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Review on role of precision agriculture on nutrient management

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ABSTRACT

Precision Agriculture (PA) includes several strategies technologies and management elements aimed in the direction of addressing area variation that have an effect on crop yield by way of the usage of greater specific land leveling, seeding, fertilizer software, irrigation and pesticide use so on optimize crop production, improve profitability and reduce environmental risk. PA is carried out in massive and cluster farms also as lowlands of Ethiopia in particular in irrigated fields. It may help to precisely degree land, correct seeding and alertness of the right amount of fertilizer, irrigation water and pesticide supported the plant want. Despite of its extra advantage, the high value of machineries, software program and skilled hard work could scare the adoption of PA in Ethiopia. However, researches have proven that the advantages of PA out weight the cost and it may make contributions to food security appreciably. The arena populace is exponentially growing so on feed the developing populace, producers should depend on new technology to increase yields. Globally there may be goal warming and pollutants with a purpose to harm ecosystems. A way to resolve each of those conundrums is through knowledge of nutrient cycles and so the implementation of precision agriculture techniques to create a nutrient management gadget that meets the necessities of the flora, but yet prevents useless losses from the cycles. Research display promise inside the implementation of precision agriculture structures, with multiplied yields and better nutrient use efficiencies.

Keywords: Technology, Nutrient, Precision, Agriculture.

LIST OF ABBREVIATIONS

ATP: Adenosine Triphosphate; DOD: Department of Defense; GPS: Global Positioning Satellites; GNSS: Global Navigation Satellite System; SPS: Standard Positioning System; PA: Precision Agriculture; VRT: Variable Rate of Technology**.**

INTRODUCTION

Precision agriculture may also be a control method that gathers, approaches, and analyzes temporal, spatial, and person facts and combines it with different statistics to assist management selections consistent with anticipated variability for advanced resource use efficiency, productiveness, nice, profitability, and sustainability of agricultural production (ISPA, 2018).

Precision Agriculture is thought as "smart farming" or "precision farming "could be a key component of sustainable intensification. This combines remote sensing, global navigation satellite systems (GNSSs), geographic information systems (GISs), robotics, data analytics, computing, and other new technologies into an integrated high-resolution crop production system. This contains a collection of technologies that combines sensors, improved equipment, records systems to optimize manufacturing by using accounting for variability and uncertainties inside agricultural structures. Adapting manufacturing inputs web site-especially within a field and individually for every animal lets in better use of resources to take care of the same old of the environment while improving the sustainability of the meals supply. Precision Agriculture offers the way to watch the meals manufacturing chain and control both the quantity and excellent of agricultural produce (Figure 1) (Lowenberg et al., 2019).

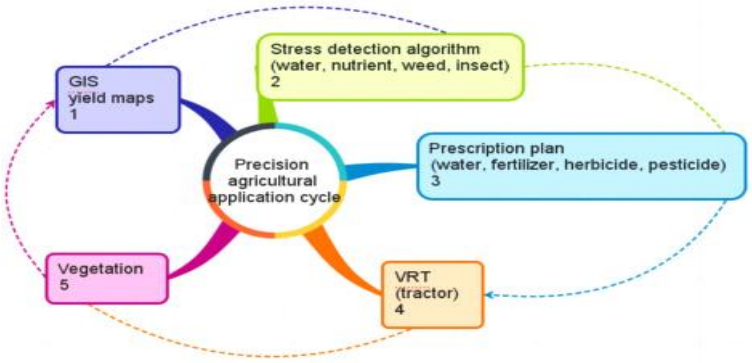

Figure 1. Cycle of precision agriculture.

Note: GIS: Geographic Information System; VRT: Variable Rate Technology Adopted from (Abdullahi and Sheriff, 2017).

All through the 20th century, fields were dealt with uniformly with fertilizers, pesticides, and herbicides due to financial pressures. After the revolution, many regions had been nevertheless present process uniform programs of fertilizers, insecticides, and herbicides, which motive water and pollution, erosion, and different environmental disturbances. Precision agriculture is related to sustainability, "the potential to stay up regular intake or productiveness with the aid of substituting between herbal resources and guy-made capital in manufacturing" (Bongiovanni, 2004). Sustainability as described by the intersection between three disciplines: ecology, economics and sociology (Thompson, 2017). Ecology may well be a branch of science that studies how organisms relate to their, natural environments; it'll be broken into many levels including the individual organism, the population, the community, and also the ecosystem (Hurd, 2018). The study of human societies and so their interactions and also the processes that preserve and alter them are known as sociology (Faris, 2015).

Nutrient Management is that the management of fertilizers (artificial and organic) to agriculture landscapes as plant vitamins. To perform sustainable nutrient management goals, the "Four Rs" are used and include using, correct quantity, right source, right placement, and right timing (4R Plus, 2020).

Agriculturalists have more technologies available to utilize than ever before. Lots of this technology are geared closer to precision agriculture and allow the farmer to more easily observe web site-specific remedies to areas inside their fields. style of the ones technologies include five global positioning

satellites (GPS), light bar steering structures, precision-based totally soil sampling strategies, faraway sensing, yield video display units, and variable rate programs (Paustian and Theuvsen, 2017).

The objective of this paper to review the role of different technologies on nutrient management.

LITRATURE REVIEW

Precision agriculture

Precision agriculture is a farming control idea based on gazing, measuring and responding to inter and intra-field variability in vegetation. The practice of precision agriculture was enabled by the introduction of GPS and other technologies i.e., crop yield video display units hooked up on GPS geared up combines, multi and hyper-spectral aerial and satellite TV for pc imagery, statistics technology and geospatial gear (Sugar Australia, 2017).

Precision agriculture (PA), satellite farming or website online specific crop management (SSCM) can be a control approach that gathers, strategies and analyzes temporal, spatial and character records and combines it with other information to help management decisions in line with estimated variability for stepped forward resource use performance, productivity, fine, profitability and sustainability of agricultural manufacturing.' with the goal of optimizing returns on inputs while preserving resources (Reina and Giulio, 2018).

PA may be a new concept adopted throughout the globe to extend production, reduce labor time, and make sure the effective management of fertilizers and irrigation processes. It uses an oversized amount of knowledge and knowledge to boost the employment of agricultural resources, yields, and also the quality of crops (Mulla, 2013)

Cycle of precision agriculture. GIS, Geographic information system; VRT, variable rate technology Adopted from (Abdullahi and Sheriff, 2017).

The rapid enhancement of precise monitoring of agricultural growth and its health assessment is very important for sensible use of farming resources and additionally as in managing crop yields (Nigam et al., 2019). Precision agriculture targets to optimize subject-stage management with (Kendall et al., 2017).

- Crop technological know-how: by means of matching farming practices greater intently to crop wishes (e.g. fertilizer inputs);
- Environmental safety: by way of reducing environmental risks and footprint of farming (e.g. limiting leaching of nitrogen);
- Economics: through boosting competitiveness through more green practices (e.g. stepped forward management of fertilizer utilization and other inputs).

Precision agriculture presents a replacement concept in sustainable use of the agricultural resources and is defined as a management concept that mixes communications and knowledge technologies for managing temporal and spatial changes within the farm (Rokeneddin et al., 2016).

Impacts of precision agriculture: This approach can't only decrease costs, but can even increase yields. Furthermore, accurately applying chemicals and fertilizers only where needed reduces the potential for ground and surface pollution (Krishnan et al., 2016).

Nutrient management

Nutrient management is that the science and practice directed to link soil, crop, weather, and hydrologic factors with cultural, irrigation, and soil and conservation practices to attain optimal nutrient use efficiency, crop yields, crop quality, and economic returns, while reducing off-site transport of nutrients (fertilizer) which will impact the environment. To achieve sustainable nutrient management goals, the "Four Rs" are used and include using, correct quantity, right source, right placement, and right timing (4R Plus, 2020).

Nitrogen, phosphate, and potash are important plant vitamins for the assembly of plants used for meals, feed, fiber, and gasoline. If over realistic, though, nitrogen and phosphate can harm the surroundings. At the same time as business fertilizers are the important thing source of applied vitamins, animal manure and other natural materials additionally make contributions vitamins for crop use (Richard and Roberto, 2020).

Green use of vitamins is carried out by means of the adoption of high-quality nutrient control practices (BMPs). BMPs encompass selecting the proper fertilizer product and making use of the proper amount at the appropriate time and area to fit plant needs and reduce nutrient losses. Additionally, making use of manure

and adopting a crop manufacturing management device to enhance soil organic fabric, reduce pests, manipulate soil moisture, and decrease eroding can beautify plant's functionality to uptake nutrients (Roberts, 2006).

A nutrient cycle (or ecological recycling)

A nutrient cycle is that the movement and exchange of organic and inorganic matter into the assembly of matter. Energy flow can be a unidirectional and noncyclic pathway (Freedman et al., 2014). There are a minimum of 16 essential chemical elements for plant growth. Carbon, hydrogen, and oxygen, obtained in large amounts from air and water, conjure the majority of plant dry matter within the products of photosynthesis, but usually aren't included as "nutrient" elements. Nitrogen (N), phosphorus (P), potassium (k), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), molybdenum (Mo), and chlorine (Cl) are obtained from the soil and required by means of all plants (Johnston and Bruulsema, 2014).

Nitrogen cycle: Nitrogen is an essential element in plant structures and is every so often carried out to vegetation. Expertise how the technique capabilities is vital to information how the nutrient are frequently lost in fields. Nitrogen lost from the natural procedure can also be a significant subject, because it reasons atmospheric pollutants, groundwater pollution, and floor pollutants inside the nitrogen gadget essential nitrogen techniques occur: organic procedure, ammonification, nitrification, de-nitrification, mineralization, and immobilization (Markov, 2013). Process occurs whilst Rhizobium microorganism lessens atmospheric nitrogen (N_2) to parent 2: The natural method (Generalized Nutrient Cycles, 2013 bacteria can stay to tell the tale the roots of plant life in an exceedingly very symbiotic relationship or as unfastened-dwelling bacteria in the soil (Figure 2) (Markov, 2013).

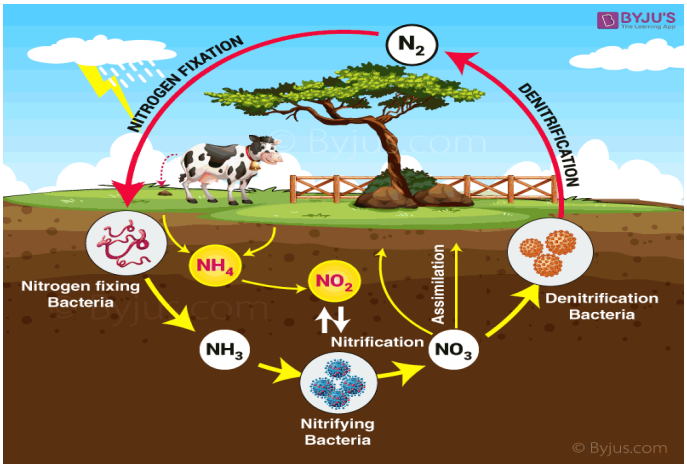

Figure 2. The nitrogen cycle (Worldwide Nutrient Cycles, 2013).

Ammonia (NH_4^+) is additionally created via ammonification via dwelling organisms. Ammonia is produced thru waste of animals and fish thru decomposition of natural nitrogen waste (Markov, 2013). This technique is aided with the aid of microorganism in the soil or within the gadget of animals. Ammonia can even be fashioned via the decomposition of flowers (Markov, 2013).

Nitrification is also a two-step process that finally ends up within the formation of nitrite (NO_2) as a mediatory product. Through this manner, two organizations of bacteria, ammonia-oxidizing microorganism and nitrite-oxidizing microorganism, upload steps to convert the ammonia to nitrite thru mineralization (Markov, 2013). Within the organic manner, nitrogen is frequently lost from the gadget thru nitrate leaching, denitrification, and volatilization, having sizeable results. Nitrate anions do not connect to the predominantly charged soil colloids, so nitrate is in a very position to maneuver freely with water and leach from the soil, because the water drains via the profile (Weil, 2010). De-nitrification is that the technique of soil microorganism changing nitrate into gaseous nitrogen (NO, N_2, N_2O) (Markov, 2013). Nitrogen is regularly misplaced from the cycle by means of de-nitrification, which occurs when nitrate ions are converted to gaseous forms thru biochemical discount reactions whilst oxygen is unavailable.

Phosphorus cycle: Most plants are only about 0.2% P by weight, but that tiny amount is critically important. Phosphorus is a necessary component of ATP (ATP), which is involved in most biochemical processes in plants and enables them to extract nutrients from the soil (Bünemann et al., 2016). Phosphorus also plays a critical role in cell improvement and DNA creation. Insufficient soil P may result in delayed crop maturity, reduced flower development, low seed quality, and decreased crop yield (Figure 3) (Hofmann et al., 2016).

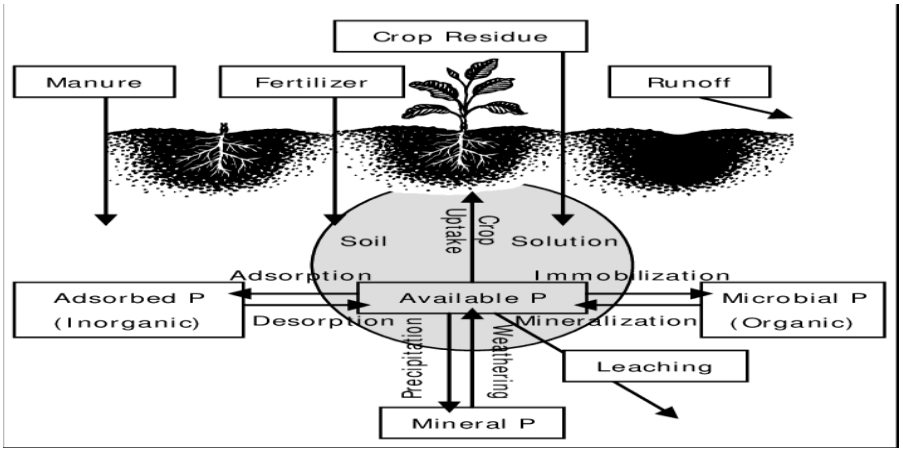

Figure 3. Simplified phosphorus cycle.

Too much P, on the opposite hand, will be harmful in some situations; when P levels increase in water streams and lakes, algae blooms can occur. When algae die, their decomposition leads to oxygen depletion which may cause the death of aquatic plants and animals. This process is termed "eutrophication" (Beaulieu et al., 2019).

Phosphorus, like nitrogen, is an essential detail and is of situation because of capacity avenues of pollution. Phosphorus movements through earth via soils, rocks, water, and also the ecosystem making its cycle very complex (Schlom, 2015). The phosphorus cycle is liable for increasing the supply of phosphorus within the soil for plant growth and soil fertility (Huang et al., 2017).

Potassium cycle: Potassium is additionally a necessary nutrient, but in contrast to nitrogen and phosphorus is has little environmental concerns while lost from the soil, making it less centered on from a pollution viewpoint. However, it's essential to plant improvement and its cycle is crucial to understand so as to properly manipulate (Figure 4) (Weil, 2010).

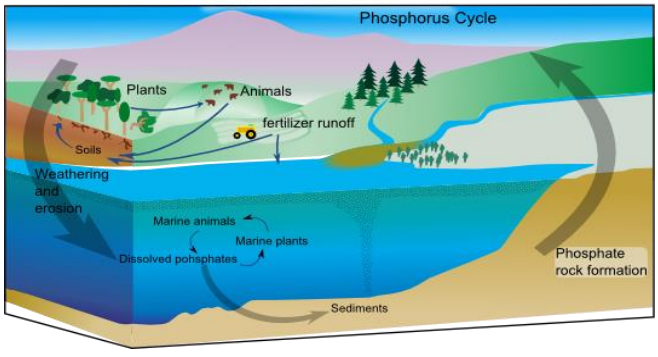

Figure 4. Simplified potassium cycle.

Potassium regulates the opening and last of plant stomata with the aid of a k ion pump. On the grounds that stomata are vital in water law, okay reduces water loss from the leaves and will increase drought tolerance. K is also important in helping plants adapt to winter hardiness, fungal diseases and insect pests (Wang et al., 2013).

Lime: The pH of the soil is a key issue in

nutrient management; if the soil is too high or too low in pH, it can have an effect on the nutrient availability and plant up take. The pH of the soil may be stricken by acid rain and soil kind making the pH too acidic for plants to correctly take up vitamins (Weil, 2010). Preferably soils must be among 6 and 7 at the pH scale, relying on the crop, soil type, and nutrient availability; for maximum plants the pH must be between 6.2 and 6.5. Liming is a not unusual agriculture exercise especially in humid areas to elevate the pH of acidic soils (Weil, 2010).

Importance of nutrient cycles

Transformation of matter from one form to a different: Nutrient cycles allow the transformation of refer different specific forms that permit the utilization of that element in numerous organisms. Therefore, nutrient cycles enable the availability of elements to organisms in forms that are usable to them (Finck, 2006).

Transfer of elements from one location to a different: Nutrient cycles allow the transfer of elements from one location to a different. Some elements are highly concentrated in areas that are inaccessible to most living organisms, like nitrogen within the atmosphere. Nutrient cycles allow these elements to be transferred to more accessible locations like the soil for the case of nitrogen (Mosier et al., 2004).

Functioning of ecosystems: Nutrient cycles assist the functioning of ecosystems which humans are a part of the ecosystem which needs the state of equilibrium to function properly and restore to the equilibrium state through the nutrient cycles (Folke, 2004).

Storage of elements: Nutrient cycles facilitate the storage of elements. Elements that are carried through the nutrient cycles are stored in their natural reservoirs and are released to organisms in small amounts that are consumable. For example, through the organic process, plants are ready to use nitrogen in small suitable amounts although it's abundant within the atmosphere (Botkin and Keller, 2014).

Link organisms, both living and non-living: Nutrient cycles link living organisms with living organisms, living organisms with the non-living organisms and non-living organisms with non-living organisms. This can be essential because all organisms rely upon each other and is significant for the survival of living organisms. These organisms are linked by the flow of nutrients which is engineered by the nutrient cycles (Mosier et al., 2014).

Regulate the flow of drugs: Nutrient cycles regulate the flow of drugs. Because the nutrient cycles meet up with different spheres biosphere, lithosphere, atmosphere and hydrosphere, the flow of elements is regulated as each sphere encompasses a particular medium and rate at which the flow of elements is decided by the viscosity and density of the medium. Therefore, the weather within the nutrient cycles flow at different rates within the cycle and this regulates the flow of elements in those cycles (van Zyl, 2011).

Precision agriculture in relation to nutrient management

Agriculturalists think about many factors while producing commodities for the arena; those concerns include stewardship, yields, and profitability. producers work to save you pollution, soil erosion, and greenhouse gasoline emissions so that it will hold the integrity of the surroundings that their livelihood is based on Precision agricultural strategies permits farmers to accomplish those desires, through reducing pollution emissions from gadget and losses from nutrient cycles (Schimmel pfennig, 2018).

Technologies are geared closer to precision agriculture and permit the farmer to extra effortlessly apply web site-precise treatments to regions inside their fields. a number of these technologies consist of five worldwide positioning satellites (GPS), mild bar steering systems, precision-based soil sampling strategies, faraway sensing, yield monitors, and variable price applications (Dunbar, 2015).

Development of PA technology

PA technology is a combination of application of different technologies and all these combinations are mutually inter related and responsible for developments of main 7 sectors of PA, which are discussed below (Nigam et al., 2019).

Remote sensing for PA: Remotely sensed data, acquired either by way of aircraft or satellite, containing electromagnetic emittance and reflectance records of crop can provide information beneficial for soil situation, plant increase, weed infestation and so forth. and this form of information is price powerful and may be very beneficial for web site-particular

crop control programs (Hyung-Sup, 2019).

Yield mapping for PA: Yield is ultimate indicator of version of various agronomic parameters in several elements in the zone. So, mapping of yield and interpretation and correlation of that map with the spatial and temporal variability of diverse agronomic parameters facilitates in development of subsequent season's crop control method (Trevisan et al., 2019) gift yield monitors degree the quantity or mass float to give you time periodic document of amount of harvested crop for that duration (Plant, 2001).

Variable rates or site-specific application of inputs: Precision farming or website-specific farming isn't always an approach however a number multifactual factors that intention to increase the precision of farm management. Many interpret this as a site-specific variant as opposed to a single entity inside a paddock. There are a variety of things to be considered to set up a precision farming or variable charge application or website online-precise application of inputs particularly monetary, environmental, agronomic or technological factors (Sugar Australia, 2017).

Precision planting: Establishing superior plant populace and most appropriate spacing among flora minimizes interplant competition and allows maximizing seed yield. Seed rate and row spacing play crucial position in figuring out inter plant spacing, that's once in a while a function of planter and planter speed (Jeschke et al., 2015).

Site-specific nitrogen management: Agricultural intensification without ok restoration of soil fertility can also threaten the sustainability of agriculture. Suitable management of soils may want to maintain soil health and agricultural sustainability, and minimize environmental risks like soil pollution, soil acidification, loss of soil natural carbon, and soil salinization (Agegnehu and Amede, 2017).

Leaf chlorophyll meter: Studies indicates an in depth link among leaf chlorophyll content material and leaf N content in crops, which is wise due to the fact the majority of leaf N is contained in chlorophyll molecules (Agegnehu et al. 2016). Chlorophyll meters enable agronomists to fast and actually measure potential photosynthetic hobby, which is closely linked to leaf chlorophyll content material, crop N popularity, and leaf greenness. The chlorophyll meter facts the mirrored image of sunshine inside the picture synthetically lively waveband of plant leaves and might be wont to display crop N fame and doubtlessly boom N use performance (Hergert et al., 2011).

Site-specific irrigation management: Precision irrigation refers back to the management of irrigation amount and frequency supported the crop want. The quantity of waters implemented to the crop is predicated on measurement of soil, crop, and climate variables that refers back to the repute of the plant (Sarma, 2016). The most critical purpose of precision irrigation is elevating in water performance, the reduction of energy intake and maximization of crop productiveness the use of the generation like Wi-Fi sensors networks, cell devices, far flung sensing, and actual time manipulate and information system (Lozoya et al., 2016).

DISCUSSION AND CONCLUSION

With the sector’s population exponentially increasing producers will face many challenges and with societal pressures producers are focused on stewardship over ever, in particular with but 2 percentage of the world’s populace being farmers. Precision agriculture can be a solution to both of these conundrums. Precision agriculture techniques will allow producers to use website-unique treatments to a district of a field or to person plant life the usage of technology. Supported current research precision techniques can produce higher yields than the usage of conventional farming practices and can boom the vegetation’ nutrient use efficiency. Supported the research highlighted there is a few variability from location to location in which precision strategies have been applied, demonstrating the requirement for greater studies to check the implementation of these practices compared to conventional strategies. There’s promise in enforcing these techniques, however each vicinity is unique and can be trial and mistakes in a few regions to search out techniques that employment 30 for each state of affairs. The usage of information and studies manufacturers have a wonderful place to begin to are trying to find out the technology and techniques that process high-quality.

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