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Adoption of Tissue Culture in Horticulture

A Study of Banana-Growing Farmers in Kadapa District

Ch. Krishna Rao

CENTRE FOR ECONOMIC AND SOCIAL STUDIES
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Foreword

The Centre for Economic and Social Studies (CESS) was established in 1980 to undertake research in the field of economic and social development in India. The Centre recognizes that a comprehensive study of economic and social development issues requires an interdisciplinary approach and tries to involve researchers from various disciplines. The Centre's focus has been on policy relevant research through empirical investigation with sound methodology. Being a Hyderabad based think tank, it has focused on, among other things, several distinctive features of the development process of Andhra Pradesh, though its sphere of research activities has expanded beyond the state, covering other states apart from issues at the nation level. In keeping with the interests of the faculty, CESS has developed expertise on themes such as economic growth and equity, rural development and poverty, agriculture and food security, irrigation and water management, public finance, demography, health, environment and other studies. It is important to recognize the need to reorient the priorities of research taking into account the contemporary and emerging problems. Social science research needs to respond to the challenges posed by the shifts in the development paradigms like economic reforms and globalization as well as emerging issues such as optimal use of environmental and natural resources, role of new technology and inclusive growth.

Dissemination of research findings to fellow researchers and policy thinkers is an important dimension of policy relevant research which directly or indirectly contributes to policy formulation and evaluation. CESS has published several books, journal articles, working papers and monographs over the years. The monographs are basically research studies and project reports done at the Centre. They provide an opportunity for CESS faculty, visiting scholars and students to disseminate their research findings in an elaborate form.

The present monograph by Dr. Ch. Krishna Rao is an attempt to understand the influence of the adoption of tissue culture, one of the techniques of biotechnology, on the various social groups and motivational factors behind the adoption of new technology. It deals with one of the commercially successful biotechnologies, i.e. plant tissue culture technology (PTC) in horticulture. Sociological study on the social economy of crops gained significance recently in studies in the area of science, technology and society (STS) studies. Much before the launch of farmer level biotechnology based products like Bt cotton, seeds in PTC products like plantlets of fruit, species, ornamental plantation produced invitro using PTC technology have been used by the farmers in different parts of the country and particularly in Andhra Pradesh. However, not many empirical studies have been conducted to examine the nature of adoption by farmers and issues concerning PTC technology at the micro level.

I hope that this study would be useful to academicians and policy makers in view of the current contestations on the applications of biotechnologies in agriculture.

Manoj Panda
Director, CESS.

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October 19, 2010 **Ch. Krishna Rao**

CHAPTER I

Introduction

Society provides human, physical and cultural resources for growth and development of science and technology. Developments in Science and Technology influence Society. Technology and Society are obviously in a reciprocal relationship. All social Institutions are affected by Technology (Jerry Gaston: 1980). Changes in social institutions may be brought about by several other factors in addition to science and technology. The study of social change acquired significance after the II World War because of the increased emphasis on planned change and development by the developing countries after they gained political independence.

Understanding influence of technology in bringing about social change has assumed greater significance in sociological research with the development of technologies such as Information Technology and Biotechnology. The present study aims at understanding the influence of the adoption of tissue culture, one of the techniques of biotechnology, on the various social groups and motivational factors behind the adoption of new technology.

Social Change: concept and existing theories

Social change implies change in social system over a period of time. MacIver and Page (1986) viewed social change as distinct from cultural change and defined social change as "change in social relationships, every change in man's relations to his environment leads to some change in his relation to his fellow beings'. Harry M. Johnson (1966) defines social change as a change in social structure. Social structure includes structural elements like statuses, roles, groups, sub-groups, and collectivity. Hence, change in any one of these structural elements may be regarded as social change. Bottomore (1962) defined social change as change in the social structure (including changes in the size of society) or in a particular social institution or in the relationships between institutions.

Social change has certain distinctions on the basis of the dimensions of change. These are (i) time (ii) magnitude. Short-term and long-term changes represent the temporal dimension of change. By and large, large-scale change corresponds to long-term change and small-scale change to short term change.

Culture change

Structural and cultural changes are interrelated. Changes in social structure the system of social relations in terms of class, caste, gender and power relations may trigger changes in culture, attitudes, values, and systems of meaning. Similarly change in culture may bring about changes in social structure. Sociologists have been engaged in formulating theories about social change. Sociologists have been focusing on understanding the factors that bring about social change in the economy, polity and culture.

Structural-functionalist theory

Structural-functionalist theory assumes that there is order in the society and there is consensus on the value framework that underlies the order. Each institution serves certain functions in maintaining the order of the society. When events from outside or inside disrupt the social system, the social order, comprising interrelated social institutions, make adjustments to restore stability. This perspective has its roots in the work of the early sociologists especially Durkheim (1950), Herbert Spencer (1903), and Radcliff-Brown (1952). Among contemporary scholars, it is most closely associated with the work of Parsons (1951) and Merton (1969). According to Parsons (1951), the sources of change can be classified as endogenous (from within the social system) or exogenous (from outside the social system), very often, both sources work together and influence the magnitude of change (Coser: 1971).

Structural-functionalists argue that change generally occurs in gradual fashion and not in sudden violent, radical fashion. Change in the social order, which is based on consensus on the value framework that underlies the social order, undergoes change with gradual changes in the values related to different institutions that comprise the social order. Even changes, which appear to be drastic, have not been able to make a great or lasting impact on the core elements of the social and cultural system. A change, according to Parsons (1951) and Merton (1968), comes from basically three sources:

i) Adjustment of the system to exogenous changes (i.e. War, Conquest);

ii) Growth through structural and functional differentiation (e.g. change in the size of the population through births and deaths);

iii) Innovations by members of groups within society (e.g. inventions and discoveries in a society).

Because structural-functionalists' concern was for 'social order' they are often criticized for not dealing with the problems of social change adequately.

Conflict theory

Conflict theory takes the principle of dialectic as central to social life. Conflict theorists do not assume that societies evolve smoothly from lower to higher or complex levels. According to this theory, every pattern of action, belief, and interaction tends to generate opposing reaction.

Marx, in his theory of class struggle, developed the idea of social change resulting from internal conflicts. For Marx, social change is not a smooth, orderly progression, which gradually unfolds in harmonious evolution. Marx believed that the class struggle was the driving force of social change. Marx's views on history are based on the idea of the dialectic. Dialectical movement represents a struggle of opposites, a conflict of contradictions. Conflict provides the dynamic principle, the source of change. Contradiction between relations of production and forces of production manifests as class conflict.

Haralambos (1980) paraphrases Marx's theory of social change as follows: societies change from one type, characterized by a given mode of production, to another type characterized by another mode of production through revolutionary politics.

Conflict resolution through revolution results in a new social formation, which allows the growth of productive forces up to a point. When contradiction between relations of production and forces of production becomes sharp, the contradiction relates the conditions for another revolution through class struggle. The growth of forces of production, which is result of the capacity to produce, is essentially a function of scientific and technical knowledge, technological equipment and the organization of labour force (Raymond Aron: 1965).

Science, technology and social change: Intertwining relationship

Both structural functional theory and Marxist theory recognize the significance of inventions and discoveries for social change. For structural functionalists the inventions and discoveries bring about social change gradually. For Marx, Science and technology are part of forces of production which come into the sharp contradiction with relations of production. As contradictions could not remain unresolved beyond a point, the contradiction manifests itself as class conflict and paves the way for qualitative change in the relations of production.

Science in most general sense is any systematic study of physical and social phenomena. In restricted sense, science is study of physical and social phenomena where this involves observation, experiment, appropriate quantification and the search for universal general laws and explanation. And science could be referred to any specific branch of knowledge in either of the above senses (e.g. social sciences).

Science is social in nature, because science is pursued by human beings in a social environment to produce new knowledge. Science is concerned with understanding the basic natural process in the universe; technology is concerned with developing innovative processes and products (Jerry Gaston: 1980). Science is the act of 'knowing' and 'technology' is the act of doing. This conception of science and technology has been challenged by Haraway (1998) who argued that science and technology are interpenetrating systems and she uses the term' techno-science' to describe this (quoted in McKenzie and Wazcman; 1999; page No.41-49).

In sociology, science is seen, involving a complex process of social production, working upon and transforming previously existing knowledge. As a socially located phenomenon, science must also be recognized as occurring in a social context in which the cultural values and interests of scientist, and also the wider interests always potentially influence the production of knowledge. According to David Jary and Julia Jary (1995) sociology of science concerned with study of the social processes involved in the production of scientific knowledge as well as the social implications of this knowledge, including technology. For Durkheim (1915) science is a specialized social activity. Michael Mulkay (1979) called the science, as a "socio-cultural phenomenon. According to J.D. Bernal (1983) science is a major factor in maintaining and improving the production. Science and technology have been recognized as important factors that bring about structural and cultural changes in human society. As mentioned earlier, technology is one of the important sources of social change and technological change produces transformations in all spheres of social life.

Technology is a vitally important aspect of the human condition. Our lives are intertwined with technology from simple tools to large technical systems. Some societies are more responsive to change than others. The response to change depends upon the level of technological advancement. Today, the distinction between science and technology is difficult to maintain because of the interpenetration of science and technology.

Technology: Definitions

Technology constitutes generally, tools, machines, instruments, weapons, appliances; physical devices associated skills, methods, procedures, routines activities, and so on. The rise of men from his apelike ancestors has depended on his ability to make and use tools. In the few thousand years that have passed since the discovery of agriculture, man's power over his surroundings has been growing at an ever-increasing rate (Nicol Russell: 1978).

According to International Encyclopedia of the Social Sciences, technology is described as 'bodies of skill, knowledge, and procedures for making, using and doing useful things (Julius Gould, William L.Kolb: 1969).

Technology refers to the application of cultural knowledge to tasks of living in the environment. It centers on processes that are primarily biological and physical rather than psychological and social processes. They represent the cultural traditions developed in human communities for dealing with physical and biological environment, which includes the human biological organism itself. Technology is defined here as a method of using science in producing goods and services. It is a parameter of the system and determined by scientist and technologists. (Nicol Russell: 1978)

The term technology also implies: (a) a body of means and skills characteristic of a particular civilization, community or period (b) technical methods used in a particular field of industry. In other words technology has three components i) hardware i.e. the tools, equipment ii) software i.e. knowledge underlying the construction of hardware iii) orgware i.e. social organization required for implementation of the technology.
David Jary and Julia Jary (1995), observe that technology is the practical application of knowledge and use of techniques in productive activities. This definition reflects a sociological concern with technology as a social product, which incorporates both the 'hardware' of human artifacts such as tools and machines and the software knowledge and ideas involved in different productive activities. More recent developments in energy production and information technology may, however, depend upon innovations derived from organized science, sometimes technology is referred to in the narrow sense as machines, whereas wider definitions include productive systems as a whole and even work organization and the division of labour. The narrow definition tends to treat technology as autonomous and ignore the social processes involved in the design and choice of technology; more inclusive definitions make it difficult to distinguish between the technology and the social arrangements with which it is related.

Relationship between science and technology

The relationship between science and technology is one of the most controversial problems confronting historians and philosophers interested in technology and its history. John Staudenmeier (1985) has pointed out, that they have argued ceaselessly over competing interpretations of the relationship. The philosopher Mario Bunge (1966) has maintained that successful technological practice depends on the systematic application of scientific knowledge. Science influences history in tow major ways, i) by the change in the methods of production and ii) by the impact of its findings and ideas on the ideology of the period.

All science is simply an intensified form of technology, generated by the material needs of society. Throughout the greater part of history, improvements in techniques have arisen mostly under the stimulus of the immediate advantage they would give to certain individuals or classes (Bernal J.D: 1983).

Technology has changed radically in quantity and quality over the millennia. The rise of technological sciences occurred only with the creation of a community of practitioners separate from either the body of inventors or that of scientists. The new group of specialists, who came to be called engineers, possessed scientific training and a grasp of mathematics and physics and an intimate knowledge of technology. During the first decades of the 19^{th} century, iron became a common material in the construction of building, bridges and other structures.

Technology is not neutral with respect to history, class, country and factor endowments and technological changes take place with the development of technological knowledge (Stewart Richards: 1983). Technology is a social activity, all the social sciences-Sociology, Economics, Psychology, Political Science, Anthropology are also pertinent to studies of its social origins and influences of technology.

Donald Cardwell (1965) argued that the growth of science owes a great deal to technological practice as technological artifacts have provided tools and the techniques for exploring the new ideas. Edwin Layton (1977) argues that science and technology are not abstract functions of knowing and doing; they are social (p.209).

According to Otto Mayr (1976) this search for a single, timeless account of the relationship between science and technology may be so fruitless because it is a fundamentally flawed endeavor. The critical terms, "science" and "technology", Otto Mayr (1976) argues, cannot be treated as invariant across different period of history and different cultural context. These terms should be treated as historical objects whose invention and ever-changing definition and mutual relationship cry for explanation.

Theories of technology development

As mentioned earlier, society provides the context and conditions for growth and development of technology. One of the theories of technology is technological determinism, this theory assumes that technology is both autonomous and has determinate effects on society. Technology seen as a political and as an independent variable in social change. This assumption is criticized for ignoring the social processes and choices, which guide the use of technology and the variety of possible social arrangements, which coexist with different types of technology. In Langdon Winner's words (Mackenzie: 1985) technology could be political because it is designed, consciously, or unconsciously to open certain social options and close others. The technological deterministic approach looks at technology as an independent factor that causes changes in the social economic, political and cultural aspects of human society. The socio-technical systems approach focuses on functional groups i.e. builder, inventors, engineers, managers, financiers, and inventing and controlling over technological systems, heterogeneous social classes/groups, disciplines, organizations institutions become part of 'seamless web' (Hughes: 1986).

The Actor-Network theory emphasizes the relations between actors of technical and non-technical world (Callon: 1986), Latour: 1987, Law: 1987). The notions of 'actors'- physical and social that are involved in the development of technological systems replace the conventional categories distinguishing animate and in inanimate things and forces.

The general perception is that new technologies are developed or existing technologies are upgraded to enhance the efficiency whether in the field of agriculture or industrial production. The latent object of all technological improvement is economic efficiency. However, the consequences of scientific and technological advancement are not just confined to economic one but pervade all areas of life. This means that there are always two sides to the advancement of science and technology. On the one hand, the advance of instrumental rationality or of seeking the most efficient means to achieve a given end entails an increasing mastery over the natural and social worlds. On the other, this process also brings about the increasing impersonality of the external conditions of life. That is why Brubaker (1984) endorses Weber's argument of that regards science and technology as central to the process of "disenchantment" or the increasing extension of instrumental rationality through out the social world.

The pervasive influence of technology on society in the contemporary world is much widely noticed and seems qualitatively different from that of past societies. This is for the following obvious reasons. One, the present day tools are more powerful than any before. For example, while the domestication of animals and invention of the wheel literally turned food production around and lifted the burden from mans'back. Now-a-days, computers freed human being from all their hectic and complex labour. Compared to rifle of yester years, nuclear weapons of modern days could wipe out mankind from earth. Second as the quality and finality of modern technology improved, it has brought the society to explicit awareness of technology as an important determinant of human beings an institution (Mesthne, 1972).

Technology has been viewed as an important tool in the advancement of production process. As a consequence, production process became complex skill-based, mechanized and automated. Marx (1974), while analyzing the division of labour in the age of technology-driven industrial revolution distinguished between organic manufacture and heterogeneous manufacture. In organic manufacture, the basic raw material passes through a sequence of stages in which it is converted into the finished product. In heterogeneous manufacture, different parts are manufactured by a large number of detail workers and these parts are collected for the final assembly worker. For example, making of a watch used to be the individual product of one craftsman, but in the 19^{th} century, it became the social product of a large number of workers like dial maker, hairspring makers, screw makers and gliders. Marx (1974) did not consider the worker who at the end assembles al the parts to make a watch as a craftsman despite his skill, since he did not work directly for the customer, but for the capitalist who organized the coordination of various component parts (Goody, 1982).

One of the most significant outcomes of technological advanceman in the production process during eighteenth century was Industrial Revolution. The most important change brought about by the Industrial Revolution was transformation of craft based production to industrial production. Craft based production lacks specialization and division of labour. However, industrial revolution led to specialization and high degree of division of labour. For example, making pins was broken in to 18 separate operation which could be carried out by as many workers with an astonishing 240 fold increase in productivity, using the same technique and tools (Adam Smith: 1776).

In the late twentieth century with the application of biotechnologies work in agricultural production process is under going a transition comparable in scope and magnitude to the industrial revolution. The industrial revolution, brought about by capital investments in machines, was such revolutionary that substituted mechanical for animal and human energy (Simpson, 1999). However, the bio-revolution seems to be more revolutionary brought about by capital and intellectual investments in general and Research and Development labs that substitute for field and farmer.

Technology and social change

As mentioned above, technology is one of the important sources of social change, and technological changes produces transformation in all the spheres agriculture, industry and services. Technology improves efficiency, productivity. It affects social relations among workers at work place, also in class relations in a society. Sometimes technological choices are governed by the goal of controlling the process of production and workforce involved in production.

The changes in the levels of and the nature of technology in any sphere of activity, be it production, education or entertainment will have an effect on various aspects of social institutions and culture and thus leading to social change. The choice of an alternate and new technology in the place of an old technology will alter the roles of relationships between individuals, their attitudes and values in course of time and this leads to social change.

The knowledge underlying technology, interlinked beliefs and values, the degree of complexity and the degree of contact it has with the cultures of other societies, are important sources of social and cultural change. Rahman (1978) believes that science and technology bring deeper changes in attitudes and value systems, and technology, satisfies the basic needs, and helps in removing traditional inequalities in society (Sharma and Qureshi: 1978).

Ogburn (1979) coined a term "cultural lag" to describe the disequilibrium between material and non-material aspects of a culture. He pointed out how changes in non-material culture such as values, belief, norms, family, religion after lag behind changes material culture that is technology means of production, and output of the economic system.

Ogburn has pointed out social change is the result of a combination of new inventions. Since cultural change influences the social relations of people, it also tends to increase the pace of social change at a greater tempo through time. Often material inventions result in undermining the established social patterns and giving rise to new patterns as a result of them.

Technological innovations are accepted readily from the utility point of view but social norms and values are more traditional and get adjusted much more slowly and gradually to the change material conditions. According to Ogburn (1979) various parts of modern culture are thus not changing at the same rate. Since there is a correlation and interdependences between several parts, or rapid change in one part necessitates change in the correlated parts of culture.

As per Human Development Report (2001), technological change like all changes poses risks as shown by the industrial disaster in Bhopal (India), the nuclear disaster in Chernobyl (Ukraine), the birth defects from thalidomide and the depletion of the ozone layer by chlorofluorocarbons. This report also remarked that technological breakthroughs without attendant social and infrastructural change could produce distorted results, being witnessed in India today in the simultaneous existence of grain stocks and hunger in several states, albeit drought related (HDR: 2001), agriculture is one of the areas where technological improvements have been contributing to increased productivity over time.

Technology and agriculture

Agriculture is one of the areas where technological improvements have been contributing to increased productivity over time. Technology plays very key role in agricultural productivity. According to the 1997 World Bank Report, about 12% of the world's total land surface is used to grow crops, about 30% is forest or woodland, 26% is pasture or meadow. The reminder, one third, is used for other human purposes or is unusable because of the climate or topography. In 1961, the amount of land supporting food production is 0.44 hectares per capita. Today it is 0.26 hectares per capita and based on population projections; it will be in the vicinity of 0.2% a year and continues to fall.

Under these circumstances, there is a need to increase productivity per hectare to feed the increasing population with the decreasing amount of land available for cultivation. Global agriculture is steadily gaining production over the past few decades. However, it not been successful to overcome the problem of rising demand, which is a result of the increasing population. The challenge is immense because by 2050, global demand for food may be three times greater than today. Moreover, during the past two decades the production growth has declined, dropping form 3% annually during 1960's to 2.4% in the 1970s and finally to 2.2% in the 1980s.

On a global basis, average yields per hectare of wheat, rice and maize have climbed fairly steadily since 1961. The aggregate figures nonetheless mask some disturbing regional trends. In Asia, for instance, rice yields raised drastically in the 1960, with introduction of new varieties and management practices. Yields continued to increase in the 1970s but in the 1980s began to level off or decline.

According to Wenke (1980), agriculture was made possible by advancements in technology. Similarly, agriculture allows for further increase in population. As people come into contact with one another, there is diffusion of crops, which has resulted in increased diversity of foodstuffs to consume. Norman Borlaug (1981) lists twenty-three plants that form the base of world agriculture, as indicated in Table No.1.1.

Over 80% of the harvested food by the weight is from plants, and just about half of all food and calories are from the five cereal grains. When domesticated plants were diffused to new regions, varieties are bred and adapted to fit the environmental circumstances. Most of the plants have been crossed with local varieties to fit micro climatic and cultural needs. It is interesting to note that majority of wheat and rice production of third world comes from the plants, which share a common ancestry. This is a cause of concern as this is a prescription for disaster because this would lead to loss of genetic diversity among the crops.

Table No.1.1: The twenty-three main crops that form the base of world agriculture

Category	Varieties
Five cereals	Wheat, rice, maize, sorghum and barely
Three root crops	Potato, sweet potato and Cassava
Two sugar crops	Sugar cane and sugar beet
Six grain legumes (pulses)	Dry beans, dry peas, chick pea, broad bean, ground nut and Soya bean
Three oil seeds	Cotton seed, sunflower and rape seed (the pulses groundnut and Soya bean are also oil seeds)
Four tree crops	Banana, cocoanut, orange and apple

Source: A Theory of Technology: Continuity and Change in Human Development, Thomas R. DeGregori, Ames: The Iowa State University Press, 1982.

According to Krimsky and Wrubel (1996), though cultivation of crops was carried out through the past ten to fifteen thousand years, the technological advancements started only 200 years ago. These include mechanization, plant-breeding hybridization, chemical based pesticides and herbicides and chemical fertilizers. Green revolution, a set of techniques involving use of high yielding varieties, assured irrigation facilities, use of chemical fertilizers and pesticides, institutional credit facilities, etc. has radically transformed the agriculture scenario in third world countries.

Green revolution technology in India

In India Green Revolution heralded in mid-nineteen sixties with the introduction of high yielding dwarf varieties of Mexican wheat and some exotic varieties of paddy on selected scale. Parthasararthy (1971) termed that green revolution altered social relationships on the farm and a shift of power with in the rural sector from one class to another and in addition green revolution would implied fundamental changes in farm economy, in the inter-relationships between the farm and external world, he summed up that it was an Agrarian revolution/Agricultural transformation.

Green Revolution is the net outcome of a particular type of agrarian system covering a wide variety of measures to enhance the agrarian output. This revolution is based on high yielding varieties of seeds (HYVS) with closely associated agricultural technology, manures, chemical fertilizes, insecticides, pesticides weedicides, biological stimulators along with capital investment under well-guided irrigation facilities, i.e., mechanical, chemical, biological and hydrological inputs are essential for such agrarian transformation.

Introduction of institutional inputs with regard to land reforms, consolidation of land holdings, banking system and credit facilities, associated service infrastructure in the form of rural link roads, rural electrification tube well irrigation, marketing support, storage facilities, etc, have also been instrumental in bringing the Green Revolution. These institutional inputs have brought structural changes in agrarian economy in the country. Keeping all other facilities aside, the introduction and developments in the field of irrigation –tube wells and cancels, have been most rewarding in the genesis of the Green Revolution.

Spatially, Green Revolution is limited to certain pars of the country where necessary infrastructural development in associate aspects is better than other regions. The most prominent among such areas are-Northwestern, Rajasthan-Punjab-Haryana-Chandigarh-Delhi-Western Uttar Pradesh-Regions of the Northern Plains, Krishna–Godavari Delta, in Coastal Tamil Nadu (Thanjavur Area) and parts of Maharastra.

The green revolution is appreciably localized in some particular areas of toiling farming communities like he Jats (Punjab, Haryana, Western Uttar Pradesh) , the Reddys(Andhra Pradesh) and the Gounders(TamilNadu) who have been entrepreneur cultivators since ages and they carry almost a mystical love for their farm holdings(Singh:1974). In Punjab and Haryana besides economically viable and socially acceptable technological package, the public polices and service provided were conducive for giving a lead in the filed of agricultural affluence (Chopra: 1982).

As per Surender Singh perceptions, (1992) regional disparities have been widened in India in rural development after the Green Revolution. This has led to many socio-cultural and politico-economic repercussions in the country.

Like land reforms, farm machinery has also been instrumental in augmenting farm production. Farm machinery is the direct form of energy input in agrarian sector. Farm machinery has resulted in several structural changes in agrarian economy in India. Tractor is the basic farm machinery, which is capable of supporting other mechanical inputs. Punjab has only 1.53 per cent of the total geographical area of the country but has over 25 per cent tractors and 8 per cent of tube wells of the country (SurenderSingh: 1998).

Similarly, highest ratio of stationary threshers, combined harvesters, tillers, harrows, puddlers and chemicals spraying apparatus etc, in Punjab is also proving the relationship between Green Revolution and farm mechanization. The process of farm mechanization has directly been instrumental in the realization of the Green Revolution.

Increased productivity, area and production of certain crops have also influenced the market mechanism in agrarian sector. Over 60% of the food grain production is in Punjab, Haryana, part of North-Western Rajasthan and Western Uttar Pradesh is rendered surplus to be marketed. Farm inputs requirements also increased tremendously with the advent of Green Revolution demanding huge investment in a traditional static agrarian landscape. It has resulted in the stimulation of institutional infrastructural development in rural areas, which, indicates the consequence, as well as the stimulator of agrarian development.

Technological transformation of agriculture in India has not resulted in dramatic changes and moreover its localized nature has set a chain of action for surrounding peripheral areas for agrarian reforms and development. Rural roads have also been proved to be carriers of agrarian progress and means of rural development. It has eased the transportation of inputs and marketing outputs.

The self-sufficiency of food grains in India may be ascribed to the green revolution. Annual food grains production in the country was 51 million tones in 1948 which touched 120 million tones in 1976, 150 million tones in 1984 and 151 million tones in 1986, recording an overall growth of three times in thirty seven years. Such increase in agrarian sector has never been recorded in India. It has been possible due to increase in cropping intensity. This development has not only made India self-sufficient in food grains but also has generated a deep-rooted confidence of feeding its fast increasing population.

The realization of Green revolution in India is primarily achieved through expansion in irrigation facilities. In 1949-50 total irrigated area in the country was little over 19 million hectares which increased to over 63 million hectares in 1983-84 and 70.4 million hectares in 1986-87 recording and overall growth of 3.7 times in thirty seven years. It has resulted in an all round changes in endogenous and exogenous linkages of agricultures, agricultural community, villages and society, breaking the isolation of the peasantry. The total estimated potential of irrigation in the country has been estimated around 113 million hectares. This increase is possible in the northern, western and southern sectors of the country and these areas have already out-run other areas in agricultural yields (Soni: 1987).

Green revolution has been the cause of the unusual spread of rice (a wet crop) to relatively dry areas of the country notably in Haryana, Punjab and north Western Rajasthan due to assured supply of water for irrigation from canals and tube wells. Similarly, wheat has perpetrated in non-traditional areas of Haryana, Rajasthan, Maharastra, Karnataka, Tamil

Nadu, and Andhra Pradesh. , Orissa, West Bengal and Assam giving a new dimension to our agrarian landscape. The constant rise in production is the outcome of balanced inter-action among various favorable forces including proper inputs, encouraging policies and quick adaptability of the farm community (Singh: 1987). Green revolution has not only changed the agrarian landscape but also helped other economic activities based on agro-products governing a new set up to farming systems.

Food grain production in Punjab was 32 lakh tones in 1960-61 which touched the figure of 172 lakh tones in 1985-86 recording an overall increase of 5.4 times in 25 years resulting socio-economic changes in rural Punjab. During 1968-69 wheat recorded an increase of 229.5 per cent, rice 1221.2 per cent, sugarcane 20.9 per cent, rapeseed 80.1 per cent and mustarded 126.9 per cent, which is much higher than the national average except in the sugarcane. Realization of green revolution comes through the increased productivity of cereal crops. In 1966-67 average yield of wheat in the country was 8.8 quintals per hectare which reached to 13.8 quintals per hectare in 1971-72 and 18.2 quintals per hectare in 1982-83 recording an overall increase of about 2.1 times in sixteen years.

In the corresponding period wheat yield in Punjab was 15.1 quintals per hectare in 1966-67, which rose to 24.1 quintals per hectare in 1971-72 and 30 quintals per heater in 1982-83. In Haryana, it was 14.3 quintals per hectare in 1966-67, 20.4 quintals per hectare in 1971-72 and 25.2 quintals in 1982-83. Growth in yield in Punjab was two times and in Haryana 1.8 times. In average yield Punjab and Haryana are number one and two in India. Similarly increasing yield in other crops has also been recorded. The level of yield indirectly reveals the level on inputs for enhancing the production and also indicates the potentialities (Singh: 1987).

The phenomenal rise in area under cereals and their production may be attributed to the carefully planned inputs strategy in the filed of judicious use of fertilizers, high yielding seeds and availability of water for irrigating the thirsty lands along with crop protection programmes, various incentives, subsides and procurement of cereals by various government agencies to provide the economic umbrella to the forming community and avoiding the situation of glut in the market. This all has resulted in the orientation of agrarian system in the country in favor of cereal crops, which has deeply influenced other crops (Singh: 1987).

Socio-economic impact of green revolution technology

Socio-economic impacts of green revolution have been different in various areas according to geographic and socio-political environment. It has averted famine and hunger despite the brunt of population explosion in various parts of the globe including India.

So it may not be improper to designate it as the food grain revolution. No doubt, the green revolution has heralded the era of self-sufficiency in the food grains but not without its repercussions and problems in the filed of socio-cultural and economic-political fields, because the dynamism of the green revolution has been introduced into a tradition-bound static rural society in India. The process of change in the traditional rural societies is usually very slow and accepted values are cherished despite their outmoded existence.

Agriculture is a land-based occupation, which is a non-elastic and immovable resource. After the Green Revolution the significance of landholdings have tremendously increased along with its social values. It has also increased its demand and with the increasing productivity this demand is also rising fast. Land holding is fast emerging as the point of social power and status. As the new techniques are not favorable for small holding farmers so such people sell their meager holdings and become landless laborers. It has also been observed that the farmers with medium holdings (6-12hecatres) are eager to increase their holdings. Important relationship exist between land and people who strive about the nature of property rights, distribution of ownership and control of land, system of land division and settlement patterns (Smith: 1959). Such relationships are constantly changing in the areas of Green Revolution.

Land transaction directly influences the distribution of holdings according to size. Number of large and medium sized holdings increase and small sized ones are abolished due to land transactions. Thus the position of operational land holding's size seems to be controlled by economic and technological forces. Heralding of Green revolution has made the traditionally popular system of tenancy cultivation unpopular and the holding owners now prefer to cultivate their holdings themselves owing to enhanced returns. Green revolution has also adversely affected the share-crops, tenant farmers and landless agricultural laborers because 40 percent farm households (over 8 hectares) who are economically capable to invest for Green revolution. It has made the rich farmer richer and it has resulted in the concentration of wealth and rural power in the hands of rich farmers and the poor peasants have not benefittted at all (Dutt and Sen: 1986).

Similarly benami transfers of the land on a very large scale in these areas have also adversely affected the poor and landless farmers as the government could get very little surplus land to be distributed among them. Green revolution has caused decrease in the number of small and medium farmers due to economic and technological constraints. It has resulted in the increase in the number of relatively large holdings either by selling or leasing of the land.

It has also caused significant income differential between the income of farmers and the farm labour. In the Punjab the farmers income had reduced an increase of about 195 per cent during 1979-80 but the increase in the income of farm laborers could rise only up to 114 per cent during the corresponding (Arora: 1987). It has widened the economic gap in the rural areas, which will have its own impact on the socio-economic stratification of the rural society. More risk bearing capacity of large farmers, their greater political power and control over the developmental resources and agencies have provided them access to credit and input supply systems. While the farmers with relatively limited economic capacity languish behind this rare.

After the advent of the green revolution increased economic returns have encouraged the farmers to enlarge their holdings either by purchase or encroach on the common lands or reclaim the sub-standard areas or clear the fruit plantations adjacent to the towns or cities. This tendency is widely prevalent in agriculturally rich areas. Particularly cutting of fruit plantations around the settlements have devoid them of their traditional green belts. New plantations of dwarf species giving fruits early are of very restrictive utility for green belt purposes. Track gardening around the urban centers has also now become most potent factor for clearing of the plantations.

Fast growth of towns and cities has also adversely influenced the fruit plantations on the outer periphery of the old parts of the towns and cities both for agricultural and colonization purposes.

Notable changes have been recorded in the agriculture after the Green revolution. Agricultural labour is one of such fields, which have recorded notable changes. It has also influenced the occupational structure due to the increased productivity, mechanization and replacement of traditional farm techniques with the modern methods. Certain types of agriculture have become labour intensive and produced a unique labour cycle. Local laborers have migrated to the cities and towns in the neighborhood for more remunerative jobs or small business or self-employment keeping the residence in villages. Al this had resulted in a wide gap in labour availability and the requirement.

Consequently migration of labour from distant areas in creased. Factors of cropping pattern and its nature also affected the supply of labour. Rice cultivation in the Punjab has increased at a very fast rate and it has penetrated to totally new and non-traditional areas even in the southern Punjab. But the local cultivator is not conversant with its cultivation. So the required labour comes from eastern Uttar Pradesh, Bihar, eastern Madhya Pradesh and parts of Orissa. According to an estimate such labour force for the crop-husbandry may be varied from four to six lakh people (Grewal: 1988).

Local labour joins this work only during the peak season of sowing and harvesting when the wages are maximum in the year. Thus the traditional labour-farmer relations have changed from Jajimani relations to financial relations on the contractual basis. In some aspects of agriculture mechanization has also affected the labour negatively resulting out in the need of labour for various farm jobs, which were previously done manually causing unemployment. Growing unemployment in rural areas will have its own socio-economic consequences.

Green revolution has caused a serious disturbance in the cropping pattern in its sprawl. The traditional crop rotation has been soil fertility conserving and enriching.

Fertility recharges is essential to get better yields during the next crop. But in new crop rotation one soil exhausting crop is followed by another soil exhausting crop with no intervening period of rest and fertility recharge for the soil.

Introduction of new factors in agrarian landscape in under-developed areas sometimes produces unique and unprecedented results. Introduction of canal irrigation hitherto dry areas has noticed such changes in various parts. It has even become the ultimate cause of out-migration and large sale land transactions because the farming community of the areas was not aware of the irrigational know-how, which attracted people from irrigated areas. Land transition, rendered local people landless laborers. Later it becomes the cause of social tensions and rising economic disparities, which disturbed the special fabric in a peaceful society.

Singh (1974) propounded that though term Green Revolution has a global acceptance in the academic parlance and social recognition. But in Indian context as per Singh (1974) green revolution term conjures in the minds of many people a vision of agricultural prosperity, which is not in consonance with the reality (Singh: 1974). Dantawala (1987) reasoned that Green Revolution was not spread all types of agro-climatic regions and further he exemplified that in the context of attaining food self-sufficiency less than 15 per cent of the areas under the food grains in the country (mostly in the GR belt) has contributed as much 56 per cent of the increase in food grains production in the post-Green Revolution period.

As per Surendra Singh (1992), Green revolution in India has changed the traditional subsistence farming system to market-oriented production system. It resulted in multi-facet socio-economic changes in rural areas. The concept of increasing returns per unit of area and per unit of time is the basic consideration. The traditional native farming technology was replaced in Green Revolution areas in the country, which has been instrumental in some structural change in the agrarian set-up.

The technological inputs in the from of tractor and associated implements, tube wells and pumping sets, electricity, threshing and winnowing machines along with harvest combines etc, has resulted in positive gains everywhere. Associated biological, chemical and water technology led to continuously increasing volume of harvest. Structural change in the agrarian sector encompasses a cross-section of inputs and outputs closely related to various types of farming. Consequently the resultant influence will be different in various areas. These changes have also brought pattern of crop specialization in India because the infrastructural development proved favorable for particular type of crops while restrictive for other, e.g. regular growth irrigational facilities and are have restricted the growth of dry farming crops.

Green Revolution Technology, according to Himmat Singh (2001), paved a new development in Punjab; it eliminated 'Jajimani' system, 'Sefi' and 'Begar' systems, which involved servitude. The demand for new skills and labour led to the breakdown of cast-based occupations and encouraged inter-generational and intra-generational mobility. There was real increase in wages and work opportunities for labour class. It brought a new system of wage labour like contract work that grew in importance due to new agricultural technologies leading to better terms, more work for women and lesser-child labour. According to Himmant Singh (2001) new technology has benefited small and marginal farmers.

According to Bhalla and Chadha (1983) the impact of Green Revolution technology in Punjab not only led to accentuation of inequalities, but also resulted in perpetuation of poverty and destitution. According to them any capital-intensive technological change, by it's very nature was bound to benefit only the upper strata of peasantry and may lead to an accentuation of tensions in the countryside.

Some of the technological change may have direct consequences, the other changes may not be directly caused by technological factors, and they may have indirect consequences. The acceptance of a few innovations may not always bring in considerable social change but the social change could be a cumulative affect of many innovations (Nicol Russell: 1978).

Development of production and productivity has resulted in demand of creation of certain amenities in rural areas, like drinking water, surfaced roads, transport services, health and sanitation facilities, regulated markets, regular supply of electricity and further electrification, creation of more storage facilities close to the villages improved housing facilities, educational facilities and local availability of consumer goods to avoid unnecessary commutation.

Transfer of the cultivated land also testifies the fact that during the period of Green Revolution. The large farmers are increasing their real assets while the marginal farmers are selling their small pieces of lands and moving to the urban areas in search of employment uprooting of a persons who has born and brought-up in a farmer's family leads to psychological depression and social tensions (Hussain: 1987).

Such changes in the socio-economic scenario in rural areas are also leading to changes in other sectors causing polarization of landless laborers, marginal farmers, share-croppers and laborers unemployed due to the mechanization of the agriculture. This polarization is becoming a great danger to the peace and tranquility in the rural society.

The potential to improve plant and animal productivity and their proper use in agriculture relies largely on newly developed DNA biotechnology and molecular markers. These techniques enable the selection of successful genotypes, better isolation and cloning of favorable traits, and he creation of transgenic organisms of importance to agriculture. Together, these generic techniques are both an extension and an integral part of classical breeding, contributing successfully to shortening

Limitations of green revolution technology

David Tillman (1998) reasoned that although Green Revolution in Agriculture met the food needs of most of the world's population, it paved the way for contamination of groundwater's, release of greenhouse gases, loss of crop genetic diversity and eutrophication of rivers, streams, lakes and coastal marine ecosystems (contamination by organic and inorganic nutrients that cause oxygen depletion, spread of toxic species and changes in the structure of aquatic food webs).

It also unclear whether high-intensity agriculture could be sustained, because of the loss of soil fertility, the erosion of soil, the increased incidence of crop and livestock diseases, and the high energy and chemical inputs associated with it. But as per David Tillman, the hallmark of high-intensity agriculture is its dependence on pesticides and chemical fertilizers, especially those containing nitrogen. Since 1960 the worldwide rate of application of nitrogen fertilizers has increased by several times, and now exceeds 7x tones of nitrogen per year. In a nutshell with Green Revolution, productivity reached a plateau; environmental hazards increased and raised social inequalities. It is in this context biotechnology becomes important technology for improvement of crops.

Biotechnology: setting new technological and social agendas

Biotechnology is often hailed as the new 'revolutionary' science. Undoubtedly, it has meant some very big changes in certain fields of strategic and applied science as well as ushering, in new high-tech biological products. Like any other technology, however, its impact and direction reflect the interests of those making use of it and not some asocial unfolding of an inevitable scientific path. Revolutions depend on the interaction of human agency, and social structures and technological revolutions are no exception there is nothing necessarily revolutionary about any technology; it depends on the way it is adapted by people in specific social circumstances (Webster: 1991).

Moreover the apparent 'novelty' of biotechnology in the late 1970's can also be overplayed as, like any other field, it has depended on prior developments in biology and biochemistry. At the same time, how ever, simply because this is so we would be wrong to assume, for example, that all biologists in the late 1960's would have considered genetic engineering, the most significant biotechnology, a serious proposition, a do-able problem. Some, such as Stent (1968), even believed the heyday of molecular biology to have came and gone.

Biotechnology: Definitions

Biotechnology is broadly defined by the Congressional Office of Technology Assessment (OTA: 1984) as "any technique that uses living organisms (or parts of organisms) to make or modify products, to improve plant or animals, or to develop microorganism for specific uses". The fermentation of beer, the making of cheese, and the baking of bread can all be considered "biotechnological" processes given the use they make of yeasts.

Biotechnology is the application of biological methods or processes to produce useful products. The ancient Egyptians were credited with the invention of fermenting beer by using yeast. Several conventional biotechnology processes and approaches such as fermentation are in use in India. Indians have been making curds by using biological methods for centuries. Biotechnology was in practice for ages to make fermented foods and drinks.

Biotechnology is defined as the application of biological organisms, systems or process to manufacturing and service industries (Smith. E.John: 1988). Biotechnology is the use of living organisms and their components in agriculture, food and other industrial processes (Smith.E.John: 1988). While agriculture is sources of livelihood for millions of farmers, biotechnology inputs into it can enhance productivity, improve quality of the produce, and minimize adverse environmental impact, and increases sustainability and income of the farmers. Today biotechnology includes (a) fermentation techniques, (b) tissue culture (c) embryo transfer (d) cloning and (e) genetic engineering.

Modern Biotechnology became prominent after the invention of the recombinant DNA in the Biochemistry Department of Stanford University in 1972 by Paul Berg and Dale

Kaiser (C.R.Bhatia: 2002). It was shown that genetic material can be cut at specific sites by using the restriction enzymes, and these pieces can be cloned, spliced, transferred and expressed in heterogonous organism. This made it possible to transfer and express genes into cells of other organisms. Genes can now be synthesized and expressed in he desired organism. This also called genetic engineering.

Plant Biotechnology: An Overview

Plants and their products have been necessary components of the material base on which the complex structures of human societies have been raised, historically, whatever the period and the mode of production.

Crop improvement is as old as agriculture itself and the earliest agriculturalists were engaged in a simple form of biotechnology. There is a substantial amount of genetic diversity within species. And germ plasm—the complement of genes that shapes the characteristics of an organism—differs from individual to individual. Out of each year's harvest, farmers selected seed from those plants with the most desirable traits. Over thousands years, the slow but steady accumulation of advantageous genes produced more productive cultivars. Following the rediscovery in 1960 of Mendel's work illuminating the hereditary transmission of traits, this globe process of simple mass selection was augmented by the systematic "Crossing" of plants by scientists with the express purpose of producing new varieties with specific characteristics.

The process of plant breeding can be thought of as "applied evolutionary science", because it encompasses all of the features of neo-Darwinian evolution (Simmonds: 1983; 6). Plant breeders collect the genetic material provided by nature and recombine it in accordance with the parameters of speciation. In essence, they apply artificial selection to naturally occurring variance in the DNA" "messages" characteristics of different genotypes (Medawar: 1977). On this basis humanity has enjoyed tremendous productive advances in plant agriculture (Kloppenberg: 1988).

But though modern breeding methods of considerable sophistication have been developed for the recombination of pant genetic material, the sense in which plant breeders can be said to have "made natural history" is somewhat limited. Breeders have had to work within the natural limits imposed by sexual compatibility. In their work, plant scientists have rearranged a given genetic vocabulary but they have not been able to create new worlds or novel syntactical structures. As Marx might have phrased it, we have not historically had the powers to alter "species being". That is, we have not had this capacity until very recently (Kloppenberg: 1988).

In Biotechnology genetic engineering has far-reaching economic and social implications upon agricultural production. We are now witnessing a radical rechracterization of the nature of the link between the "productive organs of man in society" and the productive organs of living creatures. This profound advancement in the process of science and technology could be expected to have broad and important effects on social and economic relations in agricultural production.

Many observers of what is often perceived as a "biorevolution" have emphasized the degree to which the global "biofuture" will break with the past. (e.g., Hutton 1978, McAuliffe and Mc Auliffe: 1981, Sylvester and Klotz; 1983, Yoxen: 1983).

Kloppenburg (1988) pointed out that new technology's objective is improvement of yield of agricultural productivity. And he said that plant improvement took place in the historical context of capitalism. He argued that agricultural plant sciences have overtime become increasingly subordinated to capital and that this ongoing process has shaped both the content of research and, necessarily, the character of its products. This is not to say that capital has achieved complete domination of the sector. Capital has encouraged a variety of barriers in its attempts to penetrate plant breeding and make the seed a vehicle of accumulation. As per Kloppenburg (1988) analysis, there is increasing subordination of agricultural science to capital and its effect have been complex in social structure.

Biotechnology and its Application in Horticulture

India is second in fruit and vegetable production in the world. However, India's share in global export of horticultural commodities is negligible due to low productivity, lack of infrastructural facilities and inadequate post harvest management. The varietals wealth available in the country can be exploited for production throughout the year. Biotechnology as a tool offers great scope to remove many such impediments (Ghosh: 1999).

Intervention of biotechnology in horticulture promises a great potential in increasing productivity, enhancing quality and shelf life of the produce, and meeting the challenges posed by insect pests and diseases (Ghosh: 1991). Some genetically modified horticultural produce has reached the market, establishing their commercial viability. Even in India, micro propagated banana, cardamom and certain ornamentals, available in a large numbers are well received by the farmers.

Plant tissue culture technology in agriculture

Historically farming communities have been selecting and sowing the seeds from plants with beneficial characters, such as higher yield, better nutrition and resistance to diseases and pests etc, unknowingly, they have been modifying the genetic make-up of plants and animals, albeit slowly.

The power of these practices was enhanced dramatically in the twentieth century by the breakthroughs achieved in basic science of genetics, leading eventually to modern hybrid seed varieties for important food crops such as maize and, by mid century, to high yielding "Green Revolution" seed varieties for wheat and rice. Today tissue culture is extensively used in agriculture and horticulture. Genetic engineering has potential for improving productivity. But it has become controversial because of its implications for environment and morals and ethics.

Micro propagation is an important alternative to more conventional methods of plant propagation. It involves production of plants from very small plants parts (e.g. buds, nodes, leaf segments, root segments etc.), grown aseptically (free from any microorganism) in a container where the environment and nutrition can be controlled. The resulting plants are genetically identical to parent plants.

It has been the most successful commercial application, and has a large potential to meet the demand of high quality planting material in horticulture, plantation and vegatatively propagated crops, forestry and agroforestry. This technology can play a major role in rapid multiplication of elite planting material, and in providing clean, disease free material of vegatatively-propagated corps.

Plant tissue culture technology has introduced a new phase into plant multiplication and is being increasingly utilized in plant breeding. Many horticultural important plant species are difficult or impossible to manipulate by conventional propagation and breeding programmes. Consequently, propagators and breeders seeking more effective methodologies, employ tissue culture technology, with the goal of enhanced production of improved ornamental plants. Plant tissue culture is an increasingly important aspect of plant biotechnology has introduced an exciting new phase into plant multiplication and breeding.

By the experimental methods isolated cells and tissue can be grown in the laboratory, under aseptic conditions, subjected to various biotechnological manipulations. Because of their totiptency, they can be stimulated to undergo regeneration into whole plants.

The concept of improving plants by tissue culture methods is not new, Steward (1970) who, with his characteristic forward look for plant biology, foresaw the development of micropropagation systems and a 'sort of tissue culture genetics', all of which would be based on the totiptency of plant cells.

Later studies confirmed Steward's vision of the use of this methodology for the improvement and rapid multiplications of horticultural plants and shrubs. Tissue culture has become commonplace and routinely used by many commercial laboratories for the large – scale production of ornamental plants, vegetables, fruit and some edible oils.

There are two distinct areas in which plant tissue culture methodology is important for horticulturalists. The first includes situations where large-scale multiplication and the Maristems of genetic stability are paramount. This comprises the micropropagation of plants, their improvement as result of pathogen elimination and conservation in a stable form. The second concern situations in which spontaneous and induced variations can be induced by modern cell biological methods. Both approaches, however, rely on our ability to successfully control plant cell genesis and to develop reliable cell to plant regeneration systems.

Tissue culture in horticulture production

Today Plant Tissue Culture (PTC) is one of the most commonly used techniques of biotechnology in commercial propagation of horticultural plant. PTC has been proved to be the most successful commercial application of biotechnology because of following reasons:

- Large-Scale propagation of elite clones from hybrids or specific parent lines is possible.
- Large number of plantlets can be obtained in very little time and in a small space, starting from a single plant. This makes propagation of temperate species possible throughout the year.
- Making plant material disease-free through eradication and also maintains of plants in virus-free state.

PTC applications have tremendous commercial prospects in case of horticultural plants species most of which are vegatatively propagated. A large variety of high value horticultural plant species ranging from ornamental, flower, plantation, and fruit to species can be produced through PTC. PTC represents a group of techniques comprising of simplest micro propagation technique to the most sophisticated one as gene transfer. However, the most popular application of PTC is micro propagation.

The need for healthy stock of plants and quality planting material is of paramount importance for farmers, nurserymen, traders, seed producers and exporter. Quality planting material can help farmers in increasing yields thus high economic returns.

Through pro-active polices of state and central government, private entrepreneurs came forward in establishing PTC laboratories. These laboratories, though started as export oriented units concentrating on production and export of high value horticultural plants, such as ornamentals, flower plants, to developed and western countries, in the recent years they shifted their attention to domestic market and started producing plantlets, which were hitherto produced through conventional propagation methods. The range of plant species produced through PTC has increased significantly over the years; the plant portfolio includes the plants shown below.

Table 1.2 Plant Portfolios of Plant Tissue Culture Nurseries

Product Category	Plant Portfolio
Foliage	Focus ,Spathiphylim, Syngonium, Ferns, etc
Flowering	Anthodium, Chrysanthemum, Carnation, Gerber , Orchids, Marigold, Rose ,Kalaheo, Saintpoulia etc
Fruit	Banana, Fig, Strawberry, Grapes, etc
Vegetable	Potato, Onion, Asparagus, etc
Spices	Turmeric, Ginger, Cardamom, Vanilla, etc
Plantation	Sugarcane, Coffee, Teak,Paulowia, Neem, Eucalyptus, Bamboo, etc
Medicinal	Licorice, etc

(Source: C.Raghave Reddy and E.Haribabu's paper on 'Biotechnology and the industrialization of horticulture in India' in Outlook on AGRICULTURE Vol.No.3. 2002, pp 187-192).

Tissue culture research in india

In India, the significance of in vitro culture technique was realized quite early by Professor P. Maheswari. He initiated investigation with complex tissues such as ovary, ovule, and control of fertilization. The initial exploratory work on these organs laid the foundation of several achievements in plant cell, tissue and organ culture in India. During 1956 to 1966, attempts were initiated to culture the pollinated ovaries of Aerva tomentos, Allium, Cepa, Althea rosea, Anethum graveolens, Foenciculum Vulgae, Ityossameus, Niger, Iheris amoara, Linaria maroceana.

Progress in commercialization of plant tissue culture in India

In India, commercialization of agricultural biotechnology began in 1987 (Swaminathan: 1991). When various private sector organizations looked at this technology as a means of increasing the productivity of their primary produce or as a part of their diversification programme. These include A.V.Thomas Group Companies (AVT), Indo-American Hybrid Seeds (IAHS), Hindustan Lever, Tata Tea, Uncorn Bioteck, Nath Seeds, RPG Enterprises, Indian Tobacco Company, Maharashtra Hybrid Seed Company, Hindustan Agrigoentics Ltd, and many others.

The first professionally managed commercial plant tissue culture until in the country was set up in 1987-88 by AVT, when the author was their Research Director. This unit was set up in cochin Export processing Zone and remained unit one of the largest in Asia and only one of its king in India, until IAHS began production in its Bangalore based unit which not only has forty-eight laminar flow work stations, five US-class 100 growth rooms each accommodating 400,000 cultures at one time, but also has a greenhouse covering 30, 000 sq feet (2790 esq.) with most advanced equipments such as automatic shade system, fogging, blackout, irrigation systems, and movable benches for hardening of tissue culture plants.

Both IAHS and AVT have exported millions of tissue culture plants to Europe and released several hundred thousands of bananas and cardamoms to farmers at home. According to Swami Nathan during the last 2 or 3 years several corporate plant tissue culture laboratories have commercialized at least two important crops-cardamom and banana for the domestic market, selling them at a price of Rs.5 to Rs.8 per plan table seedling.

As Jiterndra Prakash (1991) described that laboratories book the orders at least one year in advance with some down payment and accept it only if the order is at least for ten or twenty thousand plants. If the private sector laboratories operate in any other way than described above it is not profitable to them (Swaminathan: 1991).

As per the observation made by Jitendra Prakash (1991), to take the advantage of such plant tissue culture progress in India, a farmer must have Rs. 50,000, something small scale farmers do not have. Doubtless it is the large scale farmer who will benefit from the current advances in India. The priorities of the private sector laboratories have to be commercial, not necessary national, although they may fall under national priorities.

Jitendra Prakash propounded that although we have achieved considerable technical strength in plant tissue culture, the penetration of such technology to the small scale farmers is absolutely essential (Swaminathan:1991).

Tissue culture technology in banana fruit production

Micro propagation through the tissue culture has acquired the commercial significance owing to uniformity in crops, earliness, freeness from disease and high yields. Bananas in India ranks fourth in terms of gross value after paddy, wheat and milk and is the larges fruit crop, in terms of production (Ganapathi, et at: 1999). Majority of the edible bananas are triploid and are propagated vegatatively by suckers. In addition to this, sterility and polyploidy often hamper the breeding programmes for the development of superior banana varieties.

Plant cell and tissue culture techniques have helped in the rapid multiplication of elite varieties employing shoot tips or floral apices (Ganapathy et al: 1999). As per Mohan and Ganapathi (1997), banana is propagated vegetatvely by suckers has seriously limited by its low rate of multiplication. Several attempts have been made to increase the number of suckers, but the rate of increase has been only marginal and hence commercial production of planting material in some of the elite varieties of banana has not succeeded. In the recent years tissue culture propagation of banana through shoot tip as well as floral apices has been demonstrated successfully (Ganapathi. Mohan J.S.S: 1995).

The major limitation in employing tissue culture technique on a commercial scale is the high cost of production per plant compared to suckers and the appearance of off-type plants in the progeny, and labour and media constitute more than half the cost of tissue culture operations (Ganapathi and Mohan et al: 1995).

Biotechnology in Andhra Pradesh

Andhra Pradesh is endowed with rich bio-resources. There are 7 agro-climatic zones across the state with 19 major food and commercial crops grown in different parts of the state.

There are more than 5000 species are flowering trees. About 40 percent of the land is utilized for agriculture and 23 percent of the land is covered by forests in the state. Agriculture is the lifeline of Andhra Pradesh's economy. The sector contributes over a third of the states GSDP and provides livelihood for over 70% of its population. It is one of the top three rice-producing states in the country and accounts for about 12% of the nation's rice production. The state has a strong base in horticulture, producing a variety of cardamoms, fruits and vegetables such as mangoes, citrus fruits, grapes, custard apples, and bananas, etc. In fact Andhra Pradesh is the second largest producer of fruits in India and one of the largest vegetable producing states in the country. Thus, abundant and diverse agriculture and forest wealth of the state, large marine resources and cattle population provides tremendous opportunities for the development of the biotech industry.

In Agri-biotech, tissue culture for food crops and ornamental plants has been taken up in several parts of the state with considerable success. There are about half a dozen agri-biotech companies doing flourishing business in this sector in the state.

Andhra Pradesh has several pioneers in Biotech industry such as Shanta Biotechniques Pvt.Ltd., Bharat Biotech International Ltd., Biological E.Ltd, Indian Immunological Ltd, Krebs Biochemical's, Jupiter Orga, Dr.Reddy's Laboratories (India) Ltd, Biotissues Pvt Ltd, Fortune Biotech Ltd., et. (Andhra Pradesh Biotechnology policy; 2001).

In Andhra Pradesh Agriculture Biotechnology will be given a thrust in districts of Gunter, Krishna, west Godavari and East Godavari using the facilities available at the Larm Farm in Günter District, Marutur Farm (for rice research) and Kovvur Research centre (fro vegetables, tubers, and bananas) in west Godavari district.

In Andhra Pradesh vision 2020 statement programme also identified the significance of biotechnology and it will be used to enhance production and productivity.

Plant tissue culture method in banana production

In this method explants are selected from disease free mat, after initial treatment, it is cultured under controlled conditions wherein it proliferates and roots within 8 weeks. Rooted plants are banded in three stages before planning in field. Sword sucker is the best source material. A healthy, free sucker of an elite mother plant is chosen after it is indexed for BBTV and BSV Virus by biological or molecular tests.

Mohammed Jaffar (2003) suggested that Banana propagation through tissue culture made popular in Theni District for its guaranteed increase in productivity.

Banana tissue culture technology in Andhra Pradesh

Plant Cell and Tissue technology will be used to develop horticulture in the State with a thrust on clonal propagation, disease elimination, gemrplasm exchange, gene transfer by wide hybridization, molecular genetically engineering, variant selection including some-clonal variation, initially, the new techniques will be applied to crops such as mango, banana, citrus and turmeric and to some ornamental crops.

Currently in Andhra Pradesh almost in all districts banana tissue culture products are under cultivation. They are Kadapa District in Rayalaseema Region and, Medak and Rangareddi Districts in Telangana Region and West Godavari District in Coastal Andhra Region are extensively cultivated as per known information.

Conventionally edible banana (Musa sp.) is propagated by suckers, since most of the cultivars are seedless. This propagation is seriously limited by its slow multiplication rate as well as clonal degradation/degeneration. Since virtually all of the edible clones are parthenoncarpic and for all practical purposes seedless or seed sterile, multiplication must be vegetative. Although in banana conventional method of vegetative propagation is having commercial acceptability, to ensure an extremely rapid rte of multiplication tissue culture technique has definite and indispensable advantage over the conventional method. This technique is independent of season due to controlled conditions and require limited quantity of plant tissue as the explants sources (Madhumita, Vijay Joshi: 1998).

According to Jacob George and Ravishanker (1996) Plant Tissue Culture products are estimated to have a potential market of 15 billion US dollars per year worldwide. As per Mohamed Jaffer's observation (2003) banana propagation through tissue culture, became popular in the 'Theni' District in Tamilnadu, for its guaranteed increase in productivity.

Micro-propagation through the tissue culture has acquired the commercial significance owing to uniformity in banana crops, earliness, freeness from diseases and high yield. In this method explants are selected from disease free mat, after initial treatment, it is cultured under controlled condition wherein it proliferates and root with 8 weeks. Rooted plants are banded in three stages before planting in field. Sword sucker is the best source material. A healthy, free sucker of a elite mother plant is chosen after it is indexed for BBTV (Banana Bunchy Top Virus) and BSV (Banana Sigatoka Virus) Virus by biological or molecular tests.

Advantages of Micro-propagated platelets are Pathogen free plant material such a fusarium wilt, banana bunchy top etc. more uniform in stature with high vigor, plantation comes for once over harvest, 20-30 per cent higher yields than conventional material. With drip irrigation and use of liquid fertilizer tissue culture, plants are becoming acceptable as expenditure on panting material is compensated in terms of better returns.

Of all the above-mentioned crops banana is the most widely produced plant cultivated through micropropagation. In India almost all PTC laboratories are concentrating on banana crop and producing large number of plantlets. In India, banana is grown on an area of nearly 2, 40,000 ha with an annual production of approximately 3.7 million tones. Conventionally, banana is propagated by vegetative means through suckers and the annual requirement was estimated to 400 million (Viswanthan: 1990).

Through tissue culture, disease-free cultures of selected high yielding mother clones are raised and multiplied for transfer to the field. The average yields of commonly grown varieties of banana were estimated to be 12-14 kg per plant. Where as tissue culture raised plantlets were reported to have given an average yield of 20-25 kg pr plant (Mehra: 1994). It is projected buy PTC laboratories that yield up to 30 kg per plant is possible with micro propagated banana plantlet cultivation. However, according to the literature circulated by the PTC laboratories and of horticultural experts, the package of practices of cultivation of micro propagated banana is significantly different from that of conventionally propagated ones.

Micropropagated plantlets are sensitive to weather in the initial stage of establishment and to water and nutrients in the later stages. Ensuring proper and timely irrigation and nutrients or fertilizers supply is an essential requirement in the cultivation of micro propagated banana plantlets in order to achieve the specified yields. Thus, a farmer who cultivates micropropagated banana must be aware of these prerequisites associated with cultivation practices. It may be observed that the green revolution technology encapsulated a battery of practices and techniques concerning irrigation, chemical fertilizer, pesticides, etc. Similar components are also required for the application of the PTC; in addition, awareness and economic resources are required for adoption of the PTC.

Presently there are no studies concerning; a) accessibility of micro propagated seed/ plantlets and b) background of farmers who are involved in the cultivation of Micropropagated plants. The available literature also does not indicate that there have been any attempts to study cultivation other micropropagated plants such as teak, coffee, etc.

In Andhra Pradesh, banana is a traditionally cultivated crop in all the regions. Farmers engaged in the cultivation of banana have been procuring the planting material i.e. suckers from nurserymen or fellow farmers. Earlier, there was no other alternative than conventionally propagated suckers to the farmers.

However, tissue culture laboratories, in recent times, have been offering suckers developed through micropropagation to the farmer. These laboratories claim that the micropropagated plants are superior in terms of quality and thus assured of higher yields. The laboratories also assist farmers in adopting the new package of practices associated with incorporated plantlets.

Perspective of the study

The present study, from the sociology of science perspective tries to examine a more comprehensive definition of technology that should see technology as hardware (artifacts) software (knowledge underlying construction of the artifacts), and orgware (social organization). Whenever a new technology is developed and deployed, it brings about: a) changes in the knowledge and practices of users; and b) new forms of social organizations are created or modifications to the existing social organization are made. This in turn brings about changes in social relations in the organization of production. In other words, technology thus becomes the source of social change.

Sociology of science is a specialty that examines how and to what extent various socio-cultural factors, both internal to the world of science and those external to the world of science, influence and shape the production of scientific knowledge and its application. The literature suggests that the earlier conception that science is autonomous having its own dynamics unconnected with the external forces is no longer sustainable. Today rather what we find is that both science and technology are influenced by a range of factors-social, economic, political, cultural, legal, ethical, institutional, ideological, and so on. As Bloor (1976) put it, 'all knowledge, including scientific knowledge, is socially caused'. Haribabu (1999) mentioned, 'the divide between the internal world of science and external world of science is not rigid but porous'. In other words science should be seen as embedded in society rather than as an autonomous activity.

In this context, the present study is an attempt to understand level of knowledge of farmers who adopted tissue culture in cultivating banana plants, their socio-economic background and their motivational factors behind the adoption of new technology in banana crop cultivation.

CHAPTER II

METHODOLOGY AND OBJECTIVES OF THE STUDY

2.1. Introduction

As discussed in the first chapter, the objective of the present study is to examine the socio-economic background of the farmers and the motivational factors behind the adoption of Plant Tissue Culture (PTC) knowledge in banana crop, within this framework an empirical study was conducted on the question of adoption of PTC knowledge of different social groups.

However, in order to understand changes it is imperative to know the conventional techniques of banana crop. Hence as stated earlier, a benchmark study of conventional cultivation of banana crop was carried out. This chapter deals with the methodology adopted in the selection of banana tissue culture farmers. At the end of the chapter definition of concepts employed in the study is given.

2.2 The objectives of the study are:

- To analyze the socio-economic background of the farmers who have been adopting the tissue culture based banana plants
- To understand the motivational factors underlying their adoption of the PTC based banana cultivation

The current chapter discusses the methodology adhered to in selection of the villages where the PTC banana crop is in cultivation. This chapter also covers the tools and techniques of data collection employed in the study. The chapter is broadly divided into two sections. The first section deals with the selection of field work methods and section two focuses on the concepts operationalised or employed in the study.

2.3. Selection of the field

In accordance with the objectives of the study and research design, I selected Kadapa district area where Tissue culture banana is being cultivated. The rationale behind selection of the Kadapa district is that Tissue Culture Banana is grown extensively. There were two Mandals i.e., Rajampeta and Pullampeta where tissue culture banana is extenstively cultivated. In Rajampeta mandal villages like Brahmnapally, Varadayyagaripally, Mittannagaripally, Katarupally, Isukapally, Hostavaram were tissue banana areas. In Pullampeta Mandal , villages were Bavikaripally ,Puttannavaripally, Anatha Samudram, Ramapuram, E.G.Pally were tissue banana cultivated areas.

2.4. Selection of tissue culture banana farmers

The major focus of the study is the tissue banana growers or adopters of Plant Tissue Technology for growing banana. Banana growing farmers who are using tissue culture technology are spread all over the state of Andhra Pradesh. However at the time of the study still there were farmers who use conventional methods/techniques of growing banana. Actually the farmers, who adopted tissue culture, were once practicing the conventional methods. Thus selection of them was to be carefully planned. Four major private tissue labs i.e., AG Biotech, Turlapati Biotech, Godrej Biovet, Sri Biotech labs, who sells tissue banana plants to farmers were contacted, only one private lab i.e., Godrej Biovet provided the list of representatives of farmers in three regions of Andhra Pradesh, other three private tissue labs refused and did not showed any interest in revealing the farmers list.

The Directorate of Horticulture, a State Government Department that promoted tissue culture technology in banana crop was also consulted to identify the farmers who adopted this plant tissue culture in banana crop. But they told me to consult the respective District Horticulture Officer. Assistant director of horticulture provided the list of adopters. One of the biggest problems was to select the farmers according to the size of landholding.

According to the Government, farmers who hold land 11acres and above are considered as large farmers, farmers who hold 6 to 10 acres of land are called as medium range farmers, farmers who holds between 2and 5 acres of land are called small farmers; and those who have below 2 acres are marginal farmers.

As the list was not available I approached the farmers on the basis of information provided by the representatives /agents of companies, I had to resort to snowball sampling

The total sample farmers interviewed were 75. The study conducted in the year of 2009. I made personal visits to the fields of farmers and also interacted with a cross section of people in the village. I interviewed banana growers, with the help of a semi-structured questionnaire.

The questionnaire contained questions related to the farmers socio-economic background, their banana plantation acres, motivational factors behind their tissue culture banana adoption, reasons for cultivating with tissue banana crop, sources of information, differences between conventional cultivation and tissue culture cultivation, and their problems they experienced in their cultivation.

The primary data were collected through personal interviews and semi-structured questionnaire. Observation method was also extensively used in the data collection. The data pertaining to socio-economic background, which includes their age, caste, their family type, their landholding size, awareness about Plant Tissue Culture technology, problems associated with Plant Tissue Culture were collected through personal interaction and informal talk with farmers, key informants, village leaders as well as officials of the Department of Horticulture, Government of Andhra Pradesh.

2. 5. Selection of the sample

The number of households in the sample is 75. The respondents for the present study were farmers who have been practicing conventional methods and recently had adopted the tissue culture technology for Banana cultivation in Kadapa. Data obtained from 75 respondents were analyzed. Table No.2.1. Provides details pertaining to the name of Mandals selected and the number of households covered.

Table No. 2.1 Selection of the sample

Name of the Mandals	Households	
	Frequency	Percentage
Pullampeta	25	33.3
Rajampeta	50	66.7
Total	75	100.0

The table no 2.1indicates that in Kadapa District 75 respondents covered in two Mandals i.e., Pullampeta and Rajampeta. The above study includes four categories of farmers like Large, Medium, Small farmers and marginal farmers.

Section-II

Profile of the Kadapa District

Geographically, Kadapa district is situated within 30-43 and 15-14 of Northern latitude and 79-29 and 79-55 of eastern longitude. The altitude varies from 259-378.7 meters above M.S.L. The natural boundaries are Kurnool on the North, Chittoor on the South, Anantapur on the West and Nellore and Prakasam on the East.

Kadapa district is said to be the heart of the Rayalaseema as it is centrally located and connected with 4 districts. Kadapa district continues to be one of the most backward districts in Rayalaseema area, with un-even, isolated rainfall in different parts of the district and with large dry tracts. Recurring drought is the common phenomenon in Kadapa district.

The total geographical area of the district is 15,359 sq. Kms. compromising of 958 Revenue villages of which 82 are un-inhabited. There are 51 mandals out of which only Kadapa and Proddatur are urban mandals. The Kadapa district covered by 3 Revenue divisions, 51 mandals, 834 Grama Panchayats, 958 Revenue Villages and 3706 hamlets.

Paddy, Groundnut, Redgram, Cotton are the major Agricultural crops during Kharif. Mango, Citrus, Banana, Melons, Papaya are the fruit crops grown in Kadapa district. Turmeric, Onion, Chillies, Vegetables and Chrysanthemum are other commercial crops grown in the district.

Population

Total population of the district is 2,573,481, among which male population is 1,303,160, female population is 1,270,321. Total literacy is 64.02 percent in which male literacy is 76.98%, female literacy is 50.76 percent, according to 2001 census.

Soils

The soils of the district have been classified into red ferruginous soil and black soil. These two classes can be subdivided into clay, loam, and sand with finer distinctions. Further the clay type can be subdivided into six subdivisions viz, black clay, black loam, black sand, red clay, red loam and red sand. Of these soils black clay is the most superior soil of the district, which occupies about 23.7% area of the district. Second to it comes in the order in the black loam which is an alluvial soil varying in colour and texture. It forms 18.2% of the soil of the district. The soil is not very deep and subject to erosion by the vankas (hill streams) in the mandals. Black sand is not of much importance.

Crops

Agriculture plays an important role in the economy of the district. More than 80% of the total rural workers forming 35.39% of total rural population are primarily depending upon agriculture. Generally crops like Paddy, Sajja, Jower, Ragi, Groundnut, kova, redgram etc., are raised, besides, commercial crops like, sugarcane, turmeric etc.,

Rainfall

The average annual rainfall in the district is 696.2 MM. The rainfall generally increases from North-West to the South-West in the district. The rainy season starts from June and lasts till September, which is the month with the highest rainfall.

Climate

The year may be divided into four seasons. From December to February is the dry and comparatively cool season. The summer season starts from March and lasts till May, which is the hottest month of the year. This is followed by the monsoon (south-west) from June to September while October and November constitutes the post monsoon or the retreating monsoon season.

Rivers

Kadapa district is drained by the Pennuru Basin and with its chief northern tributaries to penneru viz., the Kundru, Sagileru the southern tributaries- the Cheyyeru, Papagni, and the Chitravati. Pennuru river rises in the present Karnataka state and after passing through Anantapur district enters Kadapa district at the north Western Corner near Tallaparoddature in Kondapuram MPP. It joins river Chirtravati near Gundlur of the erstwhile Muddanur taluk. Further, Pennuer flows through the erstwhile Jummalamadugu taluk and cuts through the yerramalai hill ranges at the historic for of Gandikota. Kallamalivanka at Pottadurthi joins it. Near Kamalapuram, the river is joined by Papagni and a little further on by the Kunduru River and finally enters into the erstwhile taluk of Kadapa at Adinimayapalle where the anicut for diverting the water of this river into the K.C.Canal is constructed. The river flowing slightly eastwards touches the holy hill of Pushpagiri.

Mandals

Two mandals that were covered in the district for the present study are Rajampeta and Pullampeta. The villages that come under these mandals are Brahmnapally,Varadyyagaripally, Mittannagaripally, Katarupally, Isukapally, Hostavarm, Bavikaripally, Puttannvaripally, Anatha samudram,Ramapuram, and E.G.Pally.

Amenities

As far as amenities are concerned all the villages have primarily schools, health centers, child and women welfare centers, telegraphic and post facility etc., available. Main sources of drinking water are tube wells, open wells, and taps. Tanks and tube wells are the sources of irrigation. The approach to these villages is only road and mode of transport is bus.

CHAPTER – III

ADOPTION OF TISSUE BANANA CULTIVATION: A SOCIO-ECONOMIC PROFILE OF FARMERS

3.1. Introduction

As mentioned in previous chapter, data were collected from 75 respondents of 11 villages of two Mandals of Kadapa district. This chapter provides a profile of the tissue banana farmers' socio-economic status in terms of caste, class, size of land holdings, and motivational factors underlying the adoption of tissue culture technology in banana crop.

3.2 Age and sex distribution of respondents

Tissue culture technology tends to attract farmers cutting across the age with growing awareness among farming community through newspapers, horticulture department of the government and private tissue Labs. Farmers who adopted tissue culture are found across all age groups in the sample.

Table No 5.1 provides a brief distribution of respondents in different age groups who adopted tissue culture technology in banana crop in four districts.

Table No. 3.1 Age profiles of the respondents

Age group	Frequency	Percentage
35- 39	5	6.7
40-49	44	58.7
50+above	26	34.6
Total	75	100.0

Table No 3.1 indicates that almost 58.7% of the respondents fall in the age group of 40-49 years. The second largest proportion the adopters fall in the age group of 50 and above 50 (34.6%). The proportion of respondents in the category of 35-39 years is 6.7% and that is relatively less compared to respondents from other age group.

3.3. Gender

In the present study, in a sample of 75 adopters of Plant Tissue Culture technology, the majority were men; 72 (96%) while very few 3(4%) were women farmers. Table No.3.2 gives the distribution of gender among the respondents of this study.

Table No 3.2 Gender composition of the respondents

Gender	Frequency	Percentage
Male	72	96.0
Female	3	4.0
Total	75	100.0

3.4. Caste wise distribution of adopters

Indian society is a complex society, with diverse structural entities. It has a unique system of social stratification. People are stratified according to their social status. Caste affiliation determines the social status and class affiliation shapes the economic status. Caste as a structural phenomenon and may be viewed as a 'closed rank status group' as a cultural phenomenon it can be viewed as a 'set of values, beliefs and practices'.

Social status and economic status are not independent entities. They are interrelated. Caste is considered as one of the important variables in understanding the social structure of the Indian society since the social position (status) of a particular individual or social group varies according to his/ her caste origin. Caste status is an ascribed status. It accords a high status to a particular individual or social group by virtue of their birth in it. It also gives high status and prestige to a particular set of communities and denies the same to others on the basis of hierarchical relations between the purity and pollution of the occupations practiced by different caste groups.

Earlier on, caste as a corporate group was characterized by its ascribed status, hierarchy, commensality, endogamy etc., but in recent times it has changed its form like commensality, while still playing an important role. Class as mentioned above determines one's economic status and subsequently political power. Therefore, in Indian society class and caste affiliations cut across each other (Srinivas: 1955)

The concept of 'dominant Caste' introduced by M.N. Srinivas is particularly relevant in this context. In Srinivas's (1955) words, 'A caste is dominant when it is numerically the strongest in the village or local area and economically and politically exercises a preponderant influences'.

According to him, it need not be the highest caste in terms of traditional hierarchy. The fundamental criterion for any caste to become dominant would be land ownership, which would give them economic strength, and subsequently political strength. A dominant caste, which controls means of production, transforms itself into the dominant class.

The land ownership has also given rise to class differentiation in Indian rural scene. There has been a decade long debate on mode of production in Indian agriculture which has also identified the class categories and class relations in Indian agriculture (Thorner, 1982).

In this study classification was done on the basis of the respondent's perception of position of his/her caste in the hierarchy. For the purposes of the present study we followed the categorization of caste groups adopted by the Government of Andhra Pradesh in terms of OC (Other Castes), BC (Backward Castes), SC (Scheduled Castes), ST (Scheduled Tribe).

The specific caste groups included in upper castes or other castes or forward caste, BC, SC and ST are given below. The respondents included in the study were asked to indicate to which of the caste groups in terms of OC, BC, SC, ST, did he or she belong.

(i) OC includes the respondents hailing from upper casts namely Brahmin, Vaishya (Komati), Khsatriya, Kamma, Reddy, Kapu, Raju and Velma.

(ii) Backward Castes or Other backward Castes consist of Golla, Gouda, Chakali, Mangali, Mudiraju, Kamsali, and Kummari etc,.

(iii)SC includes Mala, Madiga Castes (Dalits) and

(iv)ST includes Lambadi, Yerukal and Koya come under ST category. The data collected on caste affiliation is presented in table No.3.2.

Table No 3.3 Caste profiles of respondents

Caste	Frequency	Percentage
OC	51	68.0
BC	10	13.3
SC	14	18.7
ST	0	0.0
Total	75	100.0

Table no.3.3 shows that 68% of Farmers who adopted tissue culture belonged to the Other Castes, 13.3% belonged to the Backward Castes, 18.7% belonged to SCs and there is no farmer who belonged to ST category among the adopters. Among 75 respondents, majority i.e. 41 of them belongs to Reddi community , next Kammas (10), followed by others.

3.5. Religion of the respondents

Religion is a universally recognized phenomenon, and almost all societies ranging from simple to complex societies practice religion in their day to-day lives. The primary concern of religion is to provide a code of conduct to social individuals or social groups through its basic tenets and preaching. As a part of the code of conduct religion assigns roles to men and women. Religious codes sometimes hamper adoption of new technology in addition to economic and social factors.

Table No 3.4 Religion profile of the respondents

Religion	Frequency	Percentage
Hindu	74	98.7
Muslim	1	1.3
Total	75	100.0

The data in table no 4.4 unfolds that proportion of respondents of Hindu religion is 98.7%, Muslims represents 1.3%. In the present study data on religious background of the adopters of tissue culture of banana cultivation was collected. Banana as a fruit has cultural significance in the life of many religions and social groups. Individuals and households greet each other with flowers and fruit on social occasions such as relatives visiting each other as part of gifts during occasion such as marriages. The fruit is offered to deities during worship. Banana carries a positive meaning in the Indian cultural milieu. That is why cultivation of banana is practiced without any reservations.

3.6. Class background of respondents and their material resources

The size of landholding indicates the economic class background of the adopters. As per the government classification, those who have land between 1 and 2.5 acres are called as marginal farmers, those who have between 2.6 and 5.0 acres small farmers; those who have between 5.1 and 10.0 acres medium farmers and those who have above 10 acres are big farmers.

Table No 3.5 Landholding profiles of respondents

Acres of Land	Frequency	Percentage
Less than 2.5 Acres	2	2.7
2.5 Acres to 5 Acres	18	24.0
6 to 10 Acres	30	40.0
10 and above	25	33.3
Total	75	100.0

Table No 3.5 describe that among the 75 adopters18 (24.0%) are small farmers; 30(40.0%) are medium farmers; 2(2.7%) are marginal farmers and 25(33.3%) are big farmers.

The size of landholding indicates the economic class background of the adopters. The assets or instruments of production like bullocks, bullock cart and tractor, tube wells and bore wells, submersible pumps and drip irrigation equipment etc., indicates the class background of the respondents in addition to the land they possessed.

Table No 3.6 Class background of respondents

Size of Landholdings	Frequency	Percentage
Marginal farmers (Less than 2.5 acres)	2	2.7
Small Farmers (2.5-5 acres)	18	24.0
Medium farmers (6 to 10 acres)	30	40.0
Large farmers (10 and above)	25	33.3
Total	75	**100.0**

Table No 3.6 shows that 18 (24.0%) of the respondents hold land less than 5 acres and they are small farmers, land owners who have 6 to 10 acres are Medium Farmers constitute 30(40.0%) of the respondents, and large farmers hold land 10 and above acres constituted 25(33.3%) of the respondents.

3.7. Education profile of the respondents

Education plays a vital factor in technology adoption in crop cultivation and associated practices. It increases awareness about technology and its related information. It also may help in formation of positive attitudes towards innovative technology. In the present study the respondents showed very high level of comprehension of the technology. They had extensive experience in conventional banana cultivation. The majority of respondents possessed extensive knowledge not only of various agricultural technologies, but also other national, current issues.

Their political awareness was so high that they influence power relations in rural areas in addition to the agricultural knowledge. Through their village leaders and representatives in the state legislature they influence the agricultural polices of the state government. Data on the educational background of the adopters was collected.

Table No 3.7 Education profiles of the respondents

Level of education	Frequency	Percentage
SSC	35	46.7
Intermediate	1	1.3
Degree	1	1.3
Illiterates	38	50.7
Total	75	**100.0**

Table No 3.7 shows that among 75 respondents, only 35 (46.6%) farmers were studied up to SSC, 1 (1.3)farmers had hade college level education ,1 (1.3%) had degree level education and 38 (50.7) were illiterates.

Table 3.8. Education level and caste background of the respondants

Caste	S.S.C	Inter'	Degree	Illiterates	Total
OC	26 51.0	1 2.0	1 2.0	23 45.1	51 100.0
BC	6 60.0	0 0.0	0 0.0	4 40.0	10 100.0
SC	3 7.1	0 0.0	0 0.0	11 78.6	14 100.0
Total	35 **46.6**	1 **1.3**	1 **1.3**	38 **50.7**	75 **100.0**

The above table No.3.8 indicates the respondants caste background with their educational level.Among the OC community there were 23(45%) were illiterates. 26(51%) had up to SSC level education. One person (2%) had Intermediate level education. One had (2%) Degree level. Among the Backward Caste Community majority i.e, 60% were educated upto SSC level. And only 4(40%) were illiterates. Among the SC community majority i.e.78.6% were illiterates and 7.1% studied up to SSC level of education.

3.8. Occupation profile of the respondents

One's occupation is an important factor that influences the adoption of tissue culture in banana crop cultivation. In the present study the occupations are classified broadly under three heads based on the respondents' answers. The table no.3.10 gives a description of the occupation of the tissue culture banana farmers.

Table No 3.9. Occupation wise distributions of respondents

Occupation	Frequency	Percentage
Agriculture	69	92.0
House wife	2	2.7
Non-Agriculture	3	4.0
Job	1	1.3
Total	75	100.0

Table No.3.9 shows that among 75 respondents, 69 (92%) respondents occupation was agriculture, 1 (1.3%) was Government Employee, rest of them belongs to House wife and Non-Agriculture sector.

Table No 3.10.Occupational Status of respondants with caste back ground

Caste	Agriculture	Non-agriculture	Job	House wife	Total
OC	50 98.0	0 0.0	0 0.0	1 2.0	51 100.0
BC	10 100.0	0 0.0	0 0.0	0 0.0	10 100.0
SC	9 64.3	3 21.4	1 7.1	1 7.1	14 100.0
Total	69 **92.0**	3 **4.0**	1 **1.3**	2 **2.7**	75 **100.0**

Table 3.10 indicates the respondants Occupational status with their caste back ground Among the OC community majority of the respondants had agriculture their occupation i.e. 98.0%. Among the back ward class community all of them doing Agriculture activity as their main occupation .Among the SC community 9(64.3) had Agriculture occupation and only 3(21.4) doing non agriculture.

3.9. Family of respondents

The family is the basic unit of society. Family is formed by the relatively durable companionship of husband, wife and their sex relationships. It is in the family that a human being learns language, the behavioral patterns and social norms. In some way or the other the family is a universal institution. It exists in tribal, rural and urban communities and among the followers of all religions and cultures.

In spite of the universal nature of the family one can see vast differences in its structure in different societies. In tribal and agrarian societies people of several generations live together. These societies have large and joint families. In the industrial society the family is limited to husband, wife and their children. Sociologists call it a 'nuclear family'.

Another type of family is joint family where many generations live together it is called as joint family. When a joint family consists of grandparents, parents and grandsons and daughters, it is called a lineal joint family. When married brothers along with their wives and offspring live together, it is known as lateral joint family (karve, Iravati; 1953). In this study it shows various types of family exist in rural agrarian society.

Table No 3.11 Composition of the households of the respondents

Type of Family	Frequency	Percentage
Nuclear Family	30	40.0
Joint Family	35	46.8
Lineal Joint Family	8	10.6
Lateral Joint Family	2	2.6
Total	75	**100.0**

Table No 3.11 shows that among 75 respondents, there are 35(46.8%) joint families, 30(40.0%) are nuclear families, 8(10.6%) are linear joint families, and 2(2.6%) are lateral joint family. It indicates that joint family dominates in land based rural society.

3.10. Relationship between caste and economic status

The joint family in agrarian society is preferred because of the need to protect property from getting divided into small unviable holdings and also the possibility of more family labour that can be employed in agriculture. In rural society, people are directly or indirectly dependent on agriculture in general and horticulture in particular. Caste plays a significant factor in social life as well as in economic sphere. Upper caste people hold large acres of land while people of the lower castes own either marginal land or work as landless laborers. In rural life, land ownership plays a dominant factor, as it gives economic strength, social status and subsequently political power.

Table No 3.12 Caste and economic status of the respondents

Economic Status	OC	BC	SC	Total
Marginal Farmers	0 (0.0)	0 (0.0)	2 (100.0)	2 (100.0)
Small Farmers	6 (33.3)	2 (11.1)	10 (55.5)	18 (100.0)
Medium Farmers	25 (83.3)	3 (10.0)	2 (6.7)	30 (100.0)
Big Farmers	20 (80.0)	5 (20.0)	0 (0.0)	25 (100.0)
Total	**51** (68.0)	**10** (13.3)	**14** (18.7)	**75** (100.0)

Table No. 3.12 indicates that land ownership plays a significant factor in deciding economic status, which is attached to the caste status.

In this study, 75 (68.0%) respondents belong to Other Castes (OC). It shows that among adopters of tissue culture banana cultivation, the OCs are in majority in rural society. Second is SC category14 (18.7%) and third is BC category 10(18.7%).

And this study also shows that among marginal farmers category there are only two respondants and they belongs to SC community. All BC (2) and SC (10) respondents are the small farmers. Among the upper caste respondents' small farmers are 6. There are thirty medium farmers category. Among 30 medium farmers 25 (83.3) belongs to OC community, 3 (10.0) are from back ward class community and 2(6.7) belongs to Schedule Caste community. Among the large farmers/big farmers majority i.e. 80.0% belongs to OC community, 5 farmers (20.0%) belongs to BC community. And there were no big farmers among the SC community.

3.11. Awareness about plant tissue culture technology among adopters

Plant tissue culture technology in Banana crop is new technology. It started from 1998 onwards, as per respondents' information, being a new technology in banana crop; farmers generally don't adopt it in their crops. And moreover farmers had very few chances to know about it. They come to know through Newspapers, Mass media, Private Lab people and knowledgeable farmers.

Table No 3.13 indicates that out of 75 respondents in the study 45(60.0%) respondents came to know about tissue culture banana technology through knowledgeable person in the village. It shows that communication is vital factor in rural area. In rural society, there is a network relation among the villagers of different classes. Though rural society is stratified in terms of caste and class, when it came to sharing of technical information and adoption of technology, farmers of these villages depended more on their fellow men than mass media i.e. news paper. 21(28%) respondents got awareness through Horticulture Department officials. And 6(8.1%) respondents got it through from PVT Labs. In rural areas, educated and enterprising farmers play the role of change agents by playing the role of pioneers in adopting tissue culture technology, others in the village tend to follow the pioneers.

Table No 3.13 Awareness among the respondents

Source of Information	Frequency	Percentage
Knowledgeable Person in the village (co-farmer and village leader)	45	60.0
Horticulture Department	21	28.0
Private Tissue Lab People	6	8.1
Sangam Farmers	3	3.9
Total	75	**100.0**

3.12. Reasons for adopting plant tissue culture technology in banana crop

Technology, be it agriculture technology or horticulture technology its adoption is influenced by motivation of the adopters. Farmers said that with traditional banana cultivation they used to face some limitations like lack of uniformity in crop, variations in plants, high incidence of diseases. To overcome these problems in banana crop, farmers adopted tissue culture technology in banana crop. Any new or innovative technology is not adopted without evaluating the advantages and disadvantage. Further new technologies also have an element of risk. Farmers should be able to either avoid risk or afford the risk. To this farmers should have high levels of motivation in adoption of the new technology. In this study an attempt was made to find out as to what factors influenced farmers in adopting tissue culture technique in banana crop. Table No.3.14 gives a brief analysis of their motivational factors.

The table No 3.14 shows the motivational factors of tissue banana culture farmers. In this study majority of the farmers i.e., 64.5 %(49) said that uniformity in crop ripening and harvesting had motivated in adopting tissue culture in banana crop across the farmers of all category. 27.6% (20) tissue banana farmers said that high yield factor motivated them. And four (5.30%) farmers viewed that profit motive is factor was behind their adoption of tissue banana cultivation. two farmers i.e.(2.6%) expressed that disease free or pest free factor motivated them to adopt these technology in banana crop.

Table No 3.14 Motivational factors of respondents

Motivational factors	Frequency	Percentage
High yield	20	27.6
Uniformity in Crop Ripening, Harvesting	49	64.5
Disease free or pest free	2	2.6
profitable	4	5.3
Total	**75**	**100.0**

Conventional cultivation of banana has limitations by its low rate of multiplications as well as clonal degradation/degeneration. Suckers generally may be infected with some pathogens and nematodes. Similarly due to the variation in age and size of sucker, crop is not uniform, harvesting is prolonged and management becomes difficult. Horticulture scientists argue that tissue culture technique has definite and indispensable advantage over the conventional method.

Horticulture department of the government and tissue culture laboratories that sell saplings claim that the plants are pest and disease- free plants. They have uniformity in growth and increases yield. Tissue culture plants are available throughout the year. And 95%-98% plants bear fruit bunches. The horticulture department and the private tissue culture labs transmit the above mentioned advantages of tissue culture to farmers through various mechanisms; posters, meeting with farmers in the village, T.V.etc. In other words, multiple factors influenced farmers in adopting tissue culture in banana crop cultivation, apart from yield

3. 13. Subsidy in tissue culture banana adoption

Government of Andhra Pradesh gives subsidy to banana tissue culture farmers or adopters. Department of Horticulture gives 50% subsidy to all farmers who have up to 2.5 acres or 1 hectare to buy saplings. Presently per plant rate is Rs; 9.00, and the subsidized price is Rs 4.50 per plant is a subsidy of 50 per cent. If farmers purchase plants from private tissue culture labs also they could get subsidy from Horticulture Department. Farmers by submitting the bills from the Private tissue lab to the department, farmers get 50% costs of the saplings/suckers reimbursed.

Horticulture Department would give some extra plants per 1hactre or 2.5 acres to adopters, to take care of wastage of plants. Local officers would visit the fields frequently to check the pits dugout in the field and to verify the field. And a local Horticulture officer sees that there is no other crop except banana crop in the field. No intercropping is allowed in tissue banana cultivation.

As per Horticulture Department sources, majority of middle-range and big Farmers would purchase the banana tissue culture plants from private companies and they would also get subsidy 50% from Horticulture Department Scheme, as mentioned above. They also added that if sufficient plants were not available in their Department, big and middle range farmers would purchase them from Private Tissue Culture Laboratory.

To summarize the analysis of the socio-economic profile of the banana tissue culture farmers reveals that caste, class, education, size of landholding, and awareness of tissue culture play important role in technology adoption. Most of the adopters of tissue culture technology in banana crop are drawn from upper caste, followed scheduled castes groups and backward castes. There is none from scheduled tribe community. The proportion of tissue culture banana adopters from backward communities and scheduled castes were insignificant in the study.

CHAPTER – IV

SUMMARY AND CONCLUSION

Agriculture is the predominant occupation of the majority population in rural India. Sustained agricultural growth continues to be the key to poverty alleviation and overall economic development. Agriculture accounts for about one-fourth of the gross domestic product and is the source of livelihood for nearly two-thirds of the population. The social, cultural, economic and political spheres of this population have been so intertwined with agriculture that every technological change in agriculture has had tremendous influence on these spheres. Hence, every improvement in technology that manipulates crop production has had tremendous impact on the society. Though humans began cultivating crops between ten and fifteen thousand years ago most of the technological innovations in agriculture have taken place within the past two hundred years. These include mechanization, scientific plant breeding, hybridization and use of fertilizers, chemical pesticides and herbicides.

While the invention of hoe, plough, Persian wheel transformed primitive agriculture the present day agriculture has been radically transformed by green revolution. The major watershed in the evolution of agriculture was the green revolution introduced during 1960's.

Historically farming communities have been selecting and sowing the seeds from plants with beneficial characters, such as higher yield, better nutrition and resistance to diseases and pests etc. The power of these practices was enhanced dramatically in the twentieth century by the breakthroughs achieved in basic science of genetics, leading eventually to modern hybrid seed varieties for important food crops such as maize and, by mid-century, to high yielding "Green Revolution" seed varieties for wheat and rice.

From the third world perspective the green revolution was the single factor that brought social change along with increased food production by ten fold increase in yields of main staple crops such as paddy and wheat (Altman, 1999). Because of green the revolution, agriculture has met the food needs of most of the world's population even as the population doubled during the past four decades.

David Tillman (1998) reasoned that although green revolution in Agriculture met the food needs of most of the world's population, it paved the way for contamination of groundwater's release of greenhouse gases, loss of crop genetic diversity and eutrophication of rivers, streams lakes and coastal marine ecosystems (contamination by organic and inorganic nutrients that cause oxygen depletion, spread of toxic species and changes in the structure of aquatic food webs). However, in a nutshell with green revolution, productivity reached a plateau, environmental hazards increased and raised social inequalities.

In the current context one technology that has the potential to shape the agriculture over coming decades is biotechnology. Biotechnology which is being projected as an alternative to green revolution technology seems to be offering remarkable production prospects in agriculture through its techniques like plant tissue culture, genetic engineering, etc.

Plant tissue culture is a collective term for micropropagation, protoplast, cell, tissue and organ cultures raised in a nutrient medium under controlled environment and aseptic conditions. Micropropragation is also an ideal method for production of disease-free plants.

Tissue culture techniques are now widely used for the production of disease-free plants, multiplication of vegatatively propagated plants and gemrplasm storage (Ahloowalia, 2000). The advances in micropropagation now allow routine regeneration of 15 major vegetables and some tropical root and tuber crops (e.g. cassava, yam, coco and sweet potato). Since 1970, multiplication of many fruit species like strawberry, raspberry, banana, papaya, pineapple, grapevine, and rootstocks of peach, apple pear, plum, cherry and apricot has become a routine operation based on micropropagation. The technology is also used for production of disease-free mother-stock cultures, which are then used as a source of conventional cuttings.

Tissue culture, as mentioned above is the technique of growing cells, tissues and organs in an artificially prepared nutrient medium static or liquid, under aseptic conditions. In plant tissue culture technique a piece of plant (called 'explant'), which can be any thing from a piece of stem, root, leaf or bud to a single cell, is placed in a test tube. In an environment free from microorganisms and in the presence of a balanced diet of chemicals, the explants can produce plantlets that, in turn, will multiply indefinitely, if given proper care.

Micropropragation is an important alternative to more conventional methods of plant propagation. It involves production of plants from very small plants part (e.g. buds, nodes, leaf segments, root segments etc), grown aseptically (free from any micro-organism) in a container where the environment and nutrition can be controlled. The resulting plants genetically identical to parent plants.

Plant tissue culture technology has introduced a new phase into plant multiplication. it is being increasingly utilized many fruit plants including banana. Plant tissue culture has been proved to be the most successful because of large-scale propagation, of elite clones from specific parent plant; large number of plantlets can be obtained in very little time and in a small space, starting from a single plant. And moreover disease-free, or virus-free state. According to the farmers it is high-tech banana cultivation.

The present study focuses on the banana growers in Kadapa district who adopted tissue culture technology in banana crop cultivation. The objectives of the study are to Analyzing the socio-economic background of adopters who have been growing plant tissue culture banana plants and their motivational factors behind the adoption.

To explore the above objectives as mentioned above, Kadapa district was selected for the study area. The sample for the present study is drawn from the farmers who are growing tissue culture banana crop in their field.

The major focus of the study is the tissue culture banana growers or tissue culture technology adopters in banana crop cultivation. Banana growing farmers who are using tissue culture technology than conventional cultivation methods are spread all over Kadapa district. Identification of tissue culture banana farmers was a big difficult thing. Assistant Director of Horticulture and Godrej Biovet provided a list of representatives of the tissue culture farmers in this district. They provided the names of the representatives of tissue banana farmers in two Mandals of Kadapa district. One of biggest problem was to select the farmers according to their land size or landholding. It means the classification of farmers into Large farmers (who holds the land 11 and above acres), Middle Range farmers (6 to 10 acres holder) and Small farmers who holds the land between 2 to 5 acres of land, and below 2 acres are considered as Marginal farmers according to Government. Locating the banana tissue culture farmers according to their size of land was a major difficult; through extensive contacts with farmers, village leaders, knowledgeable farmers it was possible to locate them. As the list was not available I approached the farmers on the basis of information provided by the representatives /agents of companies, I had to resort to snowball sampling.

Total 75 tissue culture farmers were interviewed. The techniques of questionnaire, interview guide, and personal observation methods were used extensively to collect the data. Statistical Package for Social Sciences (SPSS) was used for statistical analysis of the data.

A critical survey of sociological literature in the earlier section of this report indicate that a more comprehensive definition of technology should seen technology as hardware (artifacts) software (knowledge underlying construction of the artifacts), and orgware (social organization).

In this context, the present study is an attempt to understand level of knowledge of farmers who adopted tissue culture in cultivating banana plants, new practices associated with tissue culture, new forms of social organization or modification in the existing form of social organization of production and relations among those involved in production, and changes in attitudes and values among the farmers using tissue culture. Conventionally, banana is cultivated by suckers or off shoot, which form underground rhizome at the base of main psudostem and the rhizome, they are seedless. It is also called traditional method or control method. This propagation is seriously limited by its slow multiplication rates as well as diseases and clonal degradation/degeneration. And with traditional suckers, it was not uniform in crop and low yield was observed because suckers are from different mother plants having a low yield level.

In Andhra Pradesh, banana is a traditionally cultivated crop in all the regions. Farmers engaged in the cultivation of banana have been procuring the planting material i.e. suckers from nurserymen or fellow farmers. Earlier, there was no other alternative than conventionally propagated suckers to the farmers. However, tissue culture laboratories, in recent times, have been offering suckers developed through micropropagation to the farmers. These laboratories claim that the micro-propagated plants are superior in terms of quality and thus assured of higher yields. The laboratories also assist farmers in adopting the new package of practices associated with incorporated plantlets.

The basic objectives of the study are to analyze the socio-economic background of farmers who have been adopting the PTC based banana plants, and motivational factors underlying their adoption of the PTC based banana cultivation.

Major Findings

The socio-economic profile of the tissue culture banana farmers reveals that nearly 68% of the farmers belong to upper caste background followed by Scheduled Castes with 18.7% and Backward Castes 13.3% and there were no farmer which belongs to Scheduled Tribe category. The social and economic status of the banana tissue culture farmers were related in the sense that, majority of the forward /higher castes possessed larger land holdings. It indicates that in rural society, which is based on land economy; social system is related to economic differentiation by clearly indicating that social inequalities as well as economic inequalities have been prevailing in rural society.

The study describes the gender composition of respondents. It is found that 96% are male and 4% are female farmers. In rural society male farmers' domination prevails in adopting new technology. In terms of religious background the majority of the farmers were Hindus (98.7%) followed by Muslims (1.3%).

The present study also describes the composition of the household to understand the family system of the tissue culture banana farmers. The family is the basic institutions of the society. Family is formed by the relatively durable social relations between husband, wife and their children and other dependents. In tribal and agrarian societies people of several generations live together. These societies have large and joint families. In the industrial society, the family is limited to husband, wife and their children. Sociologists call it a 'nuclear family'.

Another type of family is joint family where many generations live together it is called as joint family. When a joint family consists of grandparents, parents and grandsons and daughters, it is called a lineal joint family. When married brothers along with their wives and offspring live together, it is known as lateral joint family (karve, Iravati; 1953). In this study it shows various types of family exists in rural agrarian society.

The majority of the adopters of tissue culture technology in the study belonged to joint family (46.7%) followed by nuclear family (40%); Lateral Joint Family with (2.6%) and Linear joint Family (10.6%). It indicates that joint family in agrarian society is preferred because of the need to protect property from getting divided into small unviable holdings and also the possibility of more family labour that can be employed in agriculture.

Education plays a vital role in technology adoption in crop cultivation and associated practices. It increases awareness about technology, credit, marketing etc., In this study the majority of the farmers had nil education i.e., 50.7%, followed by SSC level education (46.60%), 1.3% had college level education and 1.3& had degree level education. It is observed that education increased awareness about the technology. Those who had reasonable levels of education could comprehend technological practices in a better way than others. Thus, the technical element in terms of technological knowledge and the social element, i.e., the educational status of the adopters were found to have a positive relationship.

The major findings of study are that the following factors influenced the adoption of plant tissue culture technology in banana crop; uniformity in crop, uniformity in flowering, fruiting, harvesting leading to total uniformity in crop pattern thus saves time and pest free/disease free. Thus multiple factors influenced adopters like uniformity in crop, pest free/disease free, remunerative price, consumer demand for tissue banana and subsidy from the Government etc.,

This present study also examined sources of information that created awareness among the farmers about tissue banana cultivation technology. The majority of the farmers indicated that they came to know about tissue technology in banana crop through knowledgeable farmers followed by the officials of the horticulture department of the government of Andhra Pradesh and the personnel of the private commercial tissue culture laboratories that produce tissue cultured banana plantlets and sangam farmers.

Communication played a vital role among farmers in rural society. While formal communication came into existence as part of network relations between adopters and promoters, the informal channel came into being among the adopters. Though newspaper is one of the channels of verbal communication is found to more effective among the adopters. In this study, the majority of the adopters of tissue culture banana also received information about banana tissue culture technology from knowledgeable farmers, the co-farmers and village leaders. Though stratification of the society in terms of caste and class was seen in rural society when it came to sharing of technical information and adoption of new technology, farmers of the villages, depended more on their fellow men than mass media, i.e., Newspaper.

This present study also examines the motivations underlying the adoption of tissue banana crop cultivation among adopters. It is found that the reasons given by the adopters for adopting banana tissue technology were: higher profitability of tissue culture banana technology compared to traditional banana crop cultivation, pest-free or virus-free nature of tissue culture banana that minimized risks, subsidy from the government, and uniformity in crop cutting, uniformity in harvest, and flowering etc.,

It is observed in this study that political affiliation of the adopters helps in getting access to information, credit sources and in initiating organized efforts in spreading technology to other farmers. It is observed that, a minority of the adopters who had political power played major role in disseminating tissue culture banana knowledge. And they also influenced other farmers in disseminating knowledge among other farmers. These minority of the adopters also built a network relation with other individuals and institutions for gaining access to technical know-how, credit, subsidies, saplings and fertilizers.

Overall large farmers were very quick in adopting any newly introduced technology in agriculture or horticulture.

It is observed that there is a great extension gap between farmers and Research laboratory and Government extension officers or local horticultural officers. Farmers felt that need to be solved thoroughly by taking farmers opinion on field itself.

Farmers felt happy over extension services done by private tissue lab (Godrej Biovet) but are unhappy over Government for not providing and even not competing in services providing with private labs.

The study has indicated that technology adoption is influenced by social, cultural and economic factors. Technology in turn influences the social, cultural and economic spheres in a society. Further in the case of agricultural technology interaction between farmers on the one hand and technology developers, government institutions, credit institutions and the market are very important for successful outcomes of technology adoption.

Limitation of the study

There is a limitation to the study in terms of the sample framework. As the list was not available, I approached the farmers on the basis of information provided by the representatives /agents of the tissue culture companies. I had to resort to snowball sampling.

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