

# Technological Interventions for Augmenting Income of Rural Households in India

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**Abstract**— One of the central issues which policy makers constantly try to address in developing countries is to explore ways to augment income of rural households. India being an agrarian economy, most of its population depend on farming as main source of income. But, large section of the farming population is distressed and look for alternative income augmenting avenues. A possible solution to enhance income of farmers is adopting technology in farming practices. With this background, the paper based on secondary data sources explores how technological interventions can help farmers to augment their income. Various issues of agriculture sector and role of technology in addressing them has been discussed in detail. Select initiatives taken by the government and private organisations are discussed in the conclusions and summary section which paves way for income augmentation of farmers in India.

**Index Terms**— Income Augmentation, Economic Development, Farmers, IoT, Sustainable Rural Development, Sustainable Livelihoods, FPOs, Technology

## 1 INTRODUCTION

Dry land areas are home to 43 per cent of India's population and receive rainfall between 150 mm to 1000 mm per annum. Ten states (Rajasthan, Madhya Pradesh, Maharashtra, Gujarat, Chhattisgarh, Jharkhand, Andhra Pradesh, Karnataka, Telangana and Tamil Nadu) account for 80 per cent of the dry lands in the country [1]. These areas are resource poor with poor soils and scarce water resources. But, they cater to about 40 percent of national food demand under the most optimistic scenario. The additional demand comes through increasing productivity of rainfed agriculture. This is a catch 22 situation where drylands have very limited irrigation and soil resources and productivity improvement needs irrigation facilities, good soils and technology. The irrigation sources (basically groundwater) have been overexploited in several parts of the country. As a result, the groundwater table declined irreversibly and water is being mined [2], [3].

In recent years, Indian agriculture has experienced a substantial impact of science and technology. A major focus of these technologies has been to enhance sustainable farming practices with an objective of increasing the economic conditions of farmers. Introduction of new technology in farming practices resulted in having many positive implications for the economy in general and for the farm sector in particular. One of the positive implications is an increase in income levels of those farmers who adopt new technology. However, there are hardly any data sources that provide information regarding income estimates of farmers.

As per the studies conducted by Chand et al in 2015 [1], the real income grew at a compounded rate of approximately four percent per annum between 2004-05 and 2011-12 which is con-

sidered as fastest compared to the last two decades. Based on the historical data, [4] researchers have concluded that the majority of the farmers in India are in distress and are exploring ways to augment income through alternative sources [5]. Though there are multiple sources of augmenting income, one of the reasons why farmers are unable to benefit from them is primarily due to lack of knowledge and awareness regarding various practices in adopting technology [3].

The focus of the paper, thus, is to explore how farmers' distress can be addressed and income be augmented using various practices which use technology.

## 2 Literature Review

In the last few decades, the agriculture industry has transformed rapidly. Advances in technology expanded the scale, speed, and farm productivity to a great extent. Also, developing varieties of seeds leading to higher productivity has revolutionized the agriculture sector catering to the demand and supply issues of the country. However, with technological advancements gaining speed, there can be another revolution in the sector driven by technology. Artificial intelligence, analytics, connected sensors, and other emerging technologies can further enhance yields and efficiency. One of the major focuses of technological advancement is to manage and improve water resources and other inputs useful for agriculture [6].

In order to have successful technological intervention, one of the prima facie requirements is to build a strong infrastructure that would facilitate technological interventions in farming. The demand for food is growing and simultaneously constraints in the supply side are increasing [7]. These constraints are mainly due to limited land and outputs. It is estimated that the world population will be around 9.7 billion by the year 2050. That would require a corresponding 70 percent increase in calorie consumption. Also, it is estimated that by the year 2030, there will be a severe water supply shortage i.e. water supply would fall by 40 percent apart from rising energy, labour, and other costs [8].

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Other challenges like land degradation, climate change, social pressures, push for more ethical and sustainable farming practices which focus on reduced use of chemicals and water are on increase [9]. To address these challenges and prevent further damage of the agriculture industry digital transformation enabled by connectivity is required. The past advancements in the sector are majorly mechanical, that is, in the form of more powerful and effective machinery, genetic reengineering to develop high yielding seeds, and so on[10]. However, given the present challenges of pest attacks, soil erosion, water depletion/water scarcity, climate change, and so on, more sophisticated tools are needed to predict and mitigate risk accurately and alleviate the farmers' economic condition[11].

The agriculture industry, at present, is facing two major challenges pertaining to technological advancements and its implementations. One, some regions are deprived of the latest technological interventions and facilities, making development of it paramount. Second, in the regions where technological interventions are initiated and implemented, their impact has not been sufficiently proven [12].

To add to this, COVID-19 crisis has further intensified challenges in the agriculture sector. There has been a significant dip in the sales volumes leading to low margins. This leads farmers to contain costs further. The gridlocked supply chains, globally, are highlighting the importance of local providers which could enhance the resilience of small-scale farmers. In the pandemic times like now, heavy dependence on manual labour affected the farming practice to a large extent due to mobility restrictions. However, there is a positive side to these restrictions. The restrictions helped and highlighted the importance of resources available locally. This has led many farmers to realise the importance and desire for local resources that are sustainable. Nevertheless, the losses incurred are huge and irreversible. Therefore, one of the major lessons the crisis has stressed on is the necessity of more widespread digitalization and automation in the agriculture sector.

In a country like India, where there are more than 15 agro-climatic zones, it is essential to understand the soil, crops suitable to grow in the region, and various other geographic specific nuances to have better yield. For example, in the dryland areas of India growing water-intensive crops will only lead to lower yield and margins. Also, farmers resorting to traditional practices are not yielding the benefits they desire. The traditional practices were certainly successful when the demand was less and so was the population. However, in the current times, with many advancements, developing infrastructure in the agriculture sector for better technological interventions is inevitable. Developed nations Like United States, a pioneer country in connectivity also face this challenge. Only about a quarter of farms in the US use any connected equipment or device in the day-to-day farming practices[13]. Also, the technology is not state-of-the-art, they still run on 2G or 3G network or on very low-band IoT which are usually expensive or

complicated to implement. This being the case with the US, countries like India that are aiming at doubling the income of farmers are aggressively trying to bring in technological practices in farming while stressing on natural ways of farming practices. Therefore, India is in a stage where it is trying to implement natural farming practices combined with the latest technology[14].

The following section of the paper will elaborate on methodology undertaken to carry out the work. The methodology section will be followed by discussion and conclusion sections.

### 3 Methodology

The study is based primarily on secondary sources and the approach of the study is qualitative. We have followed a systematic literature review followed by systematic data analysis (SDA).

#### 3.1 Systematic Literature Review

The literature review included reading various research papers published in the domain of agriculture, Internet of Things (IoT), livelihoods, sustainable rural development, sustainable farming practices, and so on. The entire literature review was conducted in three phases as depicted in figure 1.

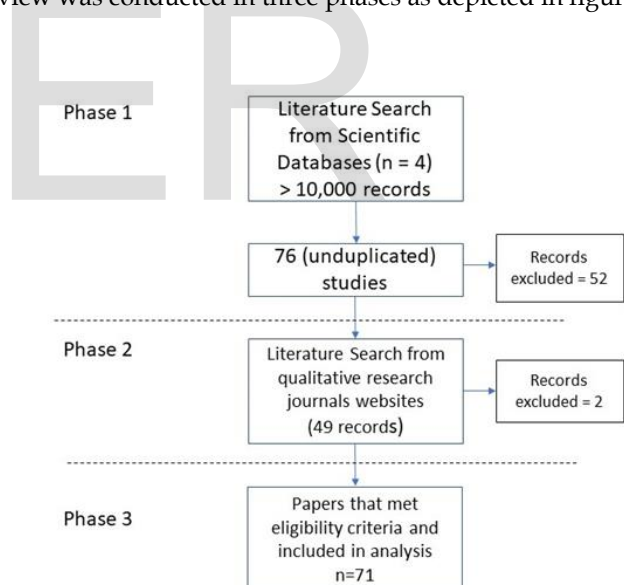


Fig. 1: Graphical representation of literature review conducted for the study

In the initial search using key-words, from various online databases more than 10,000 published articles were found, however, only 76 papers were shortlisted for the work based on the relevance and criteria for study. In phase two, we resorted to various websites to get published articles from magazines and newspapers which gave us 49 relevant articles. In phase three we studied all the material and shortlisted 71 papers based on which the study was carried forward[15], [16]

### 3.2 Qualitative Approach to the Study

The main intention behind selecting a qualitative approach was to understand and capture a variety of activities undertaken by different farmers [14]. Qualitative studies enable one to have an in-depth understanding of the main research objectives along with rich information and also helps in understanding the interpretation of the outcomes better.

The rationale behind following qualitative approach was based essentially due to the nature of questions which primarily focuses on 'how' aspects. While exploring answers to 'how' a phenomenon occurs, researchers will have to describe and explain the social world leading to developing theories and models [17].

### 4 Discussions

This section presents various insights that were derived from literature review and analysis from the data. One of the positive aspects with technology is it is constantly evolving at a very fast pace. This helps to formulate technological strategies in a new way to address age-old problems related to uncertainty in weathers, pricing, pest attacks and so on. Especially in countries like India where it is aiming to bring 100 percent broadband and 4G network connection coverage, some new tools can be enabled for optimizing and enhancing capabilities in the agriculture sector. Some of them are:

(i) Designing and enabling networks consuming low power with less expensive sensors. It will help in precision irrigation of field crops, monitoring large herds of livestock, tracking the use of remote buildings and so on.

(ii) Increasing the stability of connections can help in having confidence in network systems that run applications demanding absolute reliability and responsiveness. Drones are the best examples in this category.

One of the advantages with good connectivity is that it promises easier surveying of large tracts. However, in India where small and marginal farmers occupy more than 80 percent of arable land, these types of interventions will prove to be not only expensive but also require continuous hand holding of farmers. Most of the farmers lack information and knowledge that is required to implement and operate technological interventions. In such a scenario, especially in the dry lands of a country which suffers due to severe water shortage if technology can be used to enhance the water resources for farming, it can certainly lead to augmentation of farmers' income [15].

Income of farmers' can be augmented in three ways, first through increasing the gross income, second through reducing costs, and third by stabilizing the income. Gross income can be increased by enhancing the yield of crops, diversifying into various farm and non-farm activities, and so on. Cost reduction can happen through resorting to natural ways of farming like organic farming, better nutrient management of crops,

implementing and resorting to input saving technologies, and so on. Finally, income can be stabilized through water saving methods and technologies, crop and asset insurances, traditional coping mechanisms, and so on.

While some of the above measures are possible to be implemented immediately, others are not. The reason behind this rationale is that India being a diverse country, each state or region differs from each other. Hence 'the business as usual' concept may not work in India. However, keeping the diversity in view, some broad strategies of doubling the farmers income can be possible through:

(i) Enhancing production through enhancing yield - enhancing the yield is one the most important aspects in increasing income of farmers. However, land in terms of area is limited so the net sown area cannot be expanded. While varietal improvement through conventional breeding or biotechnology is a long-term option, bridging yield gaps through adoption recommended agronomic practices, planning profitable crop mix that can maximize aggregate income and reducing crop losses through integrated pest management are short/medium term options that can bring additional income.

(ii) Leveraging water resources - water resources too are limited and are scarce in many parts of India. With growing demand for water for various domestic and industrial purposes, it is estimated that by 2050 the global agricultural need will be 60 percent more and 100 percent in developing countries. Role of irrigation in mitigating risks and imparting certainty to agricultural production is known to many. However, to address the challenge of water scarcity, focus on micro-irrigation systems like sprinklers, drip irrigation, Tal-ya<sup>1</sup> trays of Israel and so on are the need of the hour. In India, not even 10 percent of potential area is brought under micro-irrigation systems.

With 'more crop per drop' initiative, the irrigation development efforts focus on expanding irrigated area and enhancing efficiency in the sector. These efforts can be more effective if some of the traditional practices or enhancing water resources in rural areas are adopted. These practices are watershed development, revivals of ponds and so on. Due to lack of knowledge, lack of funds for initial investment, long payback period, difficulties in accessing technical and financial support are some of the major reasons for watersheds and ponds not getting revived in rural areas as planned in the last few years [18].

Also, heavy dependence of groundwater, which is a precious resource with limited scope of recharging, water intensive cropping in most of the states and regions have encouraged many farmers to pump water indiscriminately leading to mining. Hence to address this issue participatory management of groundwater that was successfully implemented in Andhra Pradesh, India is one solution.

<sup>1</sup> <http://www.tal-ya.com/>

(iii) Technology adoption - technology adoption is one strategy that has not penetrated well in the rural areas of India. There are strategies using technology available in the field to improve crop management practices, livestock management, soil and water conservation practices, energy management practices, and so on. However, these strategies are more on paper and not being actively implemented in farmlands of rural areas in India.

(iv) Risk management - risk arises out of uncertainty which farmers face while pursuing income generating opportunities. Mitigating risk is not an easy process as it itself has been ridden with several constraints. Farmers face three types of risk pertaining to yield, price, and idiosyncratic risks. The yield risks are: weather and input risks. Weather risks include late onset of monsoon, low and untimely rainfall. Major input risks are on account of fertilizer, pesticides, labour, farm machinery, irrigation, credit, information, and seed. The price risks are related to output marketing which include price volatility, non-operational MSP system, and discrimination in price realization. Idiosyncratic risks are farmer related such as health issues of the farmers, access to non-farm employment opportunities, accessibility to public distribution and employment guarantee programs.

To address and manage risk, steps are taken in two ways, one is ex-ante strategies and another is Ex-post strategies. Some ex-ante strategies (taken up in advance) are investing in wells, resorting to mixed-farming, sharecropping, stocking grains, and so on. Some of the ex-post strategies (taken up once an event occurs) are replanting, changing input use, thinning the standing crop and so on. Price stabilization mechanisms such as building bonds with commission agents/traders, entering into contracts and income stabilizing mechanisms such as insurance and credit are other strategies followed by farmers to face risks.

(v) Focus on small-scale farmers - The small-scale farmers here are those farmers who hold less than three hectares of land. The farm size has declined over time and as per NSSO survey reports, based on the 70th round revealed, the average area owned per household declined to 0.592 ha in 2012-13. With such a small land holding a farmer cannot earn more than Rs. 7000 per month. The amount which a household incurs to meet his/her household expenditure is Rs. 6223. Thus the income earned on an average leaves very little surplus towards saving or investment. With ever increasing cost of living and demand for spending on education and health, it is extremely difficult for an average farmer to sustain, develop and grow. Smallholder agriculture, thus, operates under constraints related to the small scale of operation. However, the good news is that off-late, there has been an increased interest of corporates in small-scale agriculture as an untapped resource for increasing income of rural households [17]

The next section presents some initiatives undertaken by the government and private organizations using technology as a platform to augment income of rural households.

## 5. Summary and Conclusion:

Agrarian distress has been a perennial problem shaking the foundations of the agricultural sector. Indian farmers continue to contribute towards enhancing the food security of the country. Unfortunately, while doing so, they still remain poor and distressed because of which many farmers do not want their children to continue farming. Increase in income certainly is a way to address distress caused to the farmers and retain farmers in agriculture. In order to increase the income of farmers, one of the ways is to use technology.

Technology can be used in various fronts in the agricultural industry. The demand for digitalization in Indian agriculture is being acknowledged by policy makers in the country. In this line, various initiatives have been taken by the government. Also, some of the corporations have come forward in lending support by providing latest technological support to farmers. Some of them are:

(i) CISCO developed an Agricultural Digital Infrastructure (ADI) which acts as a platform for farmers in knowledge sharing.

(ii) The Jio Agri also known as the Jio Krishi platform provides a platform to digitalize the entire agriculture ecosystem along the entire value chain to empower farmers. Its core function is to provide advisory support to farmers.

(iii) ITC has proposed to formulate a personalized 'site specific crop advisory' service. Its main objective is to turn crop-level generic advice into a personalized site-specific crop advisory for farmers using digitized monitoring platform hosted on ITC's e-choupal 4.0 digital platform.

Apart from the corporates some of the initiatives taken by government taking technology as a platform and tool are:

(i) National Agriculture Market (eNAM) which focuses on pan-India electronic trading linking existing agricultural produce market committee (APMC) mandis to create a unified national market for agricultural commodities. It basically eliminates the role and involvement of intermediaries.

(ii) Direct benefit transfer (DBT) central agri portal is another platform which tries to unify all agricultural schemes across the country.

Apart from these initiatives, the government is taking active steps in exploring cloud computing services by collaborating with organisations like Microsoft where a unique ID is created for each farmer registered with the portal across the country. It would help farmers accessing various schemes provided by the government for the farmers.

Technological interventions based on remote sensors, soil sensors, unmanned aerial surveying, etc. allow farmers to gather, visualize, and assess crop and soil health conditions at different stages of production. It also acts as a convenient and cost-effective approach.

Artificial intelligence and blockchain technology offer tamper proof and precise data collection methods offering farmers data related to farms, inventories, secure and quick financial services, and so on. It also avoids paperwork which acts as a boon to farmers who are mostly not so highly educated.



However, to implement these strategies, tools and techniques, India and Indian farmers have to overcome the issue of fragmented land holding. Fragmented land holding, in other words, small land holdings makes it difficult to gather information and limits penetration of mechanized tools. It also increases the risk on an individual farmer during any natural calamities like drought or cyclone leading to floods. One of the ways to tackle issues arising out of small land holdings are to form Farmer Producer Organisations. The collective approach not only unifies farmers but also provides scope to experiment and innovate on a large scale. The risk of failure is also distributed making it a more cost effective and safer option.

As the Indian agriculture and allied sector is taking steps towards adopting modern technology, creating a holistic approach to address various challenges faced by the farmers is of national importance. To double the income of farmers and have sustainable development of rural areas, adopting technology and natural farming techniques are a must. Thus, a multi-stakeholder approach is required for wide scale adoption of digital agriculture in India, with the government playing a key enabler's role in the ecosystem.

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