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THE JAIN IRRIGATION SYSTEMS

**Fuelling Rural Economic Prosperity and
Ecological Sustainability**



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MUMBAI**

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SUMMARY

Jain Irrigation Systems is a unique innovation in sustainable development where the belief that progress of humankind impacts and in turn is impacted by the environment. This understanding is firmly reflected through JISL's diversified product portfolios and the way they engage with their stakeholders. In an effort to keep the technology affordable and accessible to small and marginal farmers, JISL has evolved a medium- to long-term strategy that benefits the customers in product prices, specially to underprivileged sections of the society but seldom increases the pricing burden on the same group of people. This amply demonstrates the place small and marginal farmers have in the company's strategy for business growth over the years.

In the country, JISL provides direct employment to about 8000 persons at different levels and indirect employment to about 10 times higher in the form of contractors, transporters, dealers and persons employed by them for marketing and services of JAIN products.

A large section of large, medium and small farmers have substantially improved productivity of their lands and labour, created employment for landless families, and helped increase wage level. The villages with higher density of micro irrigation, there have been reverse migration – slow down employment related out migration and accelerate return migration of persons from landed and landless families. The overall nutritional status of women and children improved; fertility declined below replacement level fertility; and aspirations of parents towards their children's education improved.

Jain Irrigation Systems is a classic story of an endeavour that has substantially transformed rural lives and livelihoods, enhancing productivity of land, water and labour, and conserving water, energy and broader ecosystem. As the technology for renewable energy gets cheaper, decentralised power generation to address the problems of power availability will become widespread. Jain Irrigation Systems offers holistic approach enhancing sustainable livelihoods and economic prosperity, and ecological regeneration.

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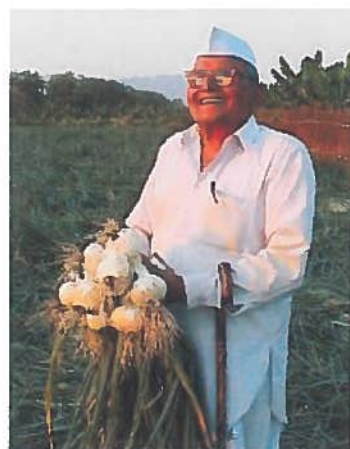
Agriculture is the backbone of the Indian Economy. While the size of the Indian population is expanding—1.2 billion in March 2011—the arable land area is decreasing due to increasing demand for housing and industrial requirements and decreasing water availability for agricultural use. Hence, the need to increase the productivity of different crops for the food security of the nation and nutrition security of the people by adopting modern agricultural practices that conserve water. India's 1st Green Revolution was ushered in by expanding irrigation capacity (mostly flood irrigation), usage of hybrid seeds and increased application of fertilisers.

Flood irrigation did increase the yield initially, but over the years led to serious consequences for the farmers, and thereby the nation. Over irrigation or excess use of water resulted in increase in salinity of the soil. This, in turn, led to reduction in crop yield as the crops were not able to extract sufficient water, resulting in a water stress for a significant period of time.

Against the backdrop of the rapid decline in the irrigation-water potential and low water-use efficiency in the conventional method of flood irrigation, drip and sprinkler irrigation, or micro irrigation systems (MIS), in general, have been introduced recently in Indian agriculture. In order to popularise the MIS, the central and state governments are providing subsidies to farmers who install MIS in their agricultural fields. This subsidy can range from 50 to 75 percent or even higher. These types of problems can be tackled by judicious use of the available water and by adopting innovative irrigation systems such as drip and sprinkler irrigation. These modern irrigation methods are adopted to ensure maximum yield with better quality of the produce and thereby contributing to the food security of the nation.

Drip irrigation is sometimes called trickle irrigation and involves dripping of water onto the soil at very low rates (2-20 litres per hour depending on the type of crop) from a system of small diameter plastic pipes fitted with outlets called emitters or drippers. With drip irrigation, application of water is more frequent (usually every 1-3 days) than with other methods and this provides a favourable and very high uniform moisture level in the soil in which plants can have a healthy growth.

Revolution in micro irrigation technology began in the country by Shri Bhavarlal Jain, who pioneered water management in agriculture through micro irrigation system in the early 1980s. The very first industrial business Shri Jain started was of Papain IP in 1978. The process used indigenous raw materials (latex of Papaya) with imported equipment and technology and the final product of highly refined Papain IP, a 100 % export-oriented product. In this venture, the objective was to produce from indigenous raw material a value added world class product that had demand world over. Later, Shri Jain diversified the business to include PVC pipes and sheets, poly ethylene pipes, drip and sprinkler sets, tissue culture plantlets, green houses, processing of fruits and vegetables, solar energy products and many more under the Jain Irrigation Systems Limited (JISL) with headquarters in Jalgaon, Maharashtra. Thus, JISL has been working for the agriculture development in India and world over for the past four decades with an objective to enhance farm productivity that helps to make agriculture a sustainable business.



Shri Bhavarlal H. Jain is known by the affectionate title 'Bhau', which means 'Brother' in Marathi. Usually the respectful suffix 'Saheb' (Sir) is attached to the term 'Bhau' whenever an elderly person is addressed, calling him 'Bhausahab' — in deference to his age and stature. However, people of all ages and strata continue to address Shri Jain simply as 'Bhau' without the deferential suffix. This is a clear indication of the sheer love and affection people feel for him, whatever be their age, profession, caste or creed. The Irrigation Association of USA bestowed the Crawford Reid Memorial award on him in 1997 for his "significant achievements in promoting proper irrigation techniques in fostering major advancements in the industry outside USA." The first and only Indian to be honoured so. The President of India conferred on him the title of 'Padma Shri' in 2008.

Four words characterise him — Land, Labour, Laboratory and Library. And his outstanding work.

Agricultural

- Pioneering and building leading institutions in the field of Sustainable Agriculture (including Bio-tech, Tissue-culture Planting Materials and Bio-organic Farm Inputs), Agricultural Research & Development, Demonstration, Teaching and Training.
- Enabling Agricultural & Horticultural cultivation including Field Crops, Agro-forestry Plants and High-yielding Seeds through owned, leased and contract farming.
- Pioneering micro-irrigation in India on a very large scale for small farm holdings; as a consequence, the micro irrigation is taking strong roots in the country and elsewhere in the world.
- Facilitating greening of wastelands through rain-water harvesting, soil conservation and watershed planning & development on a large scale.
- Adding value and improving the productivity of water, land and other farm inputs.
- Enabling prosperity of farming community and alleviating poverty on a sustained basis by adoption of appropriate Rural Technologies: PVC Pipes, Drip Irrigation, Tissue Culture, Bio-Gas, Solar Heating & Lighting Systems.

Industrial

- Raising world-class fruit & vegetable processing facilities dedicated to value addition through exports.
- Promoting and practicing large scale use of Plastic Polymers in agriculture (including Pressure, Casing & Screen Piping for water conveyance and Micro & Sprinkler Irrigation Systems for water distribution.)
- Conserving forest wealth by developing wood-substitute plastic sheets for domestic and export markets.
- Harnessing Solar Energy for environmental-friendly, green energy for hot water & lighting. A combination of micro-irrigation facilitated by solar energy is transforming lives of the rural communities.
- Demonstrating large scale models of Bio-energy from recycled agricultural and food processing waste.
- Continuous Innovation in agricultural and food processing technologies to make lives of the small farmers and farm workers better.

Social

- Encouraging, supporting and nurturing individuals, communities and institutes through holistic social and human development – sustained investment in health, sports, culture and education.
- Enabling holistic development of five villages, in Jalgaon district.
- Demonstrating world class school with emphasis on Indian cultural heritage, inter-dependence and entrepreneurial abilities; and quality education for children from economically underprivileged homes.
- Honouring the life and vision of Mahatma Gandhi through establishment of a memorial that serves to inform and educate children and people on creating economically self-reliant, socially equitable and prosperous villages.

A brief glimpse of about the various inter-connected innovations to enhance productive of agriculture and prosperity of rural communities is given below.

(i) Drip and Sprinkler Irrigation Systems

JISL introduced drip and sprinklers to Indian agriculture through their integrated system approach which includes indigenisation of drip and sprinklers to suit India's small farmers and varied climatic conditions, together with, service support for products, strong agronomic product to farmers and system demonstration through field research and development. In drip irrigation applications, drip systems carry a precise and on-demand quantity of water and fertilisers through a network of pipes and emitting devices to the roots of each plant helping to reduce water requirements and enhance crop yield. When it comes to sprinkler irrigation, it is a method of applying irrigated water in a manner similar to rainfall.

Water is distributed through a system of pipes, usually by pumping, and then sprayed on to the air, saturating the ground with small water drops. Sprinklers can provide efficient coverage for both small and large areas and are suitable for a wide range of crops and irrigable soils since they are available in a wide range of discharge capacities. Some of the proven advantages of the drip and sprinkler systems are saving of irrigation water, saving of energy for pumping, efficient fertiliser and chemical application, improved pest and disease control, reduced labour costs due to significant reduction in weed growth, maintaining soil health, enhanced crop yield, improved quality of the produce and in difficult land terrain, and has proved to be ideal for marginal lands and inferior quality waters.

The seeds of change were introduced by JISL in the 1980s for the second green revolution in India. While the first green revolution contributed to degradation of soil due to the excess dependence on water and chemical fertilisers, the second revolution contributed to the conservation of soil, water and environment. This technology has changed the lives of not only large farmers but also many small and marginal farmers in rural India and it has demonstrated the potential to transform the whole of rural India.



In the state of Maharashtra alone, the company covered a total of 36.5 thousand hectares of land under drip irrigation by 2006-07 and the area progressively increased to 180 thousand hectares by 2010-11. Broadly, JISL has achieved about fifty percent increase in drip irrigation products per year during the recent period. Under sprinkler irrigation also, in Maharashtra, the company covered a total of 17.3 thousand hectares of land in 2006-07 it increased to 91.5 thousand hectares in 2010-11 (Source: Jain Irrigation Systems Limited statistics). The micro irrigation movement is spreading to other States in the country with demonstrated success in Maharashtra.

(ii) PVC Pipes

In the 1980's JISL ventured into manufacturing of PVC pipes under the brand name *JAINPIPE* and started supplying the product to farmers in Maharashtra, Madhya Pradesh, Gujarat and Karnataka. Soon, due to sustained demonstration of good quality, the brand was established as a reliable one with premium valuations. The PVC pipes were the precursors to the drip irrigation system. It can even be fair to say that drip irrigation would not be possible without PVC pipes. Before the popularisation of PVC pipes, farmers practiced furrow irrigation i.e. water was directed from the source to the field through small channels dug in the land itself. So, it goes without saying that such irrigation led to high wastage of water through seepage and evaporation. There were also several problems created by stagnation of water in the furrows. Water borne diseases like cholera spread through these furrows. These furrows also became breeding grounds for mosquitoes. Furrow irrigation also needed a lot of labour input causing all of the family members including children to work on the fields. This led to their education being neglected.

After furrow irrigation came the age of cast iron (CI) and ductile iron (DI) pipes. But metal pipes were so expensive that not everyone could afford them. Also it got rusted over a period of time. It was only with the advent of PVC pipes, together with its cost reduced to a third of the cost of CI and DI pipes, large to small and marginal farmers stopped the practice of furrow irrigation and shifted to PVC pipes. With PVC pipes installed, the water wastage was reduced by 50%. This means that farmers earlier used to pump double the water than that they needed with PVC pipes. The carbon footprints left by PVC

pipes are much less than any other forms of water transmission. Thus PVC pipe is a classic case of saving non-renewable energy using non-renewable by recyclable product. Another benefit is that whereas canal irrigation can irrigate land below the reservoir and not above it, PVC pipes can take water to both the areas.

(iii) Tissue Culture

In the early 1990's JISL conducted an extensive survey to select a crop beneficial to propagate through tissue culture before entering into this venture. Tissue culture is a technology of propagating plant cell/organ or tissues on an artificial nutritive growth medium under controlled condition to propagate complete plant which is true to their mother plant.

The technology offers round the year propagation since the activity is carried out under controlled condition. The significance of this technology is that a large number of plantlets can be produced in a small space within a limited time period. The produced progeny is genetically pure and true to their mother plant and is free from diseases. The company has selected banana as a crop from horticulture group for propagation through tissue culture considering the demand and scope for its improvement. The tissue culture laboratory of JISL is the biggest for banana in the world, nestled in the largest banana belt of the country (48000 ha), Jalgaon, and is also known as the Banana Bowl of India. Only three talukas of the district i.e. Raver, Bhusawal and Yawal constitute 72 percent of the banana cultivated area of the state accounting for a major share in the total production of India. Currently JISL currently is the only enterprise in India producing over 30 million plants of Grand Nain variety of banana per annum.



In other crops, it propagates sugarcane, potato, onion, pomegranate, ginger and turmeric. While onion and pomegranate are propagated on commercial scale, sweet orange, guava are under research. JISL sells tissue cultured plantlets in Maharashtra, Gujarat, Karnataka, Madhya Pradesh, Andhra Pradesh, Tamil Nadu, Chhattisgarh, Manipur, Assam and Nagaland.

The significance of the tissue culture plantlets is that the plantlets are disease free (and not disease resistant), ensures uniform growth, genetic uniformity and produces early and high yield. Thus JISL supplies disease free plantlets to farmers ensuring them a higher and early yield and these changes the lives of farmers with a higher income at every harvest. The company has sold more than 6 million tissue culture banana plantlets in the year 2006-07 and it has grown to 15 million in the year 2010-11 (from JISL statistics). Correspondingly, the tissue culture banana has assured the country a contribution of 4 lakh MT per year to the food security of the nation.

(iv) Jain Food Processing

JISL manufactures dehydrated onion, vegetable products and aseptic fruit purees, concentrates, clarified juices, and frozen products of finest quality, and market them internationally under their brand name *FarmFresh*. It has the most controlled modern, world class fruit processing facility at Jalgaon in Maharashtra, Baroda in Gujarat and Chitoor in Andhra Pradesh. It process selected varieties of banana, guava, mango, pomegranate, amla and tomatoes that are brought either through the contract farming system of the company or directly from open markets. These value addition and assurance of prices incline the farmers towards initial investment and modernisation of their agriculture practices. Large MNC's like Coca-Cola, Nestle, and others purchase the fruit purees, pulps and concentrates from JISL which maintains world class standards in quality and hygiene.

(v) Contract Farming

JISL has started a state of the art onion and vegetable dehydration plant in Jalgaon in 1994. It is a 100% export oriented unit. It has food



processing units elsewhere in the country as well. The JISL has forged relationships with farmers to feed the food processing factory through a unique and rewarding contract farming arrangement with more than 3000 farmers. Through the contract, the company provided high yielding onion seeds, MIS equipments, and agronomy advice and buyback arrangement with minimum support price or market price whichever is higher. JISL is said to be the first organisation to introduce altogether a new and improved (high TSS & pungency) white onion variety. This enabled the farmers to take 2 crops in one year. The company purchased about 85 thousand tons of white onion in 2010-11 from its contract farmers in order to process it into dehydrated powder and export it.

The company procures onion and fruits not only from the contract farmers but also from the open markets for processing in its food plants. The company buys mostly Alphonso, Totapuri and Kesar mangoes mostly from Chittoor district in Andhra Pradesh where the farmers are trained under the Jain good agriculture practice norms (JAINGAP). Under the program the farmers are given information regarding micro irrigation, fertigation and harvesting fruits at the most appropriate time. Area covered under JAINGAP mango farmers is about 3700 acres. As a result of fair practice & transparency, growers supply their mangoes to the Jain fruit processing plants in Chittoor. The company also buys tomatoes, amla and guava from both the farmers and the open markets as per their requirements. The company has processed a total of 1.2 million tonnes of various fruits valued at Rs. 2.13 billion rupees in the year 2010-11 alone. All the foods processed are exported to other countries thereby contributing a good amount of foreign exchange to the country.

(vi) Renewable Energy

Fossil fuel based economic development is proving to be unsustainable and the consequences in the form of climate change are real. The rational choice is to move towards harnessing renewable energy sources. JISL has shown two ways to explore the abundantly available renewable energy and to overcome the scarcity of electricity in remote areas. As part of its environment-friendly projects, JISL has diversified into solar and bio-energy activity profiles. In India about 52 per cent of the total electricity is generated using fossil fuel (coal). Indian agriculture consumes about 30 per cent of its total electricity. However farmers are facing acute shortage of electricity and are unable to run their pumps for the required duration to fulfil the irrigation requirements. This results in rotational irrigation with the rotation period ranges anywhere from a few days to a few weeks. Due to prolonged rotational periods, plants/crops do not get water as per the required seasonal requirements. As a result the growth of crops suffers and yield reduces. In order to get over this problem, JISL recommended the use of solar pumping systems to its farmers. The idea is to couple solar pump with drip irrigation system. In such a case, the farmer is not dependent on grid-power for irrigation.

Under the inadequate and intermittent grid power situation, the solar pumping system with drip irrigation can be a better combination for maintaining a favourable soil moisture condition for the proper growth of the plants. The solar power generation is expected to pick up as the initial cost is expected to reduce with innovations in technology.

JISL also manufactures Solar lanterns, Solar power systems and Solar street lights which of course help in remote areas to overcome the darkness, and Solar water heating system which can also be used in case of hard water. There is also evacuated tube technology for the same purpose.

As a result of the food processing, a large quantity of organic agro waste like fruit peels, rotten fruits, discarded puff purees is generated at the Jain Food Processing facility that has led the company to set up a Bio Methanation plant. The plant is generating 1.7MW gross power (through 2 x 834 KW, GE Jenbacher make engines) which is grid interactive captive consumption purpose. Not only the plant converts the biomass wastes into energy but also it replaces the use of fossil fuels that would have been used for power generation in the absence of the Plant. This plant currently ensures treatment of nearly 200 tons of organic fruit wastes which is otherwise a serious concern to be addressed. Another waste management practice at Jain Food Park is composting and vermi-composting of solid waste. However, in order to utilise the calorific value of the waste, the company has decided to go in for the Bio Methanation of the organic waste. As fruit processing plant is seasonal based Press Mud Cake (PMC, filter press waste from sugar industry) is utilised to fulfil raw material demand and the power generated by the Plant replaces at least partly the power consumed from the State power grid.



There is significant scope to expand the innovations in renewal energy generation to improve life condition of the rural people as the future is in creation of decentralised energy generation for local use.

(vii) Jain Green Houses

In conventional Agronomical practices, the crops are grown (cultivated) in the open field under natural conditions where the crops are more susceptible to sudden changes in climate such as sunshine, temperature, wind, rainfall and snowfall and further affected by human, animal, birds and insects. Green Houses are just like large houses with walls and roofs



made of transparent materials wherein crops are grown under artificially controlled environment and other conditions viz. temperature, humidity, light intensity, photo period, ventilation, soil media, disease control, irrigation, fertigation and other agronomical practices throughout the season irrespective of the natural conditions outside. Jain Green Houses are built of GI structures that have a variety of applications, the majority being, off-season growing of vegetables, floriculture, planting material acclimatisation, fruit crop growing for export market and plant breeding and varieties improvement. Jain Green Houses are available in different sizes and constructed as per customer requirement. The sizes vary from as small as 100 Sq. M to 10,000 Sq M and even more. The degree of sophistication also varies from a simple polyhouse with polythene sheet covering to a highly sophisticated, fully automated systems with

Poly carbonate sheet roofing (double walled), PAR lightings, boom irrigation, rolling benches and full scale computerised (fully automated) systems. Thus the Jain green houses are highly efficient and they increase the yield 5 to 15 times and they can even be used for the production of roses, carnation, cut-flowers, plant propagation, raising of seedlings, primary and secondary hardening of tissue cultured plants and production of rare plants, orchids/herbs and medicinal plants.

(viii) Village Rejuvenation Efforts

The JISL is committed to the betterment of the society through their Gandhi Research Foundation (GRF) which houses the collection of all Gandhian books, documents, photographs, films, speeches and artefacts in printed as well as in electronic/digital formats. The GPF offers Gandhian studies through formal (by conducting diploma, degree and doctoral as well as post doctoral courses) and informal (camps, seminars, padyatras, etc. channels of education) activities. It also works towards the promotion of Gandhian constructive action programmes through rain-water harvesting, collection, storage and efficient distribution, use of renewable energy, measures for women empowerment, vocational education, Panchayat Raj, and other employment generation and entrepreneurship development programmes. Gandhi Research Foundation has adopted six villages from its neighbourhood for rural development work including educational, health, village development and sanitation works.

The JISL has established Schools and Colleges and of them a few notable institutions are: (1) **Wakod**, the birth village of the founder, has been particularly fortunate in that it has been the nerve centre of many charity initiatives. A **higher secondary school** at Wakod is a paramount example. It is a co-educational school with over 1100 students. (2) **"Anubhuti"** is a co-educational, residential, English medium school affiliated to the Council for the Indian School Certificate (CISC) and following the ICSE syllabus. The school commenced operation in July 2007 and by March 2011 it presented its first batch of students for the Class 10 exam and recorded 100% first class with 88% distinction. In the academic year 2011-12, Class 11 is being added. At present it has a student strength of 250. It maintains a teacher student ratio of 1:8. It is a not-for-profit school and generous scholarships are awarded to deserving students. (3) **"Anubhuti" (2)** is scheduled to open in July 2011. It is for children from economically underprivileged homes, to be run on a free of cost basis. It primarily works with the surplus generated by the "Anubhuti" residential school. Admissions will be on merit basis. (4) At Chandwad, Nasik district, Sow. Kantabai Bhavarlal Jain College of Engineering and the Hiralal Hastimal Jain Brothers Polytechnic are doing yeomen service to the region. Also it runs a few primary schools.

Training programmes are offered to agricultural officers of State Government/Banks and farmers of other states/countries. New associates are given orientation programmes and existing ones are given refresher courses. JHAI has been recognised as a research centre by many universities in India and abroad. Jain Research and Development Laboratory at Jain Hills is an internationally comparable lab accredited by NABL and recognised by the Department of Science and Technology,

Government of India. It undertakes intensive high end basic research in order to develop new varieties of horticultural crops and improve on the existing ones.

JISL as Multinational Company

The JISL has grown into a multi-national company with manufacturing and/or business establishments in different states within India and present in the United States of America, the United Kingdom, Switzerland, Israel and many Asian and African countries. JISL is a major agri-business company internationally and the most significant player in India with "One stop shop" for various agri-products and also for exporting PVC pipes and sheets, drip irrigation sets, sprinkler, tissue culture saplings, green houses, solar products, processed foods and dehydrated vegetables. All products are having ISI and ISO standards certificate which make it easy to compete in the world market. The JISL had a turnover of Rs. 518 crores in 2010-2011 from their exports (from JISL statistics). JISL is the largest exporter of Drip/Micro Irrigation components and systems in India. In addition to micro irrigation systems they have developed Plastic Sheets, Knobs, Windows & Doors, valves and other products for exports. Brand building has been a part of the company's overall strategy. "EX-CEL" brand of Plastic Sheets & "JAINS, INDIA" brand of Drip /Micro Irrigation Systems & components from JAINS, Jalgaon, India has place of its own in the European, African, Asian and US Markets. Presently JISL is exporting to more than 105 countries in 6 continents. With acquisitions in many countries the JISL is now serving the farmers not only in India but also worldwide. There would be but a few Organisations in the field of Agriculture like JISL which have developed such a deep understanding and respect for the relationship between land, water, soil, crop and above all, environment. Jain Irrigation has an enviable track record for developing sustainable solutions for farmers by way of technology transfer and makes them prosperous.

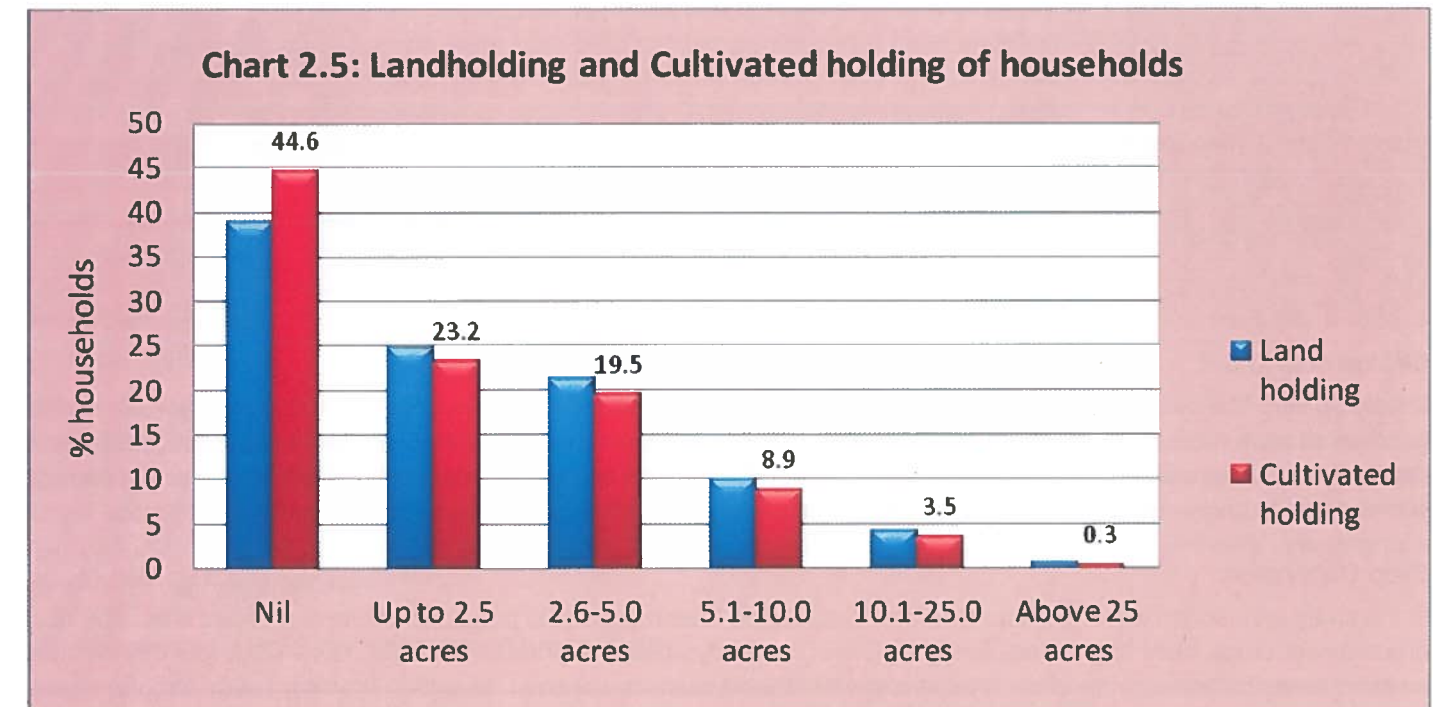
Impact of Micro Irrigation and Other Business Processes on Rural Communities

Landholding Pattern

In the study population nearly 40 percent of the households were landless and another 5 percent possessed land but not cultivated it. In total 55 percent of the households were farmer households. Further in the study population 23 percent of the households cultivated only up to 2.5 acres of land (called marginal farmers), 20 percent of the households cultivated more than 2.5 acres but up to 5 acres of land (called small farmers), another 9 percent of the households cultivated more than 5 acres but up to 10 acres of land (called semi-medium farmers), and only 4 percent of the households cultivated more than 10 acres of land (called medium/large farmers). Large farmers with more than 25 acres of cultivated holding were very few, below 1 percent. Among the farmers, 42 percent were marginal farmers, 35 percent were small farmers, 16 percent were semi-medium farmers and only 7 percent were medium/large farmers.

Non-formers were as high as 61 percent among SC/STs but only 43 percent among OBC/SBC and just 30 percent among the general category. The average cultivated holding was 4.4 acres per cultivated holding household (farmer) and it increased from 3.0 acres for rain-fed cultivated farmer, 4.6 acres per flood irrigated farmer and 7.1 acres per drip/sprinkler irrigated farmer. The proportion of cultivated land that was irrigated was 53 percent and that drip/sprinkler irrigated was just 14 percent. Similarly the proportion of irrigated land that was drip/sprinkler irrigated was only 27 percent.

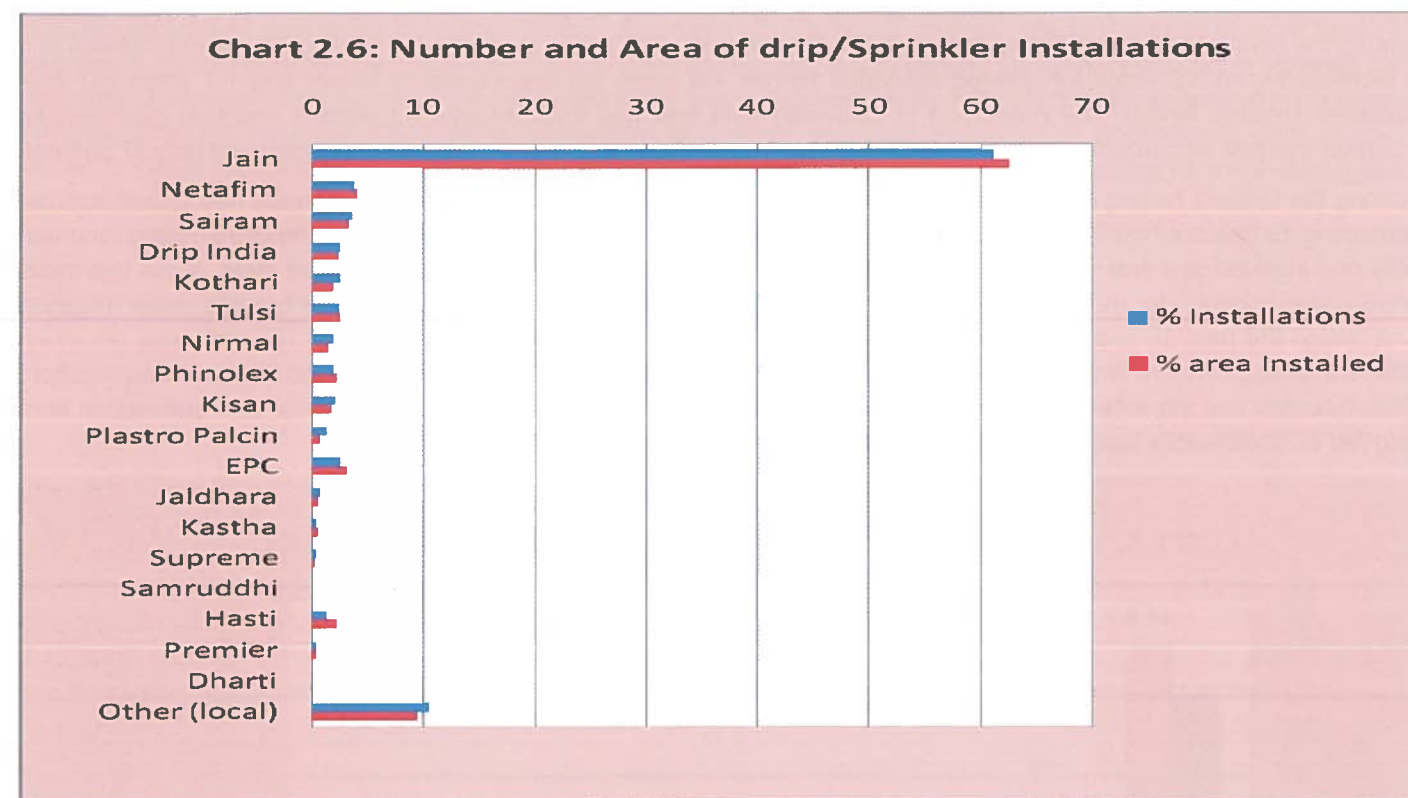
Among the farmers having irrigated land, 56 percent had only one irrigated plot, another 27 percent had 2 plots and the remaining 18 percent had 3 or more plots. However more than 87 percent of marginal farmers having irrigated land had only one irrigated plot and it was 78 percent among small farmers. Among the currently irrigated plots, about two-thirds were under irrigation for more than 20 years but at the same time 28 percent of the plots were brought under irrigation only within the past 10 years. The proportion of plots brought under irrigation within the past 10 years was not much different among different farmer categories and the current type of cultivation as flood irrigation and drip/sprinkler irrigation. This indicates that the recent popularity of drip/sprinkler irrigation has not brought any substantial land conversion from rain-fed or uncultivable land into irrigation or drip/sprinkler irrigation.



Regarding source of water for these plots, it was predominantly open well (80 percent) and in another 13 percent of the plots, bore well was used. The proportion of plots that depended on canal, river/stream, lake/pond and canal/river lifting was only a few, each 1 to 3 percent only. The pattern did not differ much by type of irrigation and farmer category. In most of the plots (93 percent) electric pump was used to lift water from the source (often well) and just 2 percent of the plots depended on oil pump or solar system or animal driven system to lift water, while in others it was direct flow into the field.

Drip and Sprinkler Installations

Across all the nine study districts in Maharashtra it was found that drip sets supplied by JAIN were the predominant micro irrigation system adopted by the farmers. The factors guiding the choice of drip/sprinkler brand were availability, quality, affordability and popularity. More than 50 percent of the currently active drip/sprinkler sets were installed during the past 2 years, that is since 2009 and in terms of land area it accounted for 45 percent of the drip installed area. For the drip sets installed since January 2009, the cost of drip reported by the farmers worked out to Rs. 22,200 per acre. About 66 percent drip customers reportedly received subsidy and the subsidy amount worked out to Rs. 10,400 per acre of drip installation.

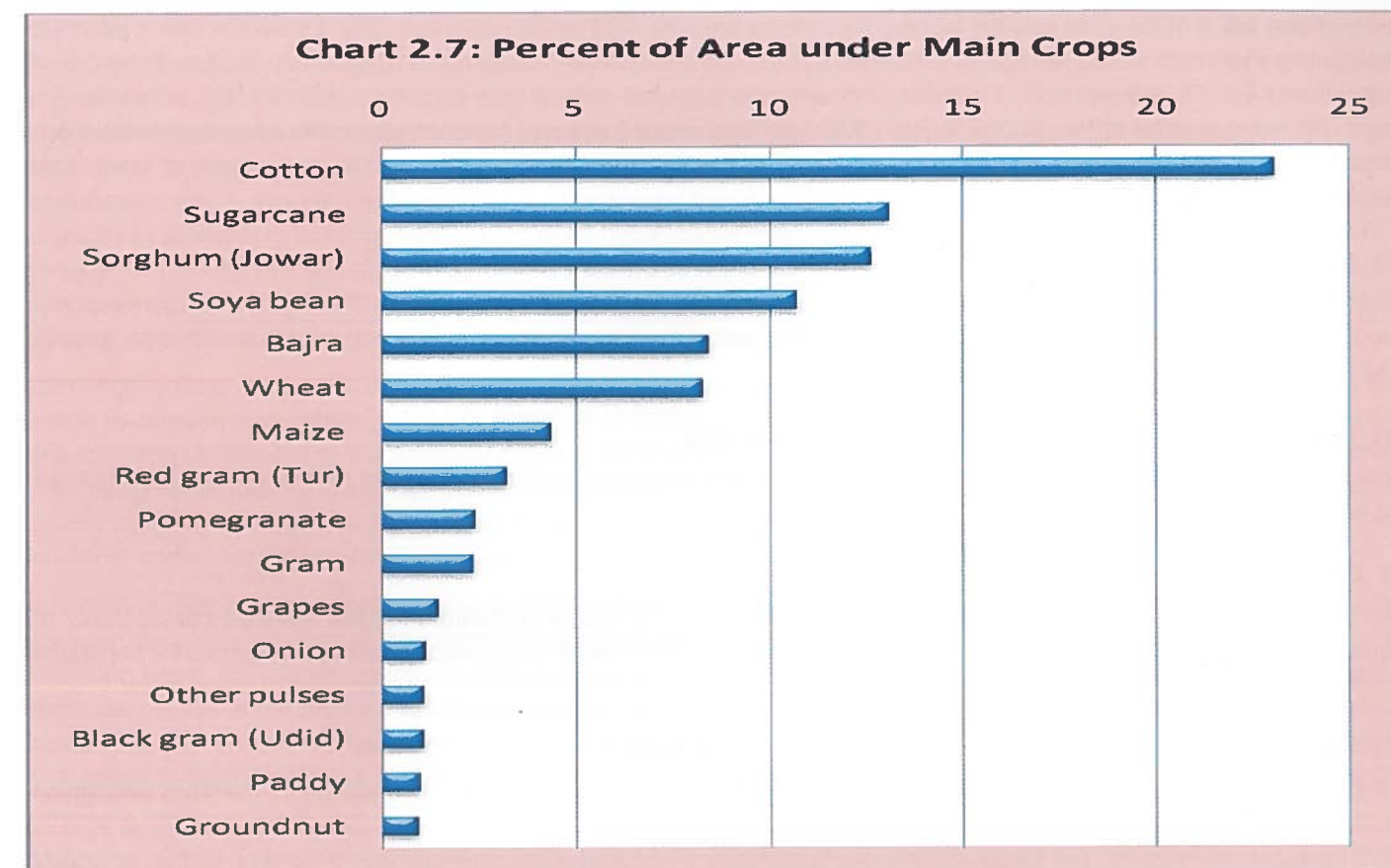


Choice of Drip Set

Nearly 90% of the farmers who installed Jain drip sets reported that the quality of Jain drip set was better. The other factors that were more in favour of Jain drip sets were: recommended by other farmers, popular in the area and after sale service. The farmers expressed that they did not enter into any annual maintenance contract with the drip company or with the dealer and it appears that annual maintenance contract is not in practice.

Crop Cultivation

In the study area cotton was the predominant crop cultivated in as much as 23 percent of the total cropped area. The next predominant crops were sugarcane, sorghum (jowar) and soya bean, each accounted for 11 to 13 percent of the total cropped area. Two other crops namely bajra and wheat were cultivated each in more than 8 percent of the cropped area. Further a long list of crops was reportedly cultivated each in a small proportion of the total land area. Most of these crops were raised during kharif season except for wheat and gram. However, onion, ground nut to a great extent and jowar, select vegetables and maize to some extent were cultivated in kharif and rabi seasons. Summer crops were rarely raised by the farmers.



Type of Cultivation

With regard to type of cultivation, grapes, pomegranate and banana were cultivated predominantly under drip irrigation, while sugarcane, wheat and onion were cultivated predominantly under flood irrigation. At the same time green gram (mung), black gram (uridid), paddy, red gram (tur), sorghum (jowar), bajra and soya bean were cultivated predominantly under rain-fed cultivation. With respect to cotton, nearly 50 percent of the area was rain-fed, 34 percent of area was under flood irrigation and just 12 percent of area was under drip irrigation. As far as sugarcane is concerned, it was 88 percent of the area was under flood irrigation and just 12 percent of the areas was under drip irrigation. With regard to seeds, only banana plantlets were obtained from Jain and that too in respect of 25 percent of the banana crops. Otherwise much of the seeds were obtained from open market or from outlets like APMC and Agro-centres.

Outcomes

(i) Crop Yield

The overall average yield per acre of cotton was 6.7 quintals and it was just 4.9 quintals under rain-fed cultivation, 6.9 quintals under flood irrigation and 10.7 quintals under drip irrigation. Maximum yield reported was 33.3 quintals per acre and was under drip irrigation. Similarly for sugarcane the overall average yield per acre was 36.8 tons and it was 36.2 tons under flood irrigation and 41.0 tons under drip irrigation. At the same time the maximum yield reported was 90 tons under flood irrigation and 100 tons under drip irrigation. This was the case with respect to all crops – that is drip irrigation resulted in high yield per acre.

(ii) Expenses on Raising Crops and Value of Yield

Grape and banana crops required larger expenditure - around Rs. 35,000 per acre - followed by vegetables, sugarcane, tomato and pomegranate - Rs. 20,000 per acre. Most of these crops were raised under drip or flood irrigation. On the other hand most of the food crops incurred lesser expenditure ranging from Rs. 3,000 to Rs. 6,000 but often these crops were raised under rain-fed cultivation. With respect to cotton the expenses were Rs. 13,400 under drip irrigation, around Rs 10,000 under sprinkler or flood irrigation and Rs. 7,600 under rain-fed cultivation.

The average value of the yield was the highest for banana amounting to more than a lakh (Rs. 1,02,300) rupees per acre. Though the expenses were the highest for banana crops, its net income (value minus expenses) was the highest of all crops, it was Rs. 69,300 per acre. The next crop with very high net income was sugarcane (Rs. 43,800 per acre). The crops with a net income of Rs. 10,000 to Rs. 20,000 per acre were fruits and nuts, tomato, cotton, pomegranate, onion, grapes, vegetables/spices and groundnut (in order, high to low income). On the other hand the net income of most of the food crops was only Rs. 3,000 to Rs. 5,000 per acre.

(iii) Considerable Water Saving

All drip irrigated farmers experienced reduction in water requirements by 25 to 50 percent. Though the farmers reported a reduction in electricity consumption, the reduction was not to the extent of the reduction reported in water requirements, may be due to the pressure required for the drip set.

(iv) Considerable Reduction in Pest and use of Pesticides

Most farmers experienced considerable reduction in pest and diseases, and the number of rounds of pest application in the field due to the adoption of drip irrigation.

(v) Employment Creation

With respect to labour for tilling, there that was no change in the labour requirements, but reduced considerably for weeding and fertiliser application. At the same time a large majority of farmers reported an increase in labour for harvesting mainly due to the increase in yield. Overall, drip irrigation created more employment and enhanced wage level.

(vi) Sharp Decline in Fertility – Below Replacement Level Fertility

The crude birth rate (CBR) per 1000 population per year for the reference period 2006-2010 was 18 for the study population. A CBR of 18 in the study population is an indication of low fertility. The crude birth rate was substantially higher at 20.5 for SC/STs and much lower at 15.9 for the general caste category. The total fertility rate (number of life-time births per woman based on current fertility pattern) was 2 and it means that on average one woman bears two children in her life time. In other words, a couple (2 persons) retire from reproductive life leaving behind two persons to take up the role of reproduction, which is also called replacement fertility. The infant mortality rate worked out to 23.25 with a sex-ratio of births 827 (females per 1000 males births).

Overall, more than 80 percent of the reference period births had occurred in health institutions such as government hospitals, private hospitals, community health centres and primary health centres and only 19 percent of the births had occurred in homes. Among the institutional births, 54 percent had occurred in government institutions and the remaining 46 percent had occurred in private institutions. The institutional births were relatively more among the general caste category but the proportion of births in government institutions was almost equally high among SC/STs (40 percent) as that among OBC/SBC and general category (46 percent). According to the respondents, more than 95 percent of the births were registered. Overall, 44 percent of the births were first order births and another 36 percent were second order births, put together, more than 80 percent of the births were first or second order births. On the other hand, just 6 percent of the births were 4th and higher order births. It confirms the pattern of low CBR and TFR observed.

(vii) Improvement in Nutritional status of Children, Adolescents and Women

Overall, among children of age 2-4 (24-59 months), with the WHO standard, about 32 percent of male children and 27 percent of female children were *underweight*, 33 percent of males and 29 percent of females were *stunted* and 25 percent of males and 19 percent of females were *wasted*. Further 23 percent of males and 19 percent of females were *thin* and 16 percent of males and 8 percent of females was MUAC-for-age Z score below -2SD. The extent of children underweight, stunting and thinness had not shown any systematic pattern of increase or decrease with age and also the pattern was different for male and female children. In general, under-nutrition among children in the study area was substantial but considerably less compared to other areas. Micro irrigation and level of increase in level of income seem to make difference to nutritional status. With increase in adoption of micro irrigation, the change is expected to be quicker and substantial.

Among the ever married women age 20-44, about 24 percent were classified as energy deficient and 3 percent were considered as severe energy deficient. However proportion of EMWs with overweight was estimated at 10 percent. There were no large differences in the pattern by background characteristics of the women.

Prosperity Facilitated by Drip and Sprinkler Irrigation

A common benefit of drip irrigation expressed by the farmers across all districts was that despite load shedding they could irrigate their crops uniformly and almost daily. Drip irrigation also made it possible for the farmers to grow certain cash crops like strawberries in Satara, pomegranates in Solapur and grapes in Nashik, which cannot be grown without drip. A case study in Satara with a strawberry farmer revealed that drip irrigation had facilitated the growing of good quality strawberries which was sent to Mumbai and other places that fetched them higher income. Another contribution of micro irrigation in strawberry farming is that, it involved huge labour during harvesting season and therefore many people get employment during this season and sometimes the wage rates goes up from 100 to 250 rupees a day. In Satara district people go to the nearby Panchgani and Mahabaleshwar for working in strawberry farms, which showed that people in the villages were also ready to move from their hometown in order to get employment and to get higher wages.

Drip irrigation had also substantially increased and sometimes even multiplied the yield of crops, especially banana and cotton in Jalgaon and grapes in Nashik. Farmers in Hirapur village of Parola taluka in Jalgaon district experienced that drip irrigation contributed to the uniform growth of banana and there had been very fewer diseases seen in banana crops after using tissue culture plantlets. Some of the tissue culture banana farmers also said that they went for Jain tissue culture plantlets because the company itself was monitoring the growth of the crops and again their drips sets were also available and accessible within the village.

In Vidarbha region which faces delayed rainfalls, wheat, cotton and soya bean are often sown in advance and sprinklers are used in the germination of the seeds during which period the requirement of water is less. And, by the time when the monsoon starts the seeds germinate into plantlets and are ready to grow with the monsoon rain. The case studies conducted in this area revealed that the farmers felt that drip irrigation had solved, at least partly, their problems of labour availability, especially for large farmers, because of the fact that drip irrigation minimises weeding, and fertigation makes it possible to apply fertilisers to the entire area of crops evenly through drip irrigation. This, together with water and electricity savings, made drip irrigation the most effective and efficient irrigation method for many farmers.

JAIN drip sets came in a wide range of products and prices; it became affordable to many farmers. Hence marginal, small and large farmers across rural areas had mushroomed for adopting JAIN drip sets. Where the dealer himself subtracted the subsidy amount from the total cost of the drip set the farmers were able to get subsidy. Otherwise, it would have been a nightmare for them if they had to claim it from the government department directly. According to a few farmers the government took longer time to sanction subsidy to individual farmers and they preferred to go through the dealers as they had links within the government department and so they could get it done faster.

Majority of the farmers did not need any training as they were mostly well aware of the installation techniques as they have observed it in neighbouring farms or they have attended some farmers meeting in their neighbourhood where they were already introduced to drip installation and its maintenance techniques. Most of farmers also were technically more sound especially in Jalgaon and Nashik districts where drip penetration was very high. When it comes to Vidharbha region farmers were very comfortable using sprinkler method of irrigation and they installed it whenever they wanted and sometimes they even gave it to other farmers on rent and help them installed in their farms especially during delayed monsoon etc.

JAIN has a wide network of service outlets (dealers) and extension service personnel provided information, education and services for drip irrigation through campaigns, short duration orientation trainings, individual contacts, and the like. There were instances of farmers complaining of inadequate services mostly due to the sheer volume of drip sets supplied by the Jain Irrigation System

In Nashik and Solapur districts, drip irrigating farmers reported that they brought more land under drip irrigation and also invested in livestock mainly in cows for milk as the latter again is a source of income to the family. On the other hand, an opinion that came from a drip irrigating farmer in Gondhanapur village of Buldana district was that agriculture, even with micro irrigation, was manageable only if it was supplemented with a fixed income from another source. Such subsidiary income sources help the farmers face the intermittent risks which are inevitable in agriculture. In Ahmednagar district, the farmers mainly invested renovating their houses or extending their land under drip irrigation. Very few farmers reportedly bought tractors but many bought two wheelers. A handful of farmers reported to have bought harvester after getting a good yield and they also said that they will give the harvester on rent as it is in huge demand.

In Satara and Vidarbha regions, farmers mostly invested their profits back in agriculture. Although not everybody could afford drip, farmers in Vidarbha region invested in at least one sprinkler set.

Transformation of Agriculture in Jalgaon District: An Insight to Achieve Food Security

The farmers generally felt that they could get more yield due to drip irrigation, and much more with tissue culture plants and contract farming. Farmers with even one acre of land has adopted drip irrigation for cotton crop and practiced all modern techniques like fertigation and he got an average of 22-25 quintals per acre. Due to the adoption of a combination of these methods their income has multiplied and they could construct better houses, have modern goods in their homes, could possess two-wheelers and four-wheelers, increase out-door activities and entertainments, better educate their children, and also buy more and more land for increasing their profitability. Improvements in agriculture enabled farmers to diversify income sources – establishing dealership for fertilisers and other equipments needed for farming. As such for many farmers it is not only the farming specifically drip farming that has made them prosper but also the side-business (or additional activities) that have contributed substantially to their prosperity.

The farmers also revealed that they provided higher education to their children whoever had shown more interest in it. All farmers said that one of their sons often whoever was weak in studies looked after agriculture and others became engineers, doctors and the like and employed or practicing elsewhere. Nonetheless, drip irrigation has made a revolution in many villages towards increasing agricultural productivity, giving more income, adapting modern agricultural techniques and contributed to social changes for the individual families. Many villages have village cooperatives that give loan to farmers at nil or low interest rates that have motivated them to install drips, cultivate commercial crops and earn more income like the ones the team witnessed in Jarandi and Girodha villages. These village cooperatives also ensured that the farmer is not taxed with the burden of selling his produce in distressed and some cooperatives pool the yields, locate a buyer and then sell the produce for good price. For example, in some villages, the cooperative executives said that most of the bananas are sold to buyers from Delhi who come here with trucks and loads huge quantities of banana and sell it at the *sabji mandai* there. In general the village cooperatives encouraged farmers to take up agriculture as a profession and ensured maximum income for them.

Social Equity and Justice

It is felt that marginal and small farmers around Jalgaon could have probably never experienced such prosperity but for the intervention of drip, tissue culture and contract farming of the JAIN model. Since these farmers have taken to multiple crops, they have also provided gainful employment to many hands in addition to their own. This employment generation is yet another social benefit from the introduction of the modern agriculture technologies such as drip, tissue culture and contract farming. Drip irrigation ensures more work for labourers at high wage rates throughout the year. The multi cropping pattern also mitigates the adverse effect of climate change and vagaries of nature. The Drip irrigated crop can sustain even during draught like situation. This ensures income security even for marginal and small farmers. In effect drip irrigation does help reduce the inequalities, and bridges the wide disparity gap of income between the large and small farmers.