

Investigating Agricultural Problems in India with Recommended ICT Based Solutions

Vivek Parashar, Bharat Mishra

Abstract: India is a land of farmers with 68.84 percent of the total population of the country living in about six lakh villages. Agriculture is the key to economic development. Agriculture contributes 17 percent of total GDP which provides employment to 60 percent of people. Indian population is growing rapidly with 1.2 percent per annum and become 1.5 billion by 2030. According to global hunger index, we stand at 103 positions in the world. To feed such a large population our current agricultural model needs some refinement. We need to devise ways and methods to overcome these issues faced by agriculture. In this paper, we are going to discuss various agricultural problems with suggested social and technological solutions.

Index Terms: Agriculture, IOT, Precision farming, ICT .

I. INTRODUCTION

Increasing population and decreasing resources are the biggest problems we are facing in India which goes deepens in the time to come. If we have not adopted the proper measures to overcome these problems, there will be a huge scarcity of food and agriculture-related products in our country. According to worldometers [1] Indian population is about 17.74% of the total world population which means every sixth person in the world is an Indian. The population density is almost 455 per Km². Approximately 70% of the total population of India are residing in villages. According to the report published by the government of India in September 2015, we have about 195 million hectares of total gross cropped area out of which only 141 million hectares are the net sown area. India is a rainfed country where agriculture is mainly dependent on rain out of total sown area only 65.3 million hectares is the net irrigation area. So, there is a huge gap between the land available and the amount of land we are using for cultivation. We must increase the land uses and find out the ways to increase the production to overcome the shortage of food grains in India in future. According to economic times, the total production of food grains in 2017-18 is about 277.49 million tones which are about 0.9% higher than the 2016-17 production[2]. It is expected that 343 million tons of food grains are required by 2020 only.

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India holds 103 position on hunger index in the world[3]. The gap of demand and supply of food grains will increase in time to come due to lower output by land and the increasing population this may deepen due to climate change. In the next sections of the paper, we will discuss various issues related to agriculture and the ways to overcome those issues

II. SMALL PARTITIONED LAND AREAS

In India there is a huge gap between the net sown area which is 141 million hectares in comparison to total gross crop area which is about 195 million hectares. There are five types of landholding in India based on the size of land.

- Marginal land holdings: Size 1 hectare or less
- Small land holdings: 1 to 2 hectares size
- Semi-medium land holdings: 2 to 4 hectares size
- Medium land holdings: 4 to 10 hectares size
- Large land holdings: Above 10 hectares size

This problem excavates when this holding of land will further be divided into small and scattered farmlands. According to census 1990-91, the marginal land holding is about 59.7% while in 2000-2001, it is about 62.1%. According to census 2011 about 67% of the landholding is marginal land holding and 18% of land holding is small land holding, while semi-medium is about 14.3 and large land holding is only about 0.7%. The problem of small and fragmented holdings is worse in states having dense population and are intensively cultivated like Kerala, Bihar, West Bengal and eastern part of Uttar Pradesh. These states have an average size of land holdings less than 1 hectare and in certain parts, it is less than even 0.5 hectare. The Nagaland has the largest land holding followed by Punjab and Rajasthan. States like Haryana, Maharashtra, Gujarat, Punjab, Madhya Pradesh and Karnataka having a high percentage of the net sown area and having land holding size above the national average. The reason behind this problem is the law we have in our country in which the land of a father is equally fragmented into equal parts due to which it keeps on fragmenting. The land holding of marginal farmers are about 51% and large farmers is about 3.9% in 1970-71. In census 2010-11 the marginal farmers land holdings increased to 67% while the land holdings by large farmers are reduced to 0.7% . This shows that the land is getting fragmented day by day. The ill effect of this fragmentation can lead to lower productivity because the land is getting wasted in making partitions.

It is difficult to irrigate such lands, taking resources to such lands need more investment and time. In order to overcome this issue, we enforce consolidation of land, so those small farmlands can be combined. There are few states who have implemented the land consolidation act, Madhya Pradesh is the first state who implemented it in 1923, Maharashtra in 1947, Punjab in 1948 and Utter Pradesh in 1953 after that almost all states have land consolidation act with some or other modification[4]. In 2004 almost 1500 Lakh Hectare land was taken for consolidation, Utter Pradesh and Punjab were among the top. The other solution is corporate farming in which the farmer will make a pool of lands with the help of some company and will share the resources to maximize the profit.

III. AVAILABILITY OF GOOD QUALITY SEEDS

A seed is the first and most important item required to get good a yield. Availability of good quality of seeds is one of the biggest hurdles in getting higher and quality produce because the cost of good quality seeds is higher and small and marginal farmers cannot afford it. According to the national initiative for information on quality seeds 15% to 20% production is based on the quality of seed only which can be increased up to 45%, In order to overcome the issues related to the variety and quality of seed government of India have established National seed cooperation in 1963 and state seed corporation in 1969. In order to further strengthen the research in seed development, the government has established, Indian Institute of Seed Science under ICAR. The government has launched a national seed project in 1974 to strengthen the research in seed development. The Indian seed industry has marked an impressive growth of 8.4% in 2012-16[5],[6], according to techsciresearch the Indian seed industry will surpass USD 3.4 Billion by the end of 2026. We have recorded production of 3.8 million metric tons of quality seed in 2016. Government is putting a lot of focus on providing good quality seed to farmers still it's not approachable to large number of farmers due to unavailability of seed or due to higher cost of seed. Indian seed programs are usually following limited seed generation system for multiplication of seed. The need for today's is to have a maximum of certified seeds to be sale in the market which are less frequently available in the rural part of India. Certified seeds have better yield, drought tolerant, pest resistance, herbicide tolerance, etc. Total five variety of seeds are available named as nucleus, breeders, foundation, registered, certified. Nucleus is the genetically pure seed, breeders seed is the offspring of nucleus seed, foundation seed is the offspring of breeder's seed, registered seeds are the progeny of foundation seed, the certified seed is the final seed which reaches to farmers after certification and testing fulfilling minimum requirements of seed certification standard 1988[7]. The ICT based solutions can be created to make farmer aware about the quality if seeds and ways methods to identify the correct seed. Online delivery of certified seed can also be provided by the government in association with other private and public organizations to remove the middlemen and to reduce the cost.

IV. FERTILIZERS, MANURES AND BIOCIDES

India is the land of farmers we are cultivating land from thousands of years, we are among the oldest civilizations in the world. In order to get a high yield from the soil the quality of the soil must be good because the productivity is directly proportional to the quality of soil. The plant needs nutrients from the soil and somehow from the atmosphere to grow healthy. The significant amount of nutrients are removed from the soil by harvesting crops. to fulfill the requirements of nutrients artificial fertilizers, manure, and sewage waste may be incorporated in the soil. The plant nutrients are divided into two categories macronutrients and micronutrients. Macronutrients are required in large quantity while micronutrients are required in less quantity. The most deciding factor in higher production of the crop is macronutrients like nitrogen(N), phosphorus(P), potassium(K), Sulphur(S), calcium (Ca), magnesium (Mg) out of which NPK are most important. Micronutrients that are essential for plant growth are molybdenum (Mo), boron(B), chlorine (Cl), copper(Co), zinc(Zn), iron(Fe), manganese(Mn). Few macronutrients that are derived from carbon dioxide, atmosphere and water are carbon(C), hydrogen(H), oxygen(O) these are also responsible for the healthy growth of the plant. To get a better understanding of the nutrient's lifecycle is shown in figure 1 from paper [8]. The dashed line represents nutrient gain or loss in the soil and solid lines represent internal transformation within the soil system. As depicted in the figure 1 the nutrients are available in forms of free ions like NH_4^+ , NO_3^- or in forms of chelates. Nutrients can be deposited on land and water from atmosphere. Biological nitrogen can also be fixed by plants ammonia (NH_4) by rhizobial bacteria. Soil nutrients can also be fixed by applying synthetic fertilizers which can provide various nutrients to soil even they may behave as an insecticide which helps plants in protecting from pests and insects. Fertilizers increase the production as well. However, they harm the environment by putting synthetic chemicals in soil and water which are not biodegradable since only 20 to 50 percent of nitrogen fertilizer is absorbed by plants rests is drain away. Plant residue can also provide various nutrients to soil if not removed from the soil and kept for a long time in soil. Manures which is also a byproduct of livestock and a good source of nutrients in the soil. Manure can be formed by decomposing the animal and plants waste, manure helps to improve the soil by adding humus into it. This helps soil to improve better moisture retention and aeration. Manure is natural hence it does not create any pollution as well. Application of municipal biosolids provide various nutrients in the nutrient cycle, since it contains lot of nutrients. Crops uptake nutrients from the soil in soluble form from soil. Plants uptake these soluble ions through the roots depends on their requirements of growth. The nutrients are removed from the soil when the harvested materials are removed from the field. The production of various compost produced in India is shown in figure 2. India produces more than 62 million tons of waste out of which only 15 percent get processed.



The total production of rural compost in 2014-15 was 226 metric tonnes, while the urban compost was 64.22 metric tons and the production of vermicompost was 583 metric tons[9],[10].

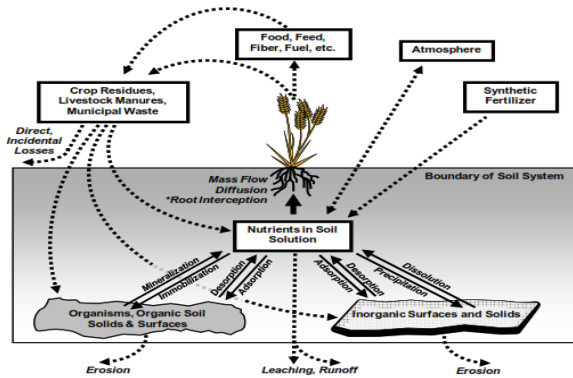


Figure 1. Nutrient Lifecycle

The government provides heavy subsidy for buying chemical fertilizers but still, it is not either available in sufficient quantity for the farmers or the farmers are not able to buy due to the high cost. To maintain the quality of fertilizers government of India has established 52 quality control laboratories, in addition to this government has one central quality control and training institute at Faridabad having its extensions at Mumbai, Kolkata, and Chennai. The excessive use of chemical fertilizers in the soil making it barren in the longer run. The excessive use of water-soluble fertilizers can run down into the water and helps in the growth of herbicides and other unwanted plants species which are harmful to the environment and human being. Therefore, we must use bio-fertilizers or manures to increase the productivity and quality of the soil. The government must run various schemes and programs to promote and manufacture the bio-fertilizers and manure. The Biocides are used to control and protect the crop from pests and diseases, but excessive use may harm the environment, animals and human beings. The government must form some policy to restrict the use of biocides in crops. Develop biocide plants as a sustainable tool for controlling pests and pathogens in plants [11]. Antimicrobial Magnesium Hydroxide nanoparticles can also use as an alternative to copper-based biocides [12].

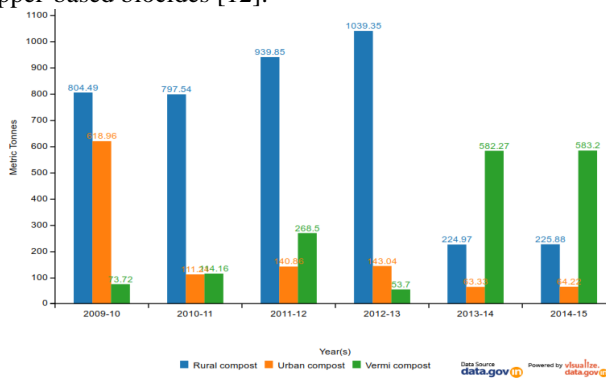


Figure 2. Production of compost in India

The requirement of fertilizer or the nutrients can be identified with ICT based solutions. Nowadays many companies are offering sensor-based solutions for the modernization of farms. In these systems sensors are placed in and above the

field which identifies the requirements of nutrients in the soil, it also identifies the type of soil, temperature and moisture in the soil. The values acquired by sensors is transmitted to a remote server which analyze these values and activate the actuator to supply only the required nutrient in the controlled manner. This will reduce the excessive use of fertilizer in the field and only the required nutrients will be provided at required location having deficiency of that particular nutrient in the field.

V. IRRIGATION

Irrigation is a method of supplying water by some artificial manner by using pipe, sprinklers, ditches, etc. It reduced the dependency of a farmer on rain. In India agriculture is based on monsoon which is very unpredictable and uncertain. India is the second largest country after China where agriculture is heavily dependent on rain, it is the most important factor in getting a good yield. India has around 140.13 million hectares of total sown area out of which only 68.38 million hectares will be under irrigation while rest 71.74 million hectares are still unirrigated, means it is heavily dependent on monsoon[13]. In order to meet such huge gap, the government have initiated Pradhan Mantri Krishi Sinchayee Yojana(PMKSY) in 2015-16. The government is giving a huge subsidy on buying micro irrigation devices under PMKSY. According to gkworld.com the statical data of irrigation through various resources are shown in figure 3. According to data available of 2012-13 the 53% of the agricultural land depends on rain only. Figure 4 shows the area sown vs area irrigated from 1950-2013[14],[15].In areas which are not dependent on rain are majorly using groundwater for irrigation about 64% of the total area is irrigated by wells and tube-wells. Due to excessive use of groundwater the water level has fallen drastically in many parts of the country.

Net Irrigated Area 65 Million Hacter

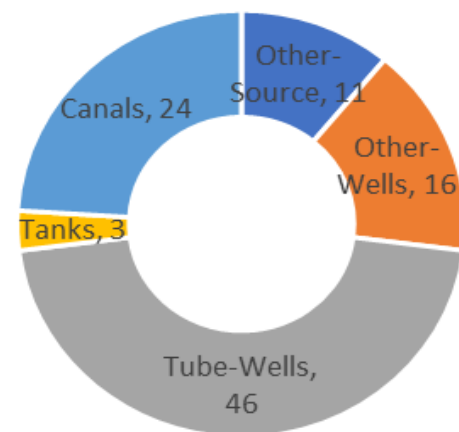


Figure 3. Different sources of irrigation 2012-13

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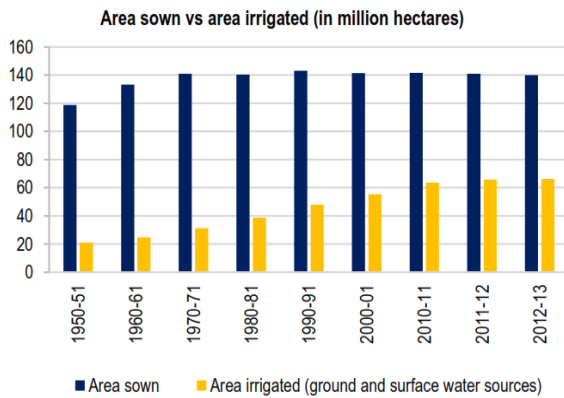


Figure 4: Area sown vs Area irrigated from 1950-2013

VI. UNAVAILABILITY OF MACHINES AND AUTOMATION

Even after the industrial revolution, India is still fighting for the availability of agricultural tools and machines in many parts of the country. Farmers are still using traditional tools like a wooden plough, sickle, etc. Use of traditional tools in the field for ploughing, weeding, sowing, irrigation, threshing, harvesting, and transportation especially by the small and marginal farmers. This will lead to low production and higher labor cost. The need for mechanization was first felt in 1960 after the first green revolution. After that government and private industries have created a large industrial base for manufacturing agricultural machinery due to this the available power for the various agricultural operation has been drastically increased from 0.3 kW in 1972 to 14 kW in 2004. There is an urgent need to make farmers capable to use machines with the help of financial support from government or self-help groups. Public media like Facebook, Twitter, WhatsApp, etc. could also be used to promote and share equipment own by an individual or by a group.

VII. SOIL EROSION

Soil erosion has emerged as the serious challenge in last one decade. Farmers are using excessive fertilizers, insecticides, pesticides to get higher production from the field. According to the research it has been found that India is losing 5334 million tons of soil every year [16]. According to agricultural ministry, the top one millimeter of soil is being lost due to soil erosion every year. Wrong irrigation practices are also responsible for the erosion, due to excessive use of water in the field result in salinity which is one of the major reasons for depletion of land. Soil erosion due to the wind is also a challenge especially in coastal areas, according to national center for coastal research one-third of Indian coastline was lost due to soil erosion in past 26 years out of which West Bengal lost the highest of 99 square kilometers [17]. There is an urgent need to focus on the preventive measures for overcoming this issue. The ministry of agriculture has established a soil health card scheme to check the health of the soil and on basis of which proper suggestions are given to farmers for cultivation of suitable crops based on the analysis of field and proper counseling is done for selection of proper crop. Apart from this IOT based solutions are also available, electronic sensors are placed in fields which measures the

quality(NPK) of soil, based on the data of field the system decides the requirement of nutrients in the field and the limited amount of nutrients in a controlled environment are provided in the field. The system also suggests the cycle of putting pesticides and insecticides in the field based on the growth of plants and environmental conditions.

INSUFFICIENT STORAGE AND PROCESSING FACILITIES

Agricultural storage means the space required by the farmer for putting his produce after harvesting before going into the market for sales or for processing. In India, we are having inadequate storage space for the agricultural produce by the farmers. According to the report published by downtoearth.org in August 2018, Indian farmers incur 92651 crores of post-harvest loss per year [18]. According to the report submitted by the ministry of agriculture in July 2018, around 89375 crores are required to uplift the post-harvest storage and transportation facilities which are just lower to the losses incurred by farmers every year. According to the report, about 40% of the total production of vegetable and fruits were unable to reach to market for sale due to poor transportation infrastructure. If such facilities will be provided it will almost double the income of farmers and will create about 3 million jobs in rural areas. As shown in table 1 there is a huge potential for growth in horticulture commodities in future and vegetables in time to come. According to the report published by Times of India in 2013 [19], We have wasted 21 Million tons of food grains which is more than the total Australian production. To store, process and transport such huge production, large and smart storing and transportation mechanisms are required.

Table 1: Report of committee on doubling farmers income
Ministry of Agriculture Welfare

Horticulture Commodities	Current Production Million Tons	Demand in 2030 Million Tones	Demand in 2050 Million Tons	Growth in demand between now and 2050
Vegetable	175	192	342	95%
Fruits	93	103	305	228%

Technology has a lot to do in this regard, smart warehouses, equipped with latest supply chain management technology, sensors, and RFID tag will allow workers to find the correct location of the item and its actual condition, use of IoT will reduce the human intervention and therefore reduce labor cost. Thereby increasing the efficiency and reducing the shipping delays. IOT can also be used from farm production to delivery of processed food to the end customer.

For example, the conversion of potato into chips and that to deliver into the market is nowadays completely automated with the help of automation and IOT. This helps in reducing the wastage of potatoes, reduce the labor cost and ensure good quality of chips.

VIII. AGRICULTURAL MARKETING AND POOR TRANSPORTATION FACILITY

Agricultural marketing and transportation play a great role in agricultural development. It is not possible to uplift the standard of farmers without proper facilities of marketing their products and then to supply and sell those products at the right time at an appropriate location and at a compatible price. Indian economy is agricultural driven, even though the condition of farmers in our country is not up to the mark. This is because of poor agricultural marketing and transportation facility. Farmers are selling their products at a much lower price than market due to lack of market information and to bring the product in the market at the right time when the prices are high. Agriculture marketing includes collecting the agricultural produce from the farmers, certifying or standardizing those products, storing of products, bringing a product to market through middlemen, buying and selling the product in the market, arranging finance if required, etc. In India due to poor agricultural marketing farmers are not able to get the reasonable price for their produce even after doing all hard work and are exploited by middlemen. The factors which affect most are pin down here

- Existence of too many middlemen
- Lack of standardization or grading of the product
- Lack of an organized marketing system
- Lack of financial resources
- Poor transportation facilities from village to mandis.
- Poor storing facilities
- Lack of awareness of market
- Illiteracy and unity among farmers.

In order to tackle these problems, the government, must ensure and undergone some policies which will eradicate these issues

- Elimination of local traders or middlemen
- Improved and smart storage facilities
- Regulated market.
- Broadcast of prices on a daily basis
- Flexible loan facilities
- Smart transportation facilities
- Improvement of road infrastructure
- Broadcasting of market policies
- Training and skill development in farmers
- Regulation of mandis
- Standardization and grading of products

Recently the government has started a project National Agriculture Market online platform (e-NAM), in this the farmers have to bring their produce to specific mandi where the online auction will be done for their produce and price will be displayed online and on mobile phone with the help of a mobile app. In this way, a farmer can sell their produce directly and get the best price because no middlemen are involved in this process. Transportation can be greatly improved with the help of technology; we can embed smart devices in transportation vehicles which will monitor the run time location of the vehicle and suggest the best possible route to transport the product with minimum delay and loss. It will also suggest the environmental/weather conditions of the current and future location from where he is going to travel so that the driver can take preventive measure to safeguard his goods and avoid unwanted damage to his goods. In case of emergency or breakdown of a vehicle the system will connect the driver to the nearest service station for timely repair of his vehicle. The transportation devices can also equip with various sensors which will not only track the condition of the vehicle like air pressure in tyres, stress and amount of load on vehicle but also take care of goods present in the vehicle by measuring the temperature, humidity, and ripening of goods.

IX. LACK OF FINANCIAL FREEDOM

The most important factor that affects the farmer is the scarcity of capital, like all other industries agriculture also an industry which also required capital to run or to produce. Due to the modernization of agriculture, the investment of farmer has increased. He has to buy good quality seeds and fertilisers, buy or lent equipment, diesel or electricity charges and many more. In order to meet out his requirement farmers have to lend money from local money-lenders or traders at higher interest rate, due to which the farmers have to sell their products at a very lower price as early as possible to meet out his financial requirements otherwise the interest borrowed on money will increase many folds that will lead to a drastic situation in farmers life. According to the provisional data given by National crime record bureau (NCRB) the rate of suicide by the farmers have decreased by 32% from 2007 to 2016[20] but still is very high in comparison to other developed nations. There are many reasons for committing suicide by farmers but one of the prominent reasons is indebtedness or bankruptcy of farmer. Figure 5 shows the statistic of suicide by farmers from 2007 to 2016.

SUICIDE IN AGRICULTURAL SECTOR

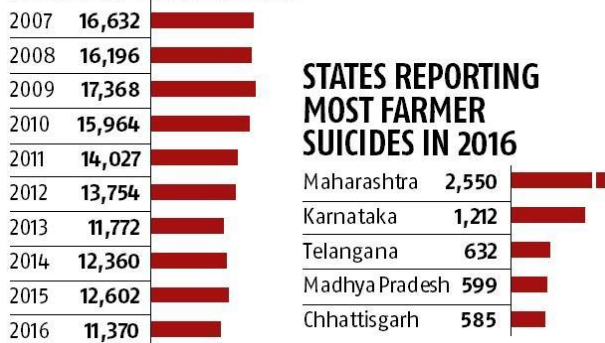


Figure 5 : Statistic of suicide by farmers(Business Standard April 2018)

According to All India Rural Financial Inclusion Survey (NAFIS) done by National Bank for Agricultural and Rural Development (NABARD). According to the survey done by rural credit survey committee in 1950-51, the money landed by farmers from local money-lenders was 68% of the total credit. The government has started many programs for financial assistance of farmers. The Kisan Credit Card scheme (KCC) launched by the government of India in 1998 enable farmers to take credit for buying seeds fertilisers and fuel with a low-interest rate of 4% only. According to the reply given by ministry of agriculture in Lok Sabha on March 9, 2019, the total number of active KCC is about 2.77 crore by March 31, 2017. According to NAFIS the 30.3% of Agri-households still, borrow money from local non-financial institutions. The survey said out of total average borrowing capital of 1.07 Lakh in 2015-16, agri-households borrow about 30,000 (28%) from non-institutional sources [21]. The NAFIS survey shows many persons still taking money or loans from local money-lenders because many farmers are afraid of taking a loan from banks due to huge formalities or the technical aspects of loan and the threat of fraud by bank personals or middlemen. Many fraud cases have been detected by the government during the loan waiver scheme where loans have been sanctioned on the name of farmer or even dead farmers. In one such case of Sagar district of Madhya Pradesh, India, where farmers of one village threatened the government to commit mass suicide [22], as their names were appearing in loan waiver list. The farmers said that they have never taken a loan from any bank. In order to strengthen the relationship between the farmers and the organized financial institution's technology can play a big role in making system transparent. One such suggestion is to link loan and other financial implication of every individual with "Aadhar Card" so that when somebody checks his Aadhar detail it will automatically display all financial and other important details. No financial transaction can be performed without proper authentication approved by the authorized individual. This will make the system transparent and not allow anyone to commit fraud on the name of another person.

X. CONCLUSION

In this paper, we have discussed various problems related to farmers and the suggested solutions by which farmer can uplift their living standard. We have suggested the ways to

overcome the land partition problem, poor quality seed problem, availability of manure and fertilizers, storage problem, transport, and finance problem. The suggested measures can be implemented by the government with the help of the public-private partnership model, through non-government or not-for-profit organizations. Microfinance facilities can be provided with the help of cooperative societies or banks. Since the internet have enough penetration in the villages, therefore, tools like Social media can be used for sharing agricultural equipment's, sharing agricultural knowledge and spreading awareness among the farmers about the hygiene, medical facilities, the drawback of pesticides, use of manure and organic farming. Internet can also help us to discriminate the various advantages of using technologies like precision agriculture and modern farm equipment's. Therefore, to overcome the current and the future agricultural problems and to have sustainable development the government has to emphasis on formal education and training of farmers. Training must be provided to farmers for understanding the government policies, welfare schemes for farmers, financial literacy, skill development, use of internet and other modern technologies.

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