | 8 |
| Eliminates the role of middleman | 25.2 | 9 | 20.6 | 11 |

**Source: Filed Survey, 2016**

The opinion of the EAMs adopters on the performance of EAMs in agriculture production were ranked and discussed in this section with two criteria expectation and realization. Among the expectation criteria, the respondents were ranked 1st for Climate data, bridging the gap between Providing timely information (2nd rank), Expert guidance (3rd rank), 24 x 7 services (4th rank), Ensures easy access (5th rank), Bridging the gap between technology generation and distribution (6th rank), Increasing the yield (7th rank) Cost effective 8th rank), elimination the role of middlemen(9th rank), Providing technology usage training (10th rank) and Eliminates the role of middleman (11th rank) these are various factors expected by the user of EAMs.

Meanwhile under the realization criteria farmers have ranked some opinion on the performance of EAMs which were listed and ranked as follows Protecting production and productivity (1st rank), 24 x 7 (2nd rank), Expert guidance (3rd rank), Providing timely information (4th rank), Ensures easy access (5th rank), Climate data (6th rank), Providing technology usage training (7th rank), Cost effective (8th rank), Increasing the yield (9th rank), Bridging the gap between technology generation and distribution (10th rank) and Eliminates the role of middleman (11th rank). The users of EAMs in agriculture production were unanimous on stating the same opinion under expectation and realization criteria is expert guidance (3rd rank) and Ensures easy access (5th rank). These are the various factors expected and realized by the users of EAMs.

# *Summary and Conclusion*

# CHAPTER-V

## SUMMARY AND CONCLUSION

The very important environmental problems before the World as a whole and India in particular is climate change, which is very closely associated with the global warming. They are very important on the ground that they have number of evil consequences on more or less all the spheres of the environment. It is not only India, but all the countries have been facing from the evil impacts of the climate change. It is adversely affecting the segments of the environments such as atmosphere, land, water and living things. Besides this the climate change is also adversely affecting the productive activities and sectors in the economies of the number of countries in the world as whole. It is therefore climate change has become at this moment a very importantly environmental problem of the globe as whole. And in the era of globalization and liberalization all countries of world are very closely interlinked and inter connected with the each other and India cannot be an exception to it. Hence India also has been severely affecting from the evil consequences of the climate change. It is a well known fact that at this moment also India is an agricultural country with over dependence of the people on agriculture as a means of lively hood, a major source of employment and a major population living in rural areas, whose prime economic activity is agriculture (Shabana Tabusum et al.,2014). This demands to discuss the interconnections and linkages between climate change and agriculture in the context of India. The prime objective of the present paper is identifying the things of serious concerns of climate change for the Indian agriculture. The study is exclusively relied on the secondary data concerning agriculture as well as climate change for the latest period prominently. The study concludes that the climate change has created severe adverse impacts on agriculture and thereby things of serious concerns , which are necessary to be tackled with the joint efforts of the government policy and active participation of the people and the society as a whole.

Farming community was facing lot of problems in maximizing of the various crops productivity in Tamil Nadu; in spite of successful research or technology on new agricultural practices the majority of famers not getting proper information due to several reasons. Precision farming, popular in developed countries, extensively uses IT to make direct contribution to agricultural productivity. The techniques of remote sensing using satellite technologies, geographical information systems, and agronomy and soil sciences are used to increase the agricultural output. The contribution of IT is bringing down costs, increasing efficiency and improving productivity. In the fertilizer marketing context, IT plays a major role in efficient sales operations, checking the marketing costs, safeguarding market share and providing efficient customer services. A well conceived IT setup endows decision makers at all levels with better reflexes to effectively respond to market. Percepted of e-Agriculture focused on information and tools. Subject areas mentioned included farming practices ,market information, training ,statistics and science or research benefits included both generally enhanced information and communication processes and specifically Agriculture related benefits such as market access and food security . e-Agriculture was also seen to contribute to broader development goals. Future priorities included developing virtual communities and networks ,capacity building in the application of ICTs, and defining and advocating e-Agriculture initiatives (Riome, et.al.,2008). This theory brought out the need for applications the e- agriculture methods and its importance of the farm level. The present study tries to cover these gaps, the major objectives of the study is to analyze "A Study on the Impact of E- Agriculture in a Selected Area in Coimbatore District".

**The specific objectives of the study are**

1. To study the Socio economic background of the selected farm households.
2. To analyze the E-Agriculture Methods (EAMs) in selected farm households.
3. To assess impacts of E-Agriculture Methods in selected farm households.
4. To estimate crop diversification in selected farm households and
5. Find out the problems of E-Agriculture Methods.

**HYPOTHESIS**

The following null hypothesis were tested in the course of study

I. Application of E-Agriculture Methods had led to

   1. Economic well being of the farmers are depended on agriculture production.
   2. There is EAMs adopted in the selected study block during the period of the study.
   3. The socio economic status of the farmers was affected due to climate change.
   4. The impacts of NEAMs caused in agriculture production of the selected study block and

II. Changing crop production and crop diversification with the adoption of EAMs.

## METHODOLOGY

Coimbatore District of Tamil Nadu was randomly selected for the present study. Multistage random sampling technique was used to select the herds. The selected district comprised 12 blocks of which Thondamuthur is randomly selected. In the next stage based on the data provided by Tamil Nadu Agriculture University in Coimbatore. The researcher selected Thondamuthur block has Thondamuthur block has better E-Agriculture Method practices. That supports Agriculture and majority of the farmers in Thondamuthur block have adopted EAMs with the recommendations of Agro climatic Research Centre, TNAU. The researcher selected 100 farmers of which 50 farmers belong to EAMs adopters and 50 belong to NEAMs. Primary data we are collected to primary data method from the farm households. The study was taken of during the months of (October2015 and Febuary2016). The appropriate tools we are used in the study for evaluations of the results.

## MAJOR FINDINGS OF THE STUDY

### Socio-Economic Characteristics of Selected Farm Households

The selected farm households are mostly headed by males. The percentages are being 80 in the EAMs and 74 in the NEAMs. The data on the age of the selected farm households in both the farmer groups reveal that about 42- 60 in the age group of 20-30. But in NEAMs s range from 55-60 per cent medium farmers and large farmers belong to 51-55 age groups. The percentages of farmers with no formal education were 4 in the EAMs and 2 in NEAMs. In both the farmer groups nearly 57-63 per cent head of the families had either high school or higher secondary education. In the EAMs farmer groups 7 per cent were completed UG and PG. In both the farmer group 57.14 per cent and 45.00 per cent of large farmer in EAMs and medium farmer in NEAMs earning annual income Rs. 1,00,000-2,00,000. In EAMs 25.00 per cent and 35.72 per cent of them are medium farmers and large farmers and in NEAMs 30.00 per cent of them are large farmers belong to Rs. 2, 00,000 and above.

### Land Use Pattern

The percentage of farmer have their own land are 74 per cent in EAMs farmers and 76 per cent in NEAMs. Farmers have tenant lands are 26 per cent and 24 per cent respectively.

**Type Of Soil**

Soil is the main factor of agriculture production. Majority of the study area are covered with red loam soil 32 per cent of EAMs and NEAMs and 34 per cent of NEAMs have red soil.

**Input Dosage**

The input dosage and base on what recommendation farmers carry their farming practices. Majority of farmers under EAMs use recommended dosage fertilizer organically followed by organic pest management, the percentage being 38 per cent and 28 per cent respectively. NEAMs use fertilizer widely use non- recommended fertilizer chemically at 28 per cent.

**Major Crops**

The majority of the farmers in E-Farms cultivates pulses and cereals. Majority of E-Farm have cultivated cereals such cholam and maize as 38 per cent and 18 per cent. Cumbu cultivations under EAMs are 22 percent and N EAMs are16 per cent. 14 per cent of EAMs and 12 per cent of N EAMs are Samai cultivations. Majority of the farmers in E-Farms have cultivated pulses such as green gram as 18 per cent and Bengal gram as 22 per cent and 20 per cent.18 per cent of EAMs and 16 per cent of NEAMs are peas cultivations.

**E-Agriculture Methods**

EAMs tools provides and apt EAMs tools for farmers. Majority of the farmers under EAMs are provided with SMS and radio 18 per cent followed by television 16 per cent. Kisan call centers14 per cent and video conferencing 10 per cent. Farmers under EAMs stated that SMS service in the apt EAMs tools for them.

**Problems**

The problems faced by selected farmers are affected by selected farmers, majority of farmers are affected by failure of monsoon. The percentage are being 52 per cent in EAMs, 46 per cent of EAMs and 50 per cent of NEAMs are affected by low rainfall. Majority of farmers under EAMs face the problem of unanticipated climate with 36 percent and N EAMs face lack of technology with 28 per cent.

**Benefits of E- Agriculture**

The benefits of EAMs by selected farmers, Majority of the farmers are benefited by Weather forecasting and regional language are being 22 percent and 20 per cent respectively. percentage of the farmers in EAMs benefits in timely advice by 18 per cent.

**Cobb Douglas Production Function**

The average net returns were Rs. 9,698 per ha and Rs. 23,583 per ha in Non E Agriculture and E Agriculture methods of Pulses and Cereals cultivation. The yield realized in Non E Agriculture method was 5.69 tonnes per hectare and it was 7.98 tonnes per hectare in E Agriculture method. The expenditure on human labour accounted for the highest share (37.26 per cent) in the total cost of cultivation of Rs. 3,1769 per ha in Non E Agriculture method. The cost of cultivation in E Agriculture method worked out to be Rs. 3,3096 per ha in which the share of human labour was 44 per cent respectively. The estimated production functions were significant with high $R^2$ for both the E Agriculture method and Non E Agriculture methods. The output elasticity coefficients for seeds, labour, preparatory of cultivation and capital were positive and statistically significant in both the methods. There was a structural break up between the two production functions. The MVP-MFC ratio analysis indicated that in the short run there was a scope for intensification of use of resources like seeds, preparatory of cultivation in Non E Agriculture method and for seeds, preparatory of cultivation and capital in E Agriculture method. The technological change in of Pulses and Cereals production has brought about 31.69 per cent productivity difference between the two methods. The major component of this productivity difference was due to the difference in method of cultivation, which contributed to 29.49per cent. The remaining two per cent difference in output was due to difference in quantities of inputs used.

**Crop Diversification Index**

**Herfindhal Index**

The crop diversification using Herfindhal Index and it had compared the indices of both EAMs and NEAMs. The Herfindhal Index attains significance level when the result is nearest to 1. The diversification index calculation clearly explains that EAMs adopters have more diversification comparatively to NEAMs. EAMs have 0.997diversification index for Cholam wherein NEAMs have 0.924. In Maize EAMs had 0.995 diversification and NEAMs attained only 0.928. In the selected block, among the farm households small farmers had maximum crop diversification mainly in Cholam (0.999), Cumbu (0.992), Maize (0.996) and Bengal gram(0.993). In Cumbu EAMs had 0.994 diversification index wherein NEAMs had 0.921. Through this analysis we clearly demonstrate that crop diversification favors to EAMs adopters rather than NEAMs adopters, so EAMs are more important in enhancing crop production.

**Modified Entropy Index**

The crop diversification using Modified Entropy Index and it had compared the indices of both EAMs and NEAMs. The Modified Entropy Index attains significance level when the result is nearest to 0. The Modified Entropy Index calculation clearly ranked that EAMs adopters have more diversification comparatively to NEAMs. EAMs have 0.003 diversification index for Cholam ranking 1st wherein NEAMs have 0.066. In Cumbu and Maize EAMs had 0.004 and 0.004 diversification ranking 2nd and NEAMs attained 0.018 and 0.014. In the selected block, among the farm households small farmers had maximum crop diversification mainly Maize (0.004) and Bengal gram (0.003), Black gram (0.002).In Bengal gram EAMs had 0.005 diversification index ranking 3rd wherein NEAMs had 0.018.

**Scaling Technique**

The opinion of the EAMs adopters on the performance of EAMs in agriculture production were ranked and discussed in this section with two criteria expectation and realization. Among the expectation criteria, the respondents were ranked 1st for Climate data, bridging the gap between Providing timely information (2nd rank), Expert guidance (3rd rank), 24 x 7 services (4th rank), Ensures easy access (5th rank), Bridging the gap between technology generation and distribution (6th rank), Increasing the yield (7th rank) Cost effective 8th rank), elimination the role of middlemen(9th rank), Providing technology usage training (10th rank) and Eliminates the role of middleman (11th rank) these are various factors expected by the user of EAMs. Meanwhile under the realization criteria farmers have ranked some opinion on the performance of EAMs which were listed and ranked as follows Protecting production and productivity (1st rank), 24 x 7 (2nd rank), Expert guidance (3rd rank), Providing timely information (4th rank), Ensures easy access (5th rank), Climate data (6th rank), Providing technology usage training (7th rank), Cost effective (8th rank), Increasing the yield (9th rank), Bridging the gap between technology generation and distribution (10th rank) and Eliminates the role of middleman (11th rank). The users of EAMs in agriculture production were unanimous on stating the same opinion under expectation and realization criteria is expert guidance (3rd rank) and Ensures easy access (5th rank). These are the various factors expected and realized by the users of EAMs.

## CONCLUSION

The impact of climate change on Indian agriculture has created the serious things of concerns for India, which are urgently needed to deal with in absence of which it can very badly and severely affect India and its billion population. The severe concerns of climate change on Indian agriculture are; in the situation of enhancing production, productivity of agriculture climate change will adversely affect and its contribution to the development of the economy will be further marginalized. The uncertainty and variations in rainfall will hamper production especially of food grains and intensify the want for food and food security of the majority of Indians especially from the socially and economically deprived sections of the society. The climate change will adversely affect the water supply through rivers and further intensify drinking water availability and irrigation facilities for the development of the agriculture of India. Such climatic fluctuations could adversely affect agricultural sustainability resulting in unforeseen situational shortages which could also impact other economic sectors. The hampered growth of agriculture by the climate change will also affect unemployment, poverty and inequality in Indian economy. This can further adversely influence the development of non agriculture activities and their contributions to the overall development of the Indian economy. However, the study yet to get substantial results in increase of agriculture production because of development of EAMs. It is found from the study, adoption of EAMs will help farmers to reap more benefits such as weather update, input dosage pre and post harvest , Providing timely information, Expert guidance, Climate data and Ensures easy access. EAMs by crating awareness among the farming community help them increasing the outcome and creating more of farming opportunities. EAMs should be adopted throughout the entire sector in India as it facilities us to have an eco friendly and environmentally viable society.

## SUGGESTIONS

- Efforts should be made to incorporate the Information Technology in all endeavors related to agricultural development.
- The organizations and departments concerned with agricultural development need to utilize the E-Agriculture in realizing its potential and for speedy dissemination of information to the farmers.

- Government at national and state level have to reorient their agricultural policies so that a full-fledged strategy to fully gear up the process of harnessing the potential of E-Agriculture in overall agricultural development of the country.
- The future E-Agriculture initiatives should make use of E-Agriculture as both information gathering tool and information sharing tool. Imbalances between these two dimensions need to be checked in the early stages.
- Efforts should be made to bring about user equity in future E-Agriculture initiatives by incorporating target specific information modules (targeted towards women farmers, youth etc.)
- Intensive training on use of E-Agriculture modules should be imparted to the persons to be recruited as interfaces (It should not necessary for the individuals to have professional degrees/ diplomas in computers.

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# *Annexure*

## A STUDY ON THE IMPACT OF E- AGRICULTURE IN A SELECTED AREA IN COIMBATORE DISTRICT

1. Name:

2. Address:

3. Age: ☐ 20-30 ☐ 30-40

☐ 40-50 ☐ 50 and above

4. Sex:

5. Education: ☐ Illiterate ☐ 1-8 ☐ 9-12 ☐ Diploma

☐ UG ☐ PG and above

6. Type of Land:

☐ own ☐ tenant

7. Type of soil:

☐ Red soil ☐ Black soil ☐ Alluvial soil

☐ Hill soil ☐ Clay soil

8. Size of land

☐ 0-1 hectare ☐ 1-2 hectare ☐ 2-5 hectare

☐ 5-10 hectare ☐ 10 and above hectare

9. Major crops

1. 2.

3. 4.

10. Which is the major problems of cultivation?

a) Inadequate Rainfall b) High temperature

c) Climate change d) Monsoon Failure

11. What are the ICTs provided to you?

a) Television b) Mobile phone

c) Radio d) Computer

12. How many years are using ICTs in farming activities?

a) Less than One year  b) 2-3 years

c) 3-5 years  d) 5 and above

13. Which ICTs are very adopted of your farming?

a) Radio  b) Television

c) Mobile  d) Computer

14. Have you change your cropping pattern after adopting ICTs

Yes ☐  No ☐

15. What are the problem that your facing in farming?

a) Unanticipated climate  b) Lack of awareness of ICTs

c) Know-How

16. Benefits of ICTs

| | **Strongly agree** | **Agree** | **Neutral** | **Disagree** | **Strongly disagree** |
|---|---|---|---|---|---|
| Weather forecasting | | | | | |
| Regional language | | | | | |
| Free cost | | | | | |
| Timely advice | | | | | |
| Market information | | | | | |
| Easy access | | | | | |

17. Problems in ICTs

| | **Strongly agree** | **Agree** | **Neutral** | **Disagree** | **Strongly disagree** |
|---|---|---|---|---|---|
| Failure of Monsoon | | | | | |
| Low Rain fall | | | | | |
| Unanticipated Climate | | | | | |
| Lack of Awareness | | | | | |
| Lack of Technology | | | | | |

18. Difficulties

| | **Strongly agree** | **Agree** | **Neutral** | **Disagree** | **Strongly disagree** |
|---|---|---|---|---|---|
| Know-how | | | | | |
| Lack of Awareness | | | | | |
| Laziness | | | | | |
| Less interest | | | | | |

19.Suggestions

1.

2.

3.