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Promoting Precision Farming in India for betterment future of Indian Agriculture

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ABSTRACT: Precision Agriculture concept is based on observing, measuring and responding to inter and intra field variability in crops (Stafford, 1997). The concept of precision agriculture first emerged in the United States (US) in the early 1980s. It is a system to manage crops and land selectivity according to their needs.Precision Agriculture integrates the latest information technology tools and techniques to enable farm managers to get a better understanding and control of their needs like GPS (Global Positioning System), GIS (Geographic Information System), RS (Remote Sensing), LCC (Leaf Colour Chart) and LLL (Laser Land Leveler). So, it is an approach where inputs are utilized in precise amount to get maximum yield by these techniques. GPS is an instrument that receives satellite signals and helps to make the soil and yield maps (Razdari, 2014). GIS is a computer based system for storing, retrieving, manipulating and displaying the spatial and geographical data (Anand and Bhatt, 1997). Remote sensing has the capacity to assist the adaptive evolution of agricultural practices in order to face the major challenges, by providing repetitive information on crop status (Shanmugapriya and Janaki, 2018). Laser Land Leveler is used to smoothen the land surface by using guided laser beam throughout the field (Aryal and Mehrotra, 2015). According to the report of National Agricultural Science Center (NASC), Laser leveling in rice fields reduced irrigation time by 47-69 h/ha/season and improved yield by approximately 7% compared with traditionally leveled fields. In wheat field, irrigation time was reduced by 10-12 h/ha/season and yield increased by 7-9% in laser leveled fields (Aryal, 2015). Leaf colour chart is used to determine the nitrogen fertilizer needs of any crops especially rice and wheat crop (Bhatt et al, 2017). Soil Plant Analysis Development (SPAD) meter is one of the most commonly used diagnostic tools to measure chlorophyll content and nitrogen status of crop (Islam and Karim, 2014). So, these technologies help the farmers to decide when to plant and harvest crops. As a result, precision farming can improve time management, reduce water and chemical use and produce healthier crops and higher yield.

Keywords: Precision agriculture, Field variability, GPS, Satellite signals, GIS, Remote Sensing, laser land leveler, SPAD meter

I. INTRODUCTION

Precision farming is an ancient farming in a modern way to achieve maximum agriculture production through improving the precision of existing agronomic management activities by implementing them. It is the latest development in the world agriculture including India. Precision farming is an approach where the exploitation of inputis in specific amount to improve the average yields. At the present time, it has been extremely highlighted to intensify the productivity, profitability and resource use efficiencies.The principleofPrecision farming is need based right input application in right time at right place in a right manner, so as to obtain highest production. Now days, it is one of any approach in which can make production more effectual. Thus, concept of precision farming gives the promise of productivity although increase the production cost & reduce the environmental impacts (Hakkim et al., 2016).

1.1 Global Scenario

During geological history, the concept of Precision agriculture firstly developed in United States (U.S.) in early 1980s. End of the 1980s, this technique was produce to operate the first input recommendation maps for fertilizer and pH corrections. In America, the leading country is Argentina, in which it was introduced in 1990s with the support of National Agriculture Technology Institute (INTA). North America is the early adopters of such technology and adoption rate are so high in many of the smart technology presently used in precision agriculture. In India, such farming are mostly practiced in southern states such as Andhra Pradesh, Telangana and Tamil Nadu. Among the developing countries, India ranks fourth position in precision agriculture. Argentina, Brazil, China, India, Malaysia are those which have start to adopt some components of precision agriculture (Dwivedi et al., 2017).

1.2 IndianScenario

Precision Farming is mostly well known in developed countries. It is still at growing stage in developing countries including India. The first thing that comes to the mind is that, this system is not for developing countries including India, where the farmers has poor farming and the land holding size is small. But in India, some are the agriculturally progressive states such as Punjab, Haryana, Rajasthan, Gujarat where 20% of agriculture land have operational land holdings of 4 ha or more. Precision farming concept was being implement by Tata Kisan Kendra (provide the inputs such as seed, fertilizers to farmers at affordable prices and also provide agronomic services such as soil testing, soil mapping and fertilizer testing). The study on precision agriculturehas been initiated in many research institutes like M.S. Swami Nathan foundation, Chennai in collaboration with NABARD, has adopted in a village of Dindigul district of Tamil Nadu for variable rate input application. IARI, New Delhi has drawn up plans to do PA(Precision Agriculture) experiments in the institute's farm. ISRO (Space application center), Ahmedabad has started experiment in the CPRS (Central Potato Research Station farm at Jalandhar, Punjab) to study the role of RS (Remote sensing), GIS (Geographic Information System) and GPS (Global Positioning System). PFDCs (Precision Farming Development Centers) located in different parts of India which are mainly works on Precision irrigation water management (Mandal et al., 2013).

II. NEED OF PRECISION FARMING

Today, the global food has expressed some fearful challenges. So, Precision farming is the key component to overcome these challenges. These challenges are:Diminishing the total productivity, natural resources, farm incomes land holdings, employment opportunities in non-farm sector and global climatic variation has major concerns in government growth and development (Dwivedi et al., 2017).

III. OBJECTIVES OF PRECISION FARMING

Precision agriculture is one of any modern technique in which the production more efficient. Some are the tips which improve the quality of product. Firstly, create a long term plan for quality improvement, break it into small steps and then make changes to achieve goals of each step.Chemical fertilizers allow growers to maximize their crop yield on a specific piece of land. Fertilizer works to ensure that each piece of land produces as efficiently as possible. To conserve the energy source are the major role in precision farming management. Conservation principles tell us that some quantity and quality of products remain constant. In this farming, use fewer chemicals in the working area. By this, we protect the soil and ground water from chemical pollution (Dwivedi et al., 2017).

IV. BASIC STEPS IN PRECISION FARMING

There are five steps to start the precision farming:-Measure, Make sections, Digital v/s Physical, Guidance line management, Precision Agronomy. Firstly, we measure the accuracy of the tools or technologies which have major concern with precision farming and know about the financial loss or profit from it. Then, we collect the data from the field with the help of these technologies. After that, we make the yield map with the help of these collected data. Farmer divides the field into small sections; with this, the application of technology can easily applied because in larger field, the technology may be applied more difficult. It is digital and physical farming because in this farming, we apply some geospatial technology and special type of tools like GPS, GIS, RS, LCC chart and SPAD meter which have the major role in this farming.In guidance line management,managing the lines year after year are most important which increases the farm activities. To manage the lines with the help of computer software, we make the maps by collected data and then evaluate the lines which can we used again then, display the geographical data with the application of technology. In the last step, we apply the concept of 5 R'S of precision agriculture i.e. Right input in right amount at right time at right place in the right manner (Jones, 2017).

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V. COMPONENTS OF PRECISION FARMING

5.1 Global Positioning System (GPS)

It is a space navigation system or computer based system that provide location or time information in all weather conditions or near the earth surface. Role of GPS in agriculture farm planning, field mapping, soilmapping, tractor guidance, crop scouting and yield mapping. Soil map are prepared with the help by collecting the soil sample. It allow the required data to accurately decide the soil variability and set up whether a given type of soil is perfect for the growth of a particular crop and also helps in determining the soils that are viable and those that are not. The method usually done on a 2.5 acre grid with 4 to 6 samples taken in each grid. Each samples taken in numbered and geographically referenced using a GPS receiver. GPS can also detect weed patches in vast areas of lands. Weed usually inhibitsthe effective growth and reduction of crop yields over a given period of time. Weed data restored into the GIS system based on geographic coordinates determined by GPS. GPS also comes in handy when planning the planting of a given crop. Each seed has specific spacing and depth required depending on soil type. Using GPS, it is easier to tell what spacing a given seed requires and to what depth the seed should be planted in order to return maximum yields. GPS plays an important role in determination of what area of a farm is ready to be harvested and how the harvesting take place. After harvesting, create the yield map with the help of yield monitor (Razdariet al., 2014). Yield mapping and monitoring are the technique of using GPS data to examine the variables such as crop yield and moisture content in a given field. Yield mapping systems record the relative spatial distribution of yield while crop is being harvested. The yield monitors are attached to the combines to measure the yield & moisture content of grain and collect the data from the GPS sensors which are mounted on the combine and prepare the yield map from these collecteddata (Singh et al., 2013).

5.2 Geographic Information System (GIS)

It is a computer based system for storing large amount of data (collected based on spatial location) retrieving, manipulating, displaying them for easy interpretation (Anand & Bhatt, 1997). Hardware is a computer system on which a GIS operates. GIS Software provides the functions and tools needed to store, analyze and display geographic information. Data operates in the form of table and chart or in some mathematical models with GIS. The source of spatial data is digitalized maps, aerial photographs and satellite images. GIS technology has limited value without people who manage the system and to develop plans for applying it (Tahir et al., 2016). A successful GIS operates according to a well- designed plan and business rules. Therefore, GIS can analyze soil data combined with historical farming practices to determine,which one is the best crop to plant, where they should go and how to maintain soil nutrition levels are best benefit for the plants. A data layers of GIS represent in map of an agriculture area, one layer might represent the boundaries of the piece of land, a second layer; soil types, another the crop yield or a specific soil treatment and still another, irrigation. GIS can show, for example- How the relationship between soil type, fertilizer and water affectthe crop yield on a square acre of land (Sood et al., 2015).

5.3 Remote Sensing (RS)

It is the acquisition of reliable information about an object without being in physical contact with the object (Shanmugapriya et al., 2019). To observe the object by a device separated from it by some distance utilizing the characteristics response of different objects to emissions in the electromagnetic energy is measured in a number of spectral bands for purpose of identification of object. They can indicate colour variations of the field that corresponds to changes in soil type, crop development, field boundaries, roads and water.There are some applications in agriculture field i.e. it is used to forecast the expected crop production and yield over a given area & determine how much of the crop will be harvested under specific condition.In the event of crop damage and crop progress, RS technology can be used to penetrate the farmland and determine exactly how much of a given crop has been damaged and the progress of the remaining crop in the farm.RS has also played an important role in crop identification especially in cases where the crop under observation. The data from the crop is collected and taken to the labs where various aspects of the crops are studied.RS has also played a very important role in the estimation of farmland on which crop has been planted.RS technology plays an important role in the assessment of the health condition of ach crop and the extent to which the crop are under stressed condition. This data is then used to determine the quality of the crop. RS technology also plays a significant role in the identification of the pests in farmland and gives data on the right pest control mechanism.RS technology has also helped farmers and other agriculture experts to determine the extent of crop nutrient deficiency and

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come up with remedies that would increase the nutrients level in crops hence increasing the overall crop yield.RS gives information on the moisture quantity of soils. This information is used to determine whether a particular soil is moisture deficient or not and helps in planting the irrigation needs of the soils. Because of the predictive nature of the RS technology, farmers can now use RS to observe a variety of factors including the weather patterns and the soil types to predict the planting and harvesting seasons of each crop.RS also allows predicting the expected crop yield from a given farmland by estimating the quality of the crop and the extent of the farmland. This is then used to determine the overall expected yield of the crop (Sinha et al., 2018)

5.4 Agricultural drones

In India, there are over 35 drone start-ups that are working to raise the technological standards and less prices of agricultural drones**.** It is the unmanned flying medium used to help to improve the agricultural operations, increase crop production and in crop monitoring. Sensors and digital imaging capabilities can give farmers a richer picture of their fields. This bird's-eye view can reveal many issues such as irrigation problems, soil variation and pest and fungal infestations. Itrecords the data from the crops with the help of digitalized images. This allows the farmer time to focus on the big picture of production rather the spending time surveying their crops. The combination shows the farmer differences between healthy and unhealthy plants. With the support of precision farming, drones can do soil health scans, crop monitoring, assist in planning irrigation schedules, apply fertilizers, yield data estimation and provide valuable data for weather analysis. Indian Council of Agricultural Research ICAR has already started application based projects on drone. Custom hiring of drones services for precision farming may be the common trend for large farms in near future but how far it will be successful for small and marginal farmers is still a function of input costs and market prices (Mukherjee, 2017).

5.5 Laser Land Leveler (LLL)

The laser land levelling is an operation in which flattening the land surface from its average elevation with a certain degree of desired slope with the help of guided beam all over the field.So, LLL is a simple operation to prepare the land before sowing. We know that undulated land does not have more water absorption capacity and also the farm productivity. With the support of Laser-levelling; in**Rice fields,** reduced irrigation time by **47-69 hours/ha/season** and improved yields approximately **7%** as compared with traditionally fields. In **Wheat field**, irrigation time was reduced by **10-12 hours/ha/season** and yield increased by **7-9 %** in laser leveled fields (Aryal, 2015).The study challenges is that only large holder or rich farmers can afford and benefit from laser- levelers. In fact, LLL is common for small holder farmers to rent the equipment 4-5 hours use in 1 ha land. The efficiency of laser land leveler are 3 years. It saves the irrigation water about >35%, labour costs, time, reduce weeds, increase in field areas about 3.5%. With the laser guided technology the only error possible is human error (Lohan et al., 2014)

Table 1. Wheat and rice yields under Laser Land Levelling (LLL) and Traditional Land Levelling (TLL) in Haryana and Punjab determined 1 year after levelling (Aryal et al.,2015)

State and crop	**Average yield (kg/ha)**		**Average yield difference (kg/ha)**	**t-test**
	LLL	**TLL**		
Haryana-Wheat	4576 (84.94)	4291 (79.42)	285	2.46
Haryana-Rice	5617 (184.66)	5295 (179.28)	322	1.25
Punjab-Wheat	4444 (57.25)	4083 (57.71)	361	4.36
Punjab-Rice	6168 (240.08)	5807 (232.91)	361	1.08

Significant at 99% confidence level

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In Table 1,Aryal et al., 2015 carried on research on the average yield of both wheat and rice yields under laser land leveler and traditional land leveler in Punjab and Haryana. In this table, it is clear that average yields of both wheat and rice were higher under LLL as compared to TLL. The average yields of wheat in Haryana with LLL and TLL were 4576 kg/ha and 4291 kg/ha respectively and this difference is statistically significant at 10% level. Similar in the case of rice field in Haryana, the average yield of rice under LLL and TLL were 5617kg/ha and 5295kg/ha respectively. This difference is greater but it is not statistically significant as the rice yield was much greater. Similarly, In Punjab, the wheat yield was 4083kg/ha in TLL and 4444kg/ha in LLL, an increase of 361kg/ha which was statistically at 1% level. Although the yield difference in rice in Punjab was also 361kg/ha, this was not statistically significant. This shows that the difference in yields between laser levelling and traditional levelling was slightly higher in Punjab and Haryana.

5.6 Leaf Colour Chart (LCC)

With the help ofLCC, farmers can decide proper time and amount of N fertilizer for application, hence reducing the nitrogen losses. It is the cheapest and easiest tool for nitrogen assessment and management. It is an easy tool for the need and assessment of nitrogen in paddy, maize, sugarcane, potato and vegetable crops. It saves 20-30 kg of nitrogen per hectare. By LCC; firstly, choose the 10 healthy plants from 14 DAT or 21 DAS where plants extended in equally.Now compare it with LCC of those 10 plants parts which has fully extended leaf only.Measuring time 8:00-10:00AM or 2:00- 4:00 PM and one important thing is that – in the time of measuring do not penetrate the light in that plants so make a shade. Only one person takes a reading from first to last. Take a reading every 7-10 days interval (Satpute et al., 2014)

5.7 Soil Plant Analysis Development (SPAD)

It is one of the most commonly used diagnostic tools to measure the chlorophyll content & nitrogen status of the crop (Islam, 2017).

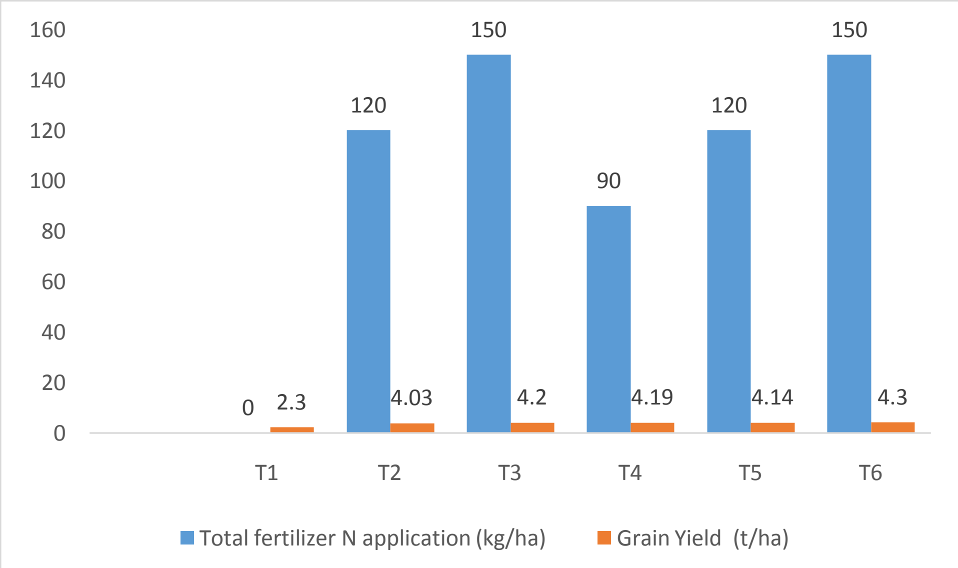
TABLE 2. Effect of different nitrogen management treatments on growth yield attributes and grain yield of wheat (Chaturvedi et al., 2017)

Treatments	**Total dose of N**	**Plant height (cm)**		**Leaf area index (LAI)**		**Number of grain/spike**	**1000 grain weight**	**Grain yield (t/ha)**
		60DAS	**90DAS**	**60DAS**	**90DAS**			
Control (no N)	0	22.1	38.0	2.4	1.6	30.6	28.6	1.3
Recommended N	150	37.3	93.8	4.1	2.9	49.2	46.4	4.3
@30 kg at LCC 4	85	30.5	80.6	3.4	2.4	35.3	35.6	2.6
@40 kg at LCC 4	105	35.1	90.6	3.9	2.5	47.1	44.0	3.8
@30 kg at LCC 4	85	32.6	80.9	3.5	2.5	36.3	36.0	2.7
@40 kg at LCC 5	105	34.4	91.3	4.0	2.6	47.8	44.0	4.1
@30 kg at SPAD 40	85	33.2	84.7	3.5	2.4	37.5	36.0	2.8
@30 kg at CRI+ @30 kg at SPAD 40	85	35.5	84.6	3.6	2.4	37.3	36.0	2.7
@40 kg at CRI+40kg at SPAF40	105	36.0	92.0	4.0	2.7	47.8	44.2	4.0
SEm.±		1.7	2.6	0.3	0.2	2.3	2.8	2.0
CD (P= 0.05)		5.1	7.7	0.8	0.6	6.8	8.3	0.6

25 kg N/ha was applied as basal, recommended N 150 kg/ha in 3 equal splits, i.e. 50 kg/ha as basal, 50 kg/ha at crown root initiation (CRI stage) & 50 kg/ha at maximum tillering stage.

In **TABLE 2**, the goal of the study to explore the effect of LCC & chlorophyll meter (SPAD meter) based nitrogen management on wheat crop. The mode of all the growth parameters viz. Plant height, Leaf Area Index (LAI) at 60 and 90 days after sowing disclose that all the N management treatments. Maximum value of above parameters were indicate in recommended Nitrogen management i.e. 150 kg N/ha. Though, they were at equal with real time nitrogen management at lower rate of 105 kg/ha based on LCC value (4 and 5) and SPAD (30 and 40) which include application of N for two time application of 40 kg at LCC 4, 5& SPAD 40 and 25 kg as basal + 40 kg at CRI stage + 40 kg at SPAD 40. So, the nitrogen application which is based on LCC and SPAD was concluded as per the crop need alternately at fixed time. Yield attributes viz. No. of grains per spike, 1000 grains weight exhibit increasing the tendency with increasing the rate of nitrogen. Real time N management of 105 kg N/ha found on given LCC & SPAD values with recommended N management for all the given yield attributes. The tendency are equal to what observed first in growth parameters like plant height, LAI. The final yield is a cumulative effect of growth & the yield component. Statistically, the growth & yield component resulted no significant difference in grain yield in real time management of 105 kg N/ ha and recommended N management at fixed time.

Table 3.Effect of N application on grain yield by leaf Colour Chart (LCC) on Maize crop (Kumar et al., 2015)

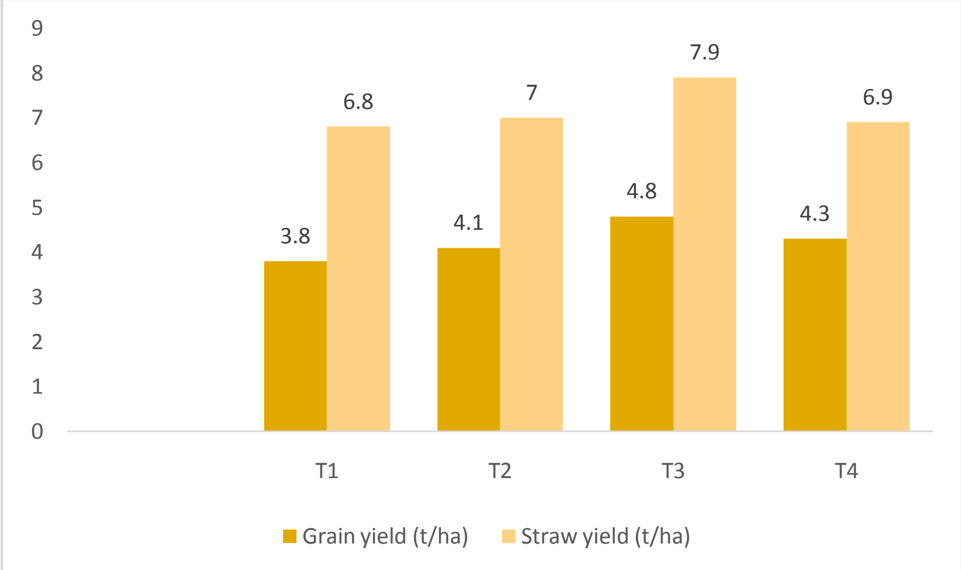


Treatment Detail	**Total fertilizer N application (kg/ha) (c.v. Parbhat)**	**Grain Yield (t/ha)**
T_1 : No-N control	0	2.30
T_2:120kgN/ha in three equal splits	120	4.03
T_3:150kgN/ha in three equal splits	150	4.20
T_4 : Need based-LCC<5(V6 to before R1 stage)	90	4.19
T_5:Need based-LCC<5.5(V6 to before R1 stage)	120	4.14
T_6:Need based-LCC<5.5(V6 to before RI stage) and LCC<6(at R1 stage	150	4.30

V6 is six leaf stages& R1 is Silking stage

In **table 3,** thestudy shows the effect of N application on grain yield by LCC on Maize crop. When amount of N application are not applied then it gives lower yield i.e. 2.3 t/ha and the grain yield are high i.e. 4.3 t/ha, where the amount of N i.e. 150 kg/ha applied. This amount were applied on the combination of both need based LCC<5.5 & LCC<6.

Table 4. Effect of improved agricultural implements on growth and yield of wheat (Gill et al., 2017)



Treatment	Plant height (cm)	Number of grains/spike	Grain yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)	Harvest index (%)
T1	88.9	37.2	3.8	6.8	10.7	36.0
T2	91.9	39.1	4.1	7.0	11.1	36.7
T3	104.1	50.3	4.8	7.9	12.7	37.9
T4	89.7	47.9	4.3	6.9	11.3	38.9
SEm.±	2.1	2.1	0.1	0.2	0.5	0.5
CD (p=0.05)	7.1	7.2	0.4	0.7	1.9	1.9

Here, **T1**=Broadcasting, **T2**= Ordinary seed drill, **T3**= Precision seed drill, **T4**= Zero till drill

In **Table 4**, the result of grain yield of wheat i.e. 4.8 t/ha with the operation of precision seed drill was extend significantly as compared to all other methods of seeding. While, in the event of broadcasting technique, the yield was low i.e. 3.8 t/ha. However, the yield performance under precision plot drill was maximum i.e. 4.8% which are followed by zero till drill (4.3%) and ordinary seed drill (4.1%).

VI. PRECISION FARMING CYCLE

Cycle is divided into 3 groups- Data collection, Interpretation and Application. In data collection; the cycle starts from the soil map. Firstly, collect the soil sample at different location of the field with the help of GPS then mapping is done to find out where the nutrient deficiencies have come. Then next step is crop condition mapping, we know that the crop is related to the soil. Now, the deficiencies in the soil will also go automatically into the crop so what will be the condition of the crop at that time. Similarly, in soil condition mapping; for example we grow maize or potato crop which are generally uptake the nutrient so what effect does it have on the condition of the soil. This is causing the gain or loss to the soil then what the effect of it on the yield. So, in this way we make the soil & yield map with these collected data.In Interpretation; firstly merge the data & then prepare the soil & crop models, which are generally mathematical based models which are stored into the computer software. Then, a treatment map is created. In this treatment map, how can we correct it. In Application, how to apply right amount of inputs like seeds, fertilizers & the application of the chemical fertilizers through GPS in exact amount at right place (Comparetti, 2015)

VII. BENEFITS OF PRECISION FARMING

By this farming, we use agronomic practices by looking at specific requirements of the crop.Over the last few decades; many new technologies have been developed for precision farming. So, it is an approach to farm management that uses information technology to ensure that crops and soil receives exactly what they need for optimum health and productivity. It allows efficient time management.Precision farming is eco-friendly in nature for each & every crop.Precision farming increases the crop yield, quality and reduce the cost of production by efficiently use of farm inputs, labour, water resources (Mandal et al., 2013).

VIII. LIMITATIONS OF PRECISION FARMING

Initial capital costs may be high; it should be seen as a long- term investment. Techniques are still under development & so it is important to take specialist advice before making expensive decisions.Lack of skills to use complex tools & techniques**.** Cultural issues like small land holding size, lack of mechanization and illiteracy of farmers (Kumar, 2018).

IX. HOW COULD INDIA BENEFIT FROM PRECISION FARMING?

Ithas capacity to transform the modern farm management in India through improvement in profitability, productivity, sustainability, crop quality, environmental protection, on-farm quality of life, food safety & rural economic development. The input costs minimize by 18-20% & improve yield of crop by 30% in the rice and wheat crop & 10% in sugarcane, fruits and vegetables (Madhavan, 2015). Site specific application of irrigation in wheat of Punjab & pesticides in Haryana on cotton crop & efficient use of fertilizer application in oil palm plantation in South India can highly reduce production costs & also reduce environmental loading of chemicals. In 2019, Patiala district of Punjab, with the help of aerial data, the some fields of Patiala field are merge to each other & make the large field for application of technology has easily applied.The increase in stubble burning in the state of Haryana, Government has started supporting farmers with 50% subsidy on cost farm equipment. India's first ethanol plant set up at Panipat, Haryana state, which will convert paddy straw into ethanol (Mohan, 2019).In India, there are many operations which are launched by government i.e. Trimble, Intello labs, Technical Mahindra Limited, Fasal, Crofarm platform (Mahindra & Mahindra ltd., 2019).With Precision agriculture, Farmers can increase their revenue by 35% to 60% per acre.Foreign companies (Mothive, CropX) can plays an important role in supplying these new technologies to Indian community. Though, there are many Indian companies active, close to 267 million farmers need. Under the farm mechanization scheme, the government is increase custom hiring centers in the country. Where farmers can rent any high end agriculture equipment (Mehta, 2019). Government also launched the multilingual mobile app 'CHC- Farm Machinery'. It helps the farmers to rent farm machinery & implements through a CHC in their area. 2300 CHC have been established in 2019-20. Narendra Singh Tomar has launched the CHC app in 2019 (Srinivas, 2017)

X. POLICY APPROACH TO PROMOTE PRECISION FARMING AT FARM LEVEL

Firstly, point out the areas for the promotion of crop specific Precision farming.For Precision farming technology, promote the progressive farmers who are able to change the position of their farming business into the future.Encourage the farmers to study of spatial & temporal variability of input parameters.Provide complete technical backup support to the farmers to develop the models which can be replicated on a large scale.Creating awareness amongst farmers about the results of applied uneven doses of farm inputs like irrigation, fertilizers, insecticides & pesticides (Hakkim et al., 2016).

XI. WAY FORWARD

Within developing countries, India should adopt technology based on socio- economic condition of country. The most important module in taking precision agriculture forward will be in creating huge resources for agriculturists to develop various component of the technology. Farmers with small land holdings are already hiring tractors and other farm equipments, instead of buying them, from custom hiring centers. The government should re-orient subsidies away from products to technology based farming. Government institutes, extension services & farmers have to work together, interact & collaborate to develop smart systems in Precision Agriculture. The extension agents convince the farms to adopt the technology.

The extension agents are link between researchers & farmers and if this link is properly strengthened, more technology would go to farmers & farmer inputs to technology creation would be higher. Government policies have significant impact on adoption of technologies.The development of field schools where farmers learn by doing, tend to be more successful in the process of technology adoption. Farmer schools are better. Public lectures are often well received by the farmers. Training is most important factor for adoption of technology. Farmers have been trained on IPM (Integrated Pest Management) in crop production from extension workers. For those farmers who adopted low seeding rate & less fertilizer through using LCC to reduce N fertilizer in rice and wheat crop because they found that low seeding rate & less fertilizer application reduce disease infestation of rice &wheat (Shankar, 2017).

Can we transform the agriculture?

Yes, through Precision Farming; Average yield per hectare of land which gives maximum returns (From productive to profitable agriculture). Precision Agriculture contributes to sustainable by enabling farmers to increase yields with fewer inputs than other application methods like broadcasting. Competitive agriculture because individual farmers have almost no control over the market price of their goods (Sustainable to competitive agriculture). Product driven means firstly make the product then trying to find a market for them & market driven means make the products that farmers want to buy (Production driven to market driven).

XII. CONCLUSION

Precision farming models are not complete, unless the parameters related to empowerment of the farmers, especially small & marginal farmers are integrated. Now, it is the turn of good news to the Indian farming community i.e. some of the research institutes of India work on precision farming experiments rapidly. The efforts of these institutes will expect to turn the green revolution into an evergreen revolution. It can help in reducing cost of production and increase profits and marginal returns. Application of GPS, GIS and RS in finding out crop performance in relation to productivity linked soil parameters and weather forecasting during monsoon. SPAD meter and LCC are the most effective tool to determine the right time for N top dressing of rice and wheat crop. Government authorities are looking for new ways to increase its efficiency. To achieve or overcome this problems precision farming looks promising as a future tool.

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