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A STUDY ON PRECISION IRRIGATION TECHNOLOGY IN AGRICULTURE: OPPORTUNITIES AND CHALLENGES IN PUNE DISTRICT

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Abstract

Purpose of the study: *The main purpose of this study is to understand the benefits and challenges of adopting precision irrigation technology among farmers in Pune district of Maharashtra. With the growth of emerging technologies, transformation the agriculture sector is being rapidly. Agriculture productivity has direct or indirect effect the economic growth of the nation. Adoption of emerging technologies can help the farmers to improve the quality and quantity of crops.*

Methodology: *Both quantitative and qualitative data was used in this research study. A questionnaire-based survey and interviews were used for collecting primary data from various stakeholders including farmers, agriculture government officers and manufacturing companies in Pune City.*

Main Findings: *From the analysis of collected data this study has been reached to some main conclusions. As per the respondents' response water, soil, crop and Land resources are to be managed for improving the quality and quantity of agriculture production. 77 percent respondents think that water is the main problem in the area of Pune district and it has to be managed effectively. 91 percent respondents involved in this study think that the implementation of modern irrigation technology will be helpful for the farmer to improve the quality and quantity of agriculture production and 80 percent respondents says that Precision Irrigation Systems will eliminate the water scarcity problem in the future. . 68 percent respondents are in the favour of implementation of drip irrigation in Pune district.*

During the analysis of collected data it was also found that many other factors can be barriers for the farmers for adopting the modern irrigation technology. 60 percents respondents think that in Pune district farmers are holding land less than 2acres and their annual income is not more than 3- 4 lacks. Due to less income they are not able to adopt the technology. A 50 -70 percent respondent says that there is less education and awareness about new technology among the farmers. 79 percent respondents due to less education and awareness of information about technology, farmers are not able to handle the complexity with software. According to 70 percent respondents, to implement modern technologies like irrigation systems initial cost will be high as small framers' annual income is less than 4 lacks.

Applications of this study: *Precision irrigation technology will help the farmers to improve the quality and quantity of crops therefore economic growth will be improved. This study will be helpful to the farmers to know about the scope of precision irrigation technology to save the water and also will make them aware of challenges for adopting precision irrigation systems.*

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Novelty of study: *This study is conducted in 3 different zones of Pune district. 3 different zones in Pune district were selected on rain intensity. This study is conducted for the marginal and small farmers of Pune district holding average land .44 and 1.42 hectares respectively.*

Sr.No	*Zone*	*Rainfall Intensity*	*(Rainfall in October 2019 - mm)*
1	*Bhor*	*Highest*	*249*
2	*Mulshi*	*Moderate*	*186*
3	*Indrapur*	*Lowest*	*130*

Keywords: *Precision, Irrigation, Technology, Agriculture, Opportunities, Challenges*

INTRODUCTION

The "technology factor," is increasingly predictable as a major source of differences in yield and benefit over time and among nations (Ruttan & Hayami,1973). The poverty improvement in a rural area depends upon economic growth and Agricultural development is essential for it (Pinstrup-Andersen & Shimokawa, 2007).

It is necessary to adopt new technologies to meet the higher food and fuel needs of an increasing population (Baptista,2012). Growth and development in agriculture are not possible without adopting the yield-enhancing technological methods (Kassie et al., 2011). Development of new skills and changes in working patterns are needed while organizations are going to be ready the adoption of modern technologies. Companies that are more focused the development of innovative technologies rather than human development. More investment in the development of technologies will not reach their full potential (Baptista, 2012).

"Sustainable agriculture" is a concept that is both determined and uncertain. A rapidly growing population, for most developing countries, real sustainability must include addressing broad food security and income generation needs.

Information is an important to factor in improving management skills and helps the farmers to have outlook and expectation towards resource problem and technology choice (Lee,2005).

The source of economic growth of any developed nation depends upon the effective diffusion of the known technology in increasing agriculture productivity. Earlier effective diffusion efforts taken are considered for agricultural development.

The most serious restrictions on the international transfer of agricultural technology are: (a) limited experiment station capacity in the case of biological technology and (b) limited industrial capacity in the case of mechanical technology (Ruttan & Hayami,1973).

Many factors that affect the source of economic growth of nation but agricultural productivity is one of them an effective driver of economic growth and poverty reduction in the nation. For raising agriculture production, access and implementation of appropriate technology are required.

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Rural infrastructure deficiencies include deficiencies in transportation, energy, telecommunications, and related infrastructure that translate into poorly functioning domestic markets and affect the economic growth of the nation (Pinstrup-Andersen & Shimokawa, 2007).

Adoption of new farming practices remains a challenge. Till date, there has been no successful effort to extract the enormous body of research knowledge into a model for making quantitative predictions of adoption of agricultural practices. Increasing demand for agricultural innovation system, there is a need to prepare agricultural agencies for the process of 'scaling' a new farming practice. The development of Adoption and Diffusion Outcome Prediction Tool can predict adoption for a population of farmers, rather than for any individual farmer and can support systematic and structured consideration of the factors influencing adoption of new agriculture practices (Kuehne et al., 2017).

Somewhere directly or indirectly 60% population of Ghana, depend on agriculture products for their survival. Agriculture plays a critical role in promoting economic growth, food security, and poverty reduction, in rural development. Applied traditional methods are not feasible to sustain the food demand under the pressure of growing population in Ghana.

In Ghana, for crop production same land is used for over the years, due to continuous use of the same piece of land, there is more chance of declining the strength of land fertility. Rice producers in Ghana can only supply 300,000mt, while the demand is estimated to be 960,000mt.

Therefore, the adoption of new agriculture technology also guides the farmers to manage the resources related to agriculture land and it avoids the declining in land's fertility (Emmanuel et al., 2016).

Food insecurity by improving crop productivity can be possible using new agriculture technology in today's digital era. Further, promoting the adoption of technologies can improve the quality of the crop and helps to improve the welfare of small farmers.

In Asia, Pakistan is the third large producer of rice after wheat and cotton but due to soil degradation and other factors, less production of rice was counted in the year of 2016-2017 (Chandio & Yuansheng,2018).

Many **factors influencing the adoption of technological innovations that include** (i) farm size, (ii) risk exposure and capacity to bear risks, (iii) human capital, (iv) labour availability, (v) credit constraint, (vi) tenure, and (vii) access to commodity markets (Zeller et al., 1998).

Transformation is almost all areas of agricultural and agricultural production growth have been driven by enhanced farming technologies, including improved seeds, fertilizer, and water control. Despite the efforts of the Ministry of Agriculture over the past dozen years, the adoption of new agricultural technologies remains low (Uaiene et al.,2009).

PROBLEM STATEMENT

Water scarcity is the main problem due to uneven climate and adoption of agriculture technologies is not so easy for the farmers in Maharashtra.

OBJECTIVES FOR STUDY

The objectives of this study are:

- To insight the scope of agriculture technologies.
- To identify the factors for adopting agriculture technologies.

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LITERATURE REVIEW

Technology and Agriculture Development:

(Kassie et al.,2011) evaluated the ex-post effects of adopting improved groundnut varieties on rural Uganda's crop income and poverty. The optimistic and important effect on crop income is consistent with modern agricultural technologies' obvious position in reducing rural poverty through increased income from farm households. Nonetheless, reaching the poor with better technologies needs government support to boost extension activities, seed access, and business channel imitating adoption.

(Lee, 2005) focused on key factors affecting the adoption of sustainable agricultural technology in developing countries and natural resource management practices. After introducing some conceptual issues, the article identifies several key features of these systems that help explain observed adoption patterns and suggested by recent research as critical limitations to their diffusion.

Adoption of Agriculture Technologies

(Kuehne et al., 2017) ADOPT model is presented in this paper and its ability to predict the spread of agricultural practices is illustrated using examples of new crop varieties, new cropping technology and weeding options. Proposed ADOPT model provides a forecast of the diffusion curve of the functional and sensitivity analyses of the factors influencing the speed and peak adoption.

This paper looks at the effect of agricultural extension on the adoption of chemical fertilizers and their effects on Ghana's rice productivity. Our findings show that exposure to extension services contributes significantly to chemical fertilizer adoption. Access to extension services and the adoption of chemical fertilizer have positive effects on the productivity of rice.

Governments and various institutions in Africa should train more extension officers, considering their substantial impact on the adoption and productivity of agriculture technology. Future studies on the adoption of agriculture technology and access to extension services in developing counties should follow methodological methods that account for end ogeneity and selectivity effects to arrive at exact magnitude and scale of impacts from successful agriculture technologies and interventions (Emmanuel et al., 2016).

The main aim of the current study was to examine factors affecting the adoption by smallholder farmers in Northern Sindh, Pakistan, of improved rice varieties. The adoption of certified and enhanced high-yielding crop varieties is an effective way to increase agricultural productivity and boost farmers ' living standards in developing countries (Chandio et al., 2018).

It presents an analysis of the determinants of the adoption of these two crops and the associated effects on income. In addition to factor endowment and exposure to agroecological risks, differences in the access of the household to the financial and commodity markets have a significant impact on its crop shares and farm income (Zeller et al., 1998).

Scope and Adoption of Precision Agriculture Technology

Rapid socio-economic changes are creating a new scope for the application of precision agriculture (PA) in certain developing countries, including India. The high-tech nature of advanced-country traditional PA technologies created a real challenge for engineers to search for suitable PA technologies for developing countries. The aim of this paper is therefore, to find out the scope, the current status and the strategies for the adoption of PA in India and some developing countries. This

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comprehensive review of the current status of PA in India and some developing countries is expected to help find out the trend and direction of future research in adoption. It also proposed a detailed strategy for the adoption of PA in India (Mondal & Basu, 2009).

Drivers for Adoption of Precision Agriculture Technology

In this review, we identify the key drivers that affect the intention to adopt technologies for Precision Agriculture (PA). The most important aspects influencing the adoption of PA technologies in the relevant literature have been identified: farm size; cost reduction or higher income to obtain a positive benefit/cost ratio; total income; land tenure; farmers ' education; computer familiarity; access to information (through extension services, service providers, technology sellers); location (Pierpaoli et al., 2013).

Precision Irrigation Technology

They have defined it in this paper using the principles of precision agriculture. It is well recognized that precision irrigation involves the treatment of field variation ' differential irrigation ' as opposed to the ' uniform irrigation ' treatment underlying traditional irrigation management. We argue, however, that irrigation is much more precise, that it must be holistic, adaptable and applicable to all irrigation methods (Smith & Baillie 2009).

Allocation of scarce freshwater resources in dry regions of the world is an issue of great importance. Economists and other observers have argued that policies to improve water allocation efficiency can help alleviate conflicts between competing users and minimize the role of water as growth limit. Efficiency-enhancing water management strategies can also help to reconcile supply and demand imbalances without costly and environmentally damaging damage and other measures to increase supply (Schoengold et al., 2004).

The present study explores new frontiers with "Precision Irrigation" (PI) to optimize the use of water resources in agriculture. The study's main aim is to develop a theoretical framework for assessing PI adoption. This Framework was validated and integrated by a Delphi study involving a structured expert group (Galioto et al., 2015).

METHODOLOGY

Both quantitative and qualitative data is used in this research study. For this research as a survey questionnaire is used for collecting primary data. Data Collection and analysis method are adopted wherein questionnaire is circulated amongst various stakeholders like engineering students, faculty and industry experts in Pune City.

The questionnaire method is chosen among the other methods for several reasons, such as low cost, the time and effort required in gathering data from a large sample, and geographic separation.

Participants

The random sampling technique was used during the selection of participants and the experimental study was conducted in the selected district in Pune city.

Sampling

Farmers: 40 randomly selected farmers in the 30-40-year-old age group were included in this study.

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Agriculture Government Officers: 10 randomly selected officers in the 30-45-year old age group were included in this study.

Manufacturing Companies: 10 engineers of manufacturing industries participated in the study. Out of 10 participants, 07 participants were male. The average age of employee was 29 years old.

Table 1: Outline of the Study

	Villages	**Agriculture Government Sectors**	**Manufacturing Companies**
Participants	40 Farmers 30 - 40 years old 35 Male and 05 Female The average age is 32 years old	10 Officers 25 – 40 years old 07 Male and 03 Female The average age is 29	10 Engineers 25 – 45 years old 06 Male and 04 Female The average age is 29
Occupation	Farmers	Government Officers	Engineering Professionals
Duration	2 Weeks	2 Weeks	2 Weeks
Evaluation of the Study	Survey method (Questionnaire	Survey method (Questionnaire) Structured interview	Structured interview

DISCUSSION / ANALYSIS

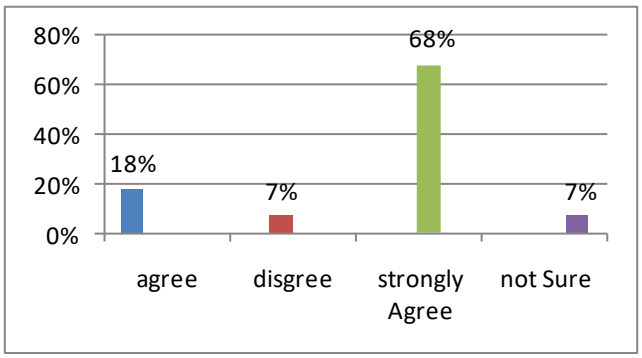

Figure 1: Percentage of respondents' perception: agricultural productivity and economic growth

Figure 1 shows that according to 68 per cent of respondents, economic growth of any nation depends upon agriculture productivity in reducing poverty and enhance the development of the nation.

ISSN: 2005-4289 IJDRBC

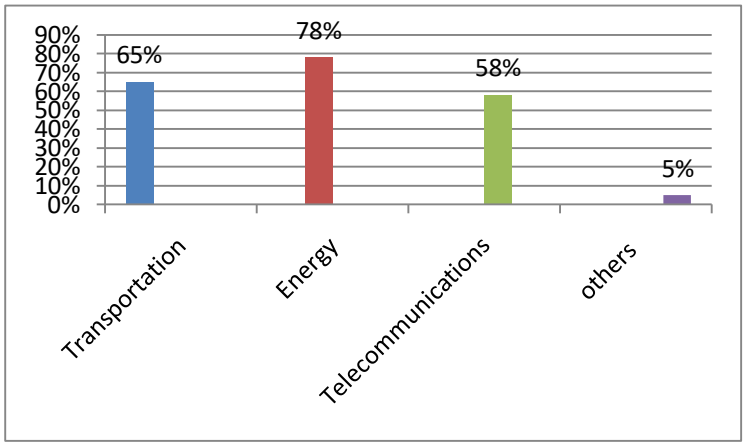

Figure 2: Percentage of respondents' perception: adoption of technology due to rural infrastructure deficiencies

According to response showed in figure 2, 78 per cent respondents think that energy factor is the main component that raises the challenges to adopt technology and 65 per cent respondents think that transportation facility should be available to make the things easy for the farmers as well as telecommunication is the main medium to exchange the information among the farmers.

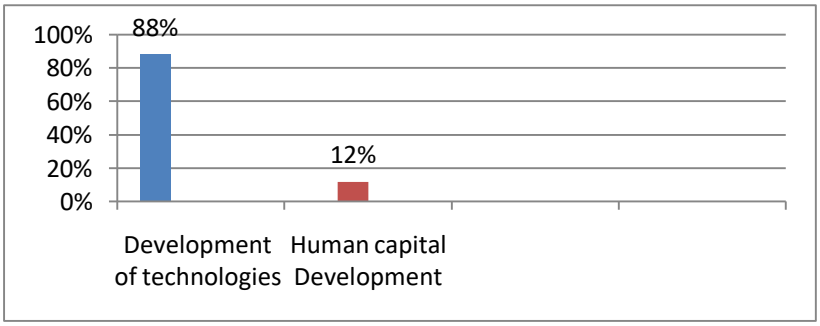

Figure 3: Percentage of respondents' perception: Company Investment

In figure 3, a high percentage of respondents think that companies are more focused on investing money on the development of technologies rather than human capital development.

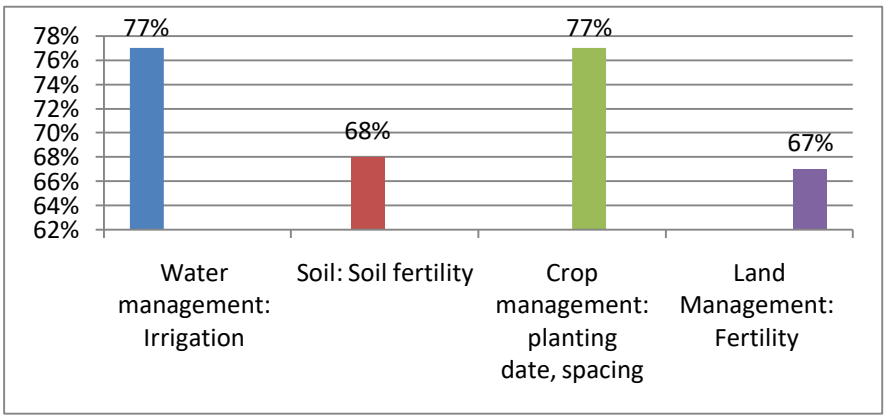

Figure 4: Percentage of respondents' perception: adoption of emerging technologies and resource management.

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Figure 4 shows that according to respondents adoption of emerging agriculture technology will be helpful for the farmers to manage the resources like water, soil, crop, land etc. in improving the crop productivity.

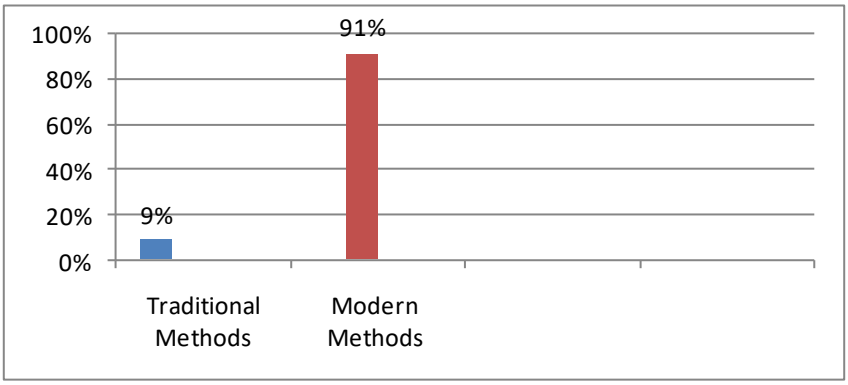

Figure 5: Percentage of respondents' perception: Adoption of Modern and Traditional Methods

Figure 5 states that quality and quantity of agriculture production can be grown if modern methods are adopted by the farmers.91 per cent of respondents are in the favour of adopting emerging agriculture technology to sustain the food production.

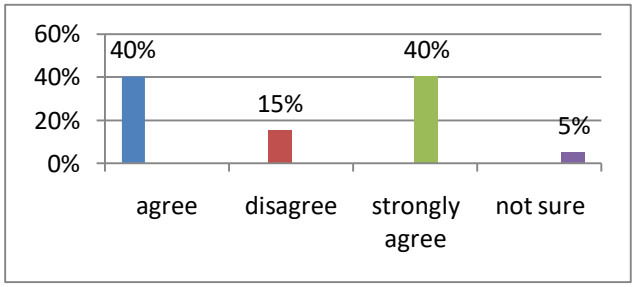

Figure 6: Percentage of respondents' perception: Precision irrigation systems and water scarcity

Figure 6 shows that 80 per cent of respondents are agreed that adoption of precision irrigation technology can help the farmers to save the water. Water shortage is a major problem in India. This problem can be solved adopting of **Precision irrigation systems.**

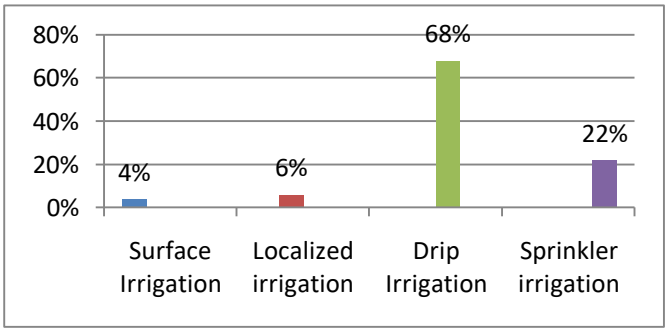

Figure 7: Percentage of respondents' perception: Irrigations Systems

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Figure 7 highlights the percentage of respondents' view on the usefulness of irrigation systems. 68 per cent of respondents have an opinion that drip irrigation will be more useful to save the water. It follows the "less drop more crop concept. According to 22 percent sprinkler can be also useful to save the water but there is more wastage of water due to following spreading concept.

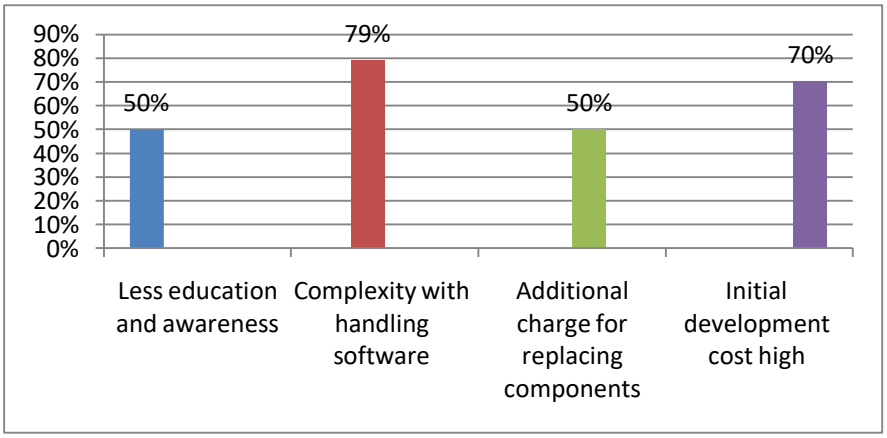

Figure 8: Percentage of respondents: challenges for adopting precision agriculture technology

Figure 8 shows that 60 percents respondents are agreed that for the implementation of precision agriculture technology initial cost will be high. 79 per cent of respondents think that due to less education and awareness of technology among the farmers they are not able to handle software and machine together.

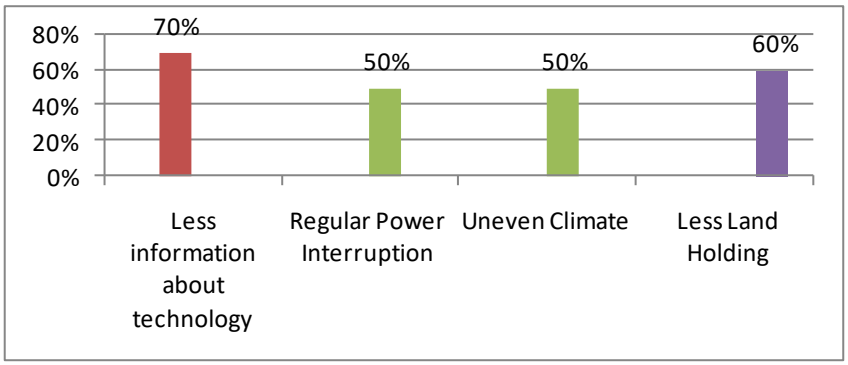

Figure 9: Percentage of respondents: factors affecting adoption of precision irrigation system

Figure 9 shows that 60 percents respondents are agreed that in villages 80 per cent population's survival depends upon agriculture production. Out of 80 per cent, 60 per cent population of small farmers holding land less than 2 hectares. This is the main factor that creates a barrier for them to adopt precision irrigation system. According to 70 percent respondents, another barrier is less awareness of technology among the farmers. 50 per cent of respondents think that regular interruption in power and uneven climate can be other major factors which can be a barrier for adoption of technology.

Scope, Drivers and Barriers for the Adoption of Precision Irrigation in India

Irrigation Technology

ISSN: 2005-4289 IJDRBC

Irrigation is the application of controlled quantities of water to plants at the intervals required. Irrigation helps grow crops, preserve landscapes, and revegetate disturbed soils dry areas and in less than average rainfall periods.

Precision Irrigation is one innovative technique that makes wise use of water and helps farmers achieve higher crop yield levels in a minimal amount of water. Netafim, one of the world's leading providers of agricultural solutions, has now turned to help Indian farmers experience the wonders of precision agriculture.

The four methods of irrigation are Surface, Sprinkler. Drip/trickle, Subsurface.

One of the most effective types of irrigation systems is drip irrigation. The efficiency of water applied and lost and the need for crop water ranges from 80 to 90%.Standard 160 acre system and end piston with actual 132 acres irrigated area installed for, at $48,000 with a power and water source and $30,000 cost of connecting equipment.

Drip, or trickle irrigation, is the system where water is often and slowly applied directly to the root zone of the crops. The concept of this irrigation system is to irrigate only the root zone instead of the whole surface of the field, thus making the crop root zone water content at the optimum level.

In a drip irrigation system, water is applied under the pressure, dripping one Water is applied under pressure in a drip irrigation system, dripping through the small emitters one drop at a time. Water can also be sprayed in small streamlets as a fine mist over a portion of the surface of the field or bubbled into the soil.

Figure 10: Drip Irrigation & Micro Spray Sprinkler

One of the most efficient types of irrigation systems is drip irrigation. The efficiency of the water used and lost and the need for crop water ranges from 80 to 90%. Only two factors result from its efficiency;

1. The soil soaks it before it evaporates

2 by applying water drop by drop. Water is applied to the (localized) crop root zone, where it is most needed

Sub-surface Drip Irrigation

The drip hose can be placed above ground or buried in the ground, which is called the irrigation of sub-surface gout. Sub-surface irrigation has a virtual zero evaporation advantage. It can be more difficult to tell though if an emitter gets plugged or damaged.

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Figure 11: Sub-surface Drip Irrigation

Why Use Drip or Trickle Irrigation System?

Drip irrigation systems do not create pollution and no runoff and very little evapotranspiration when supplying water to plants according to plant water requirements. A farmer can, of course, ensure good water management by using this system. The use of a type of drip irrigation system provides the farmer and the crop producers with other benefits:

- A simple implementation of existing soil sensors.
- Management of soil moisture level; crops are irrigated immediately when soil moisture drops below a threshold.
- Application of fertilizers and pesticides combined with irrigation.
- Reduced weed growth and facilitated management of farm activities in the field due to localized soil wetting.
- Irrigation can be stopped at any moment (if rain occurs) which prevents over irrigation.
- Easy to install, design, and it can be very inexpensive.
- Possible to implement on almost any terrain, soil, and crop type; especially suitable for high-value row crops.

A drip irrigation system is a great solution on crop productions with dry, saline, low drainage soils and on soils where moisture maintenance may result in high insect pests and disease incidence.

Limitations in Using Drip Irrigation System

Despite many benefits, the drip system has also limitation factors for successful implementation on crop production:

- Clogging of emitters due to small outlets, caused by soil particles, chemicals, fertilizers or organic materials
- Damage on plastic pipe caused by rodents
- Uniformity of water distribution due to elevation differences on the unlevelled field
- Potential salt accumulation in crop root zone between two irrigation cycles
- Plants are more susceptible to stress if a drip irrigation system fails

The most efficient and suitable irrigation system is irrigation by drip. Instead of wetting the entire surface of the field, water is only applied to the root zone of the plant. The primary goal of drip irrigation is to apply water when it is most needed by plants and at the rates required for proper growth of the plants. It also provides a very favourable level of moisture in the soil where plants can thrive.

ISSN: 2005-4289 IJDRBC

Advantages of Technology in Agriculture:

- Modern machines can control farmers ' efforts.
- They're reducing time. Used to provide the crops with water.
- They increase the product's price and demand.
- Better marketing and price exposure.
- Online trading and e-commerce facilities.
- Improve soil fertility.
- Reduce water use, fertilizers that keep prices down.
- Low circulation of chemicals and waste materials in seas and water.
- Reduce ecosystem impact.

Disadvantages of Technology in Agriculture:

- Excessive use of chemicals by machines decreases soil fertility.
- Farmers are unable to handle machines properly because of a lack of practical knowledge.
- Maintenance costs are very high.
- Overuse of machines can cause damage to the environment. It is efficient but has many side effects and disadvantages.
- It is the responsibility of the driverless agricultural machine to access technology. The robotic machine was unable to change its culture; we have to manually set its program.
- Most farmers are alphabets so that they cannot use modern machinery.

Benefits of Precision Irrigation

When you water by hand, by runoff or evaporation, more than 50 per cent of the water is wasted. By comparison, automatic irrigation settings offer multiple advantages to reduce the use of your water supply, thus conserving resources while reducing costs.

Saves you water and time

Both sprinkler and drip irrigation systems can be set to daily or weekly watering, as well as timed during day or night for specific hours. The system also shuts off the water automatically once the irrigation process is complete. To be effective, you do not need to be physically present by having an automated system to distribute your water supply. The automatic shutdown will minimize your water use and reduce your costs as less water is being used.

Reduces weed growth

By installing an irrigation system specifically designed for your landscape, it will only receive areas that need water, thereby limiting your potential for weed growth. Drip irrigation systems are particularly efficient here: the system directs water specifically to the roots of each plant, rather than sprinkling all over the garden.

Improves plant growth

ISSN: 2005-4289 IJDRBC

Plants will grow quicker and greener when watered over a longer period with smaller amounts of water, which is exactly what irrigation systems are intended to do. Installing an irrigation system will significantly improve your plant growth.

Preserves soil nutrients

Hand-watering often results in excess water flowing into the soil. Water runoff flows into the soil, removing valuable nutrients from your plants. The use of a hose can also compact the soil, leading to suffocation of plants or root disease. Using an irrigation system preserves your soil structure and keeps nutrients absorbed by your plants, not rippling water.

Factors and Drivers for adopting precision irrigation

Factors conditioning the transition from 'traditional' to 'modern' irrigation technologies:

- Environmental Sphere: Climate conditions, Sources of water, Land quality
- Regulatory Sphere: Subsidies, Water pricing policies, Regulatory clearing, Monitoring capacity
- Farm Sphere: Land ownership, Type of crops, Farmer networks, Farmer skills, Monitoring capacity, Costs of subs. inputs, Output price

SWOT Analysis

Table 1: Strength and Weakness

Strength	Weakness
Energy-saving: energy use for irrigation is a key component of all irrigated crop types, with particular reference to maize and potatoes.	**Investment costs**: These costs limit the adoption of PI mainly for small-scale farmers
Water-saving: The potential for increased water productivity with PI is particularly evident since it reduces the risk of water shortages and increases irrigation capacity.	**Labour efforts:** Big farms reluctant to adopt PI because of managerial constraints.
Optimizing fertigation: Increasing water productivity as an effect also in reducing leaching of nutrients.	**A requirement of highly-skilled labour:** Farmers ' attitude to innovation is inhibited by low educational levels

Table 2: Opportunities & Threats

Opportunities	**Threats**
Low water availability: Water productivity is important where the water resources are limited	**Absence of, or inefficient, water pricing**: Water pricing for most of India's regions are not at the debate. Water pricing affects water uses only for a few regions where water is in demand for

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	irrigation.
Low levels of Field Capacity: Increasing the coarse soil texture increases the frequency of irrigation and the possibility of saving water and energy with PI.	**Lack of Subsidies**: Subventions in India aren't high enough to overcome the financial constraints for PI adoption. Financial factors in India don't substantially limit adoption.
High irregularity in the orography: Irregular orography appears to encourage the adoption of precision irrigation, since this technology should guarantee a more homogeneous use of water.	**Lack of compliance with rules**: The effectiveness of policy initiatives is affected by the low levels of regulatory clearing in certain regions.

Table 3: Barriers and Policies

Barriers	**Policy**
Low PI usability	Research investments aimed at making crop growth models and monitoring tools in-farm easier to use.
Low levels of networking and absence of extension services	Developing advisory services to support farmers in using PI and promoting farmers ' networks (capacity building) to counter the aversion of farmers towards innovation.

SIGNIFICANCE AND PREDICTABLE OUTCOMES

The research outcome proposed gives the reasons for potential uncertainty in India's agricultural production. This research focuses on analyzing major factors that farmers in Maharashtra adopt agricultural technology. This study could be used in the future as a guideline for the farmers to adopt and implement precision irrigation technology to improve the quality and quantity of farm production. Following the principle of precision irrigation or Drip Irrigation technology “less drop more crop”, farmers can save more water for their crop and can be overcome the water scarcity problem. Studied factors will help the farmers to take appropriate steps before adopting agriculture technology especially precision irrigation systems.

CONCLUSION

Adopting of agriculture technology can be the right choice for the farmers in the 21st century. Emerging agriculture technologies can help them to improve their economic status therefore it reduces poverty and enhances the development of the nation.

Scope and factors for adopting the agriculture technology particularly precision irrigation discussed in this study will give the future perspective to the farmers to select the appropriate technology for a right crop that improves the agriculture production and secure the food for growing population.

ISSN: 2005-4289 IJDRBC

LIMITATION AND STUDY FORWARD

This research was limited to selected villages of Pune district. Further research can be possible to find the real effect of precision irrigation technology on agriculture production in a different area of Maharashtra.

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