Research Article

Modern Technology and Scope of Precision Agriculture (PA)

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Article Information

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Abstract

Traditional agriculture practices are time consuming, less productive and uneconomic. Due to uncontrolled use of resources and inputs frequently occurred by farmers caused environmental degradation, land loss and economic loss of farmers. Smart farming known as Precision agriculture which uses the modern technology and tools such as Global position system, Geographic information system, remote sensing and information and communication in integrations provides detail information about crop growth, soil conditions, nutrient level, irrigation systems as data sets which helps to take decisions in right time so that it increases the crop productivity. The use of tools like GPS, GIS and Remote sensing optimize the use of natural resources and inputs for a given crop production and quality. Agriculture becomes more productive and consistent by digital technology and effective use of resources and time. The main gist of this study is to present the scope and implications of the precision agriculture (PA) in future.

Introduction

Nepal a land locked country is agriculture based in south Asia. More than 80% populations were depended on agriculture and National income source was agriculture product (Shrestha & Khanal, 2020). With the development of technology and transportation migration of people increased unexpectedly and brain drain for the search of better opportunity became great challenge. National GDP is totally dependent on the remittance today. Agriculture work is at least priority of people. And above 80% the country is dependent with the foreign import especially from India and China. Nepal has become a big market for our neighboring countries due to which we are spending money to import for our daily uses goods like salt to sugar. National budget are affected due to change in international market price in agriculture goods. Every year the hike in tax on agricultural product becomes an issue of conflicts. The demand and supply is unbalanced and there is shortage of goods. On the other hand, government has no any plan, policy and project to enhance the agricultural product within the country. The shortage of fertilizer becomes a serious problem for the farmer each year. Insufficient fertilizer at the peak time of

crop seasons causes decrease in production rate of main crops like wheat and paddy. The poor irrigation project, practice and lack of knowledge in farmers are another major problem in agriculture. The transportation system is not reliable to transport the crop product to market in time especially in monsoon period. Land slide, flood in river becomes problems for transportation in hilly region of Nepal. Market security of agriculture product is major issue. Farmers are unsecured and hopeless from agriculture work. Uses of technology and mechanization is lagging in agriculture field where as neighboring countries India and china are becoming the leading countries to supply the food and agriculture product to the whole world. To compete with such emerging countries is impossible for underdeveloped country like Nepal. In such condition the agriculture practices with modern technology and mechanization, use of remote sensing, information technology for communication are the useful tools and techniques in agriculture that helps to promote the crop production that refer to the precision agriculture (PA) as smart farming. A precision agriculture practice is digital system which integrates GIS and remote sensing, artificial intelligence (AI) and software in agriculture which helps to optimize the natural resources and make the production more consistent by effective use of available resources

(Njoroge *et al.*, 2018). It helps to protect the environment degradation and loss in ecosystem.

Need of Precision Agriculture

An information and technology based agriculture system identifies ,analyses and manage variabilities in fields by conducting crop production practices at right place and time in right way for optimum profitability, sustainability (Fig.1) and protection of the land resources (Maloku, 2020). In precision practices inputs to the crop are utilized in precise amount to get increased yield amount compared with the traditional cultivation techniques (Mokariya and Malam, 2020). Small plot scale agriculture practices in Nepal are main problems. In hilly area agriculture land plot is very small. In such places commercial horticulture is suitable which show the wider scope of PA in the co-operative farms. Precision agriculture offers the opportunities for automation in gathering and analysis the data for accuracy in order to make the best decision possible which helps to increase the productivity by saving soil, controlling chemical fertilizer, best use of irrigation and changes the socioeconomic condition .In Fig. 2 is the Precision agriculture cycle and Fig. 3 is the model of precision agriculture applied in Missouri (Manufacturers, 2022).
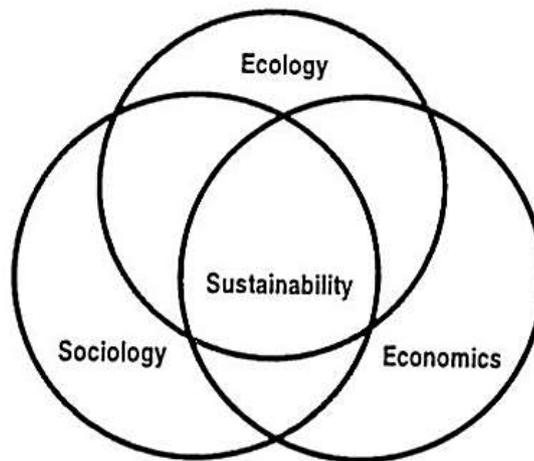

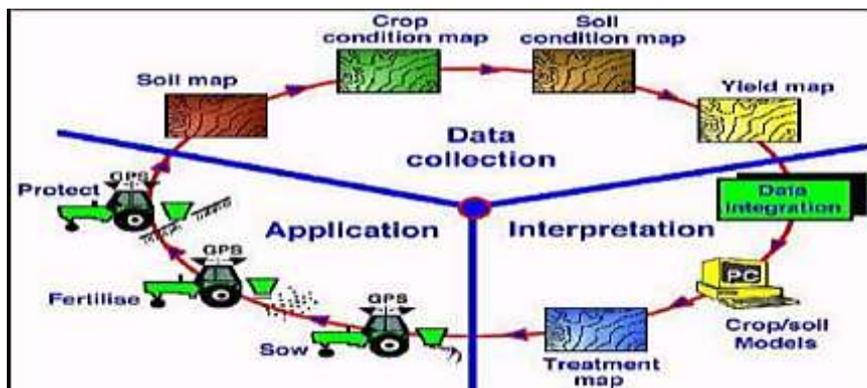**Fig. 1**: Sustainability described by intersection of three disciplines: Ecology, Economics and Sociology

Fig. 2: Precision Agriculture cycle

Fig. 3: Arial view of Central Missouri field of precision agriculture practice.

Components of Precision Agriculture

Precision agriculture is information based and treatment maps needs large amount of data, numerous strategies and planning. It is of three R as right time, amount and place. The main components of PA are use of modern technology, information and smart management(Yadav *et al*., 2017).

Technology:
Farmer should be able to understand the fundamental principles of modern agriculture systems. They must be updated with the technology and its advancement. With the use of modern technology and mechanization productivity and profitability can be increased. Technologies like GIS, Remote sensing and Drone can help to identify and quantify the growth rate and deficiencies in plant easily. They help to know the soil conditions and the moisture content. Nutrients and various crop genetic resources (Meena *et al*., 2021).

Information:
Detail information about the crop conditions and its characteristics, soil properties, pest and diseases, climatic condition, stress(biotic and abiotic) can be used to create maps which can help the farmers to use the information while making site specific decisions.

Management:
Smart management creates a complete planning by combining the information and technology. Precise management makes crop production feasible. Farmer should be able to evaluate the data correctly and use of technology effectively.

Tools of Precision Agriculture

Farmers should be knowledgeable about the tools and technologies available. Computer based applications are used to create precise farm plans, field maps, crop scouting, yield and to define the exact amount of inputs to be applied to fields. This helps to design a friendly agriculture strategy which helps to lower costs and boosts yields. The fundamental tools needed for precision agriculture are as (Sahu *et al*., 2019)

Global Positioning System (GPS):
One of the fundamental technologies that enable precision agriculture is global position system (GPS). It is a satellite-based navigation system that provides the location and real time information in all weather conditions, anywhere on or near earth surface. One of the main ways GPS is used in precision agriculture is for mapping and field–level data collection. Farmers can use GPS receivers mounted on their vehicles or equipment to collect data on the location, shape, size of their fields as well as the location of specific features within the filed such as irrigation systems, drainage ditches, and fence lines. The data are used to prepare the detail maps and are used for planning and scheduling filed operations, implementations of variable rate technology in agriculture input management and analyzing field performance. Farmers can navigate their fields with the help of GPS with high degree of accuracy reducing risk of errors and increasing efficiency.

Geographical Information System (GIS):
A geographic information system (GIS) consists of computer software database system to input, store, retrieve, analyze and display in graphical map referenced graphical information. In precision agriculture GIS allows multiple detailed data to be drawn graphically, which can be used for decision-making. A farming GIS database can provide information on field topography, soil types, surface drainage, subsurface drainage, soil testing, irrigation, chemical application rates and crop yield. Once analyzed, this information is used to understand the relationships between the various elements affecting a crop on a specific site. Farmer can use GIS to identify the most suitable locations for planting certain crops or to identify areas that are most vulnerable to pests or diseases.

Grid Sampling for Targeted Farming:
Grid sampling is technique for segmenting fields into around 0.5 to 5 ha size units. Those grids soil sample will be used to calculate the proper application rates for crop inputs. The grid samples are then collected combined and delivered to the lab for evaluation. Grid sampling can be used to collect soil samples from different parts of fields. In

order to understand the spatial variability of soil characteristics such as PH value, nutrient value and organic matter. This information can be used to make informed about fertilization and irrigation.

Remote Sensor Technology:

Remote sensor technology is a key component of precision agriculture. They are categorized as Arial or satellite sensors. They provide information on soil qualities and plant fertility/water status. Various technologies such as electromagnetic, conductivity, photo electricity and ultrasound are used to measure humidity, vegetation, temperature, texture, structure, physical character, humidity, nutrient level, vapour, air etc. Remote sensing data are used to distinguish crop species, locate stress conditions, identify pests and weeds, and monitor drought, soil and plant conditions

Variable –Rate Technology (VRT):

It consists of farm field equipment with the ability to precisely control the rate of application of crop inputs that can be varied in their application including tillage, insect control, fertilizer, plant population and irrigation. VRT's objectives are maximizing profit to the fullest extent possible, improving input application efficiencies, and ensuring long-term sustainability and environmental safety. These are automatic and can be applied to numerous farming operations. It sets the rate of delivery of farm inputs depending on the soil type noted in a soil map. Information extrapolated from the GIS can control processes, such as seeding, fertilizer and pesticide application, herbicide selection and application at a variable rate in the right place at the right time.

Advantages of Precision Agriculture

Modern PA can help farmers to increase the production by optimization of resources that minimize the cost of material and resources like seeds, water, fuel and fertilizer (Meena *et al.*, 2021). The farmer will be able to know the use of pesticides which improve the soil health, vegetation cover. With the control of leaching effect of nitrogen from crops the ground water contamination will be reduced which helps to reduce environmental impacts (Manufacturers, 2022). Farmer can realize the genetic potential of the crop produced. With the help of the tools and technologies in precision agriculture the selection of right time, place and crop type will help farmer to improve the agriculture product by crop variation. With the availability of topographic data for fields implemented with P.A. technologies, the interaction between tillage and soil/water erosion can be examined. Thus, a reduction in erosion can be achieved.

Limitation of Precision Agriculture

Modern precision agriculture is found expensive as initial cost to be invested is high (McBratney *et al.*, 2005). The

maintenance cost for hardware, software and infrastructure needed will be high. It requires high level of technical and analytical skills from farmers which may not have. Farmers may face social, cultural or ethical barriers to change their traditional practices and mindsets. Farmers must be updated with new age technology which is difficult for low class farmers and must be trained. In many villages, strong, reliable internet connectivity is not available. Unless there is a significant improvement in network performances and bandwidth speeds, P.A. will remain problematic. Cloud-based computing also needs to become stronger.

Future Scope of Precision Agriculture

With the development of new tools of technology, the traditional agriculture systems are replaced. A precision agriculture practice seems expensive initially but in long run is beneficial to farmers. The technology helps to promote the productivity of crop which eventually helps to improve the economic condition of the farmers. It preserves the environment and optimizes the resources use. With the development of artificial intelligence, the integration of other emerging technology the precision agriculture can be greatly enhanced. AI can enable PA to use machine learning, computer vision, natural language processing and other techniques to process and analyze data sets, generate insights and predictions, and automate decision making and action. Internet of things can enable precision agriculture to connect with the network of devices, sensor and actuators that collect and transmit data in real time and control remotely.AI can help farmer to diagnose the crop disease, optimize crop rotation. It helps to farmer to monitor soil moisture, adjust irrigation level and activate sprinklers automatically. According to a study by Roland Berger Strategy Consultants GmbH, its compound annual growth rate (CAGR) is about 12%. The key to this development process is connectivity. The more significant challenge of the P.A. is handling, storing and processing the data and connecting the different devices (Study, 2016).

Conclusion

Despite the limitation precision farming offers a new system-based solution to the agriculture issues and challenges. It helps to increase the productivity and protect the environmental impacts. It helps to increase economic returns. In underdeveloped countries this practice is still to be started as they are not capable to afford for the technology. The small scale plots for agriculture are barrier to apply the precision agriculture practice as it will be expensive for small and marginal farmers. And the expensive precision agriculture technology would not be cost effective. To encourage the swift adaption of PA technologies, deliberate support from public and private sector is crucial to make it beneficial. Its success depends on quick development of information to guide the new technology. From Precision agriculture farmers will be

benefited however there are hurdle in data security, technology malfunctioning and loss in job.

Conflict of Interest

Author has no any conflict of Interest with the present study.

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