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International Decade of Soils 2015-2024

FROM THE PRESIDENT'S DESK

Women have traditionally been playing very important role in all sections of agriculture. They are a vital part of Indian economy. As per Indian Census 2011, sixty five percent (65%) of the total female workers in the country are engaged in agriculture. Of the total cultivators (118.7 million), 30.3% are female. Out of 144.3 million agricultural labourers, 42.6 % are women. In 2001, female agricultural labourers were 21% which increased to 23% in 2011. Over the years, there is a gradual realization of the key role of women in agricultural development and their vital contribution in the field of agriculture, food security, horticulture, processing, nutrition, sericulture, fisheries, and other allied sectors. Women are the backbone of Indian agriculture, Comprising the majority of agricultural laborers, women have been putting in labour not only in terms of physical output but also in terms of quality and efficiency. Women are critical to the well-being of farm households. Aside from raising children, women are expected to prepare all meals, maintain the homestead, and assist in crop and animal production, all the while tending to the general health of their families. Perhaps, In Indian culture ironically, it is because women have so many responsibilities that they have been over-looked by agriculturalists and policy makers – it has been more convenient to label men as farmers and women as child raisers and cooks. In truth, women are involved in all aspects of agriculture, from crop selection to land preparation, to seed selection, planting, weeding, pest control, harvesting, crop storage, handling, marketing and processing. Whatever the reason for this neglect, the importance of developing farming technologies relevant to women has only recently been recognized. Rural women form the most important productive work force in the economy of majority of the developing nations including India.

In India, 60 percent of farming operations are performed by women. This amounts to stressful work conditions and drudgery. We need to think of innovations and opportunities at the village level that will not only meet the multiple needs of women and their families, but also make their lives healthy, satisfying and meaningful. There is a deep inter-linkage between women and agriculture, the development of both being essential for the progress of every nation. The first Prime Minister of India, Pandit Jawaharlal Nehru once said that "in order to awaken the people it is the women who have to be awakened. Once she is on move, the family moves, the village moves, the nation moves." Similarly, to describe the significance of agriculture, he said, 'Agriculture is the basis of all our development work and everything can wait but not agriculture. Self Help Groups (SGHs) have played a significant role to provide women their rightful place in the society and have propelled their inclusion into the larger economic system in India. Truly, women SHGs posses incredible potential for promoting the growth of not just rural women but boost the complete socio-economic development scenario in rural India.

As farmers, agricultural workers and entrepreneurs, women form the backbone of agricultural rural economy in the developing regions, and yet, together with children, they remain one of the most vulnerable groups. With far less access to education and technology, a host of other socio-economic factors have had an adverse impact on the lives of women farmers in recent years. These include the accelerated pace of globalization, the associated policy and institutional changes including economic liberalization and commercialization of agriculture, rapid pace of population growth and urbanization. Rural-urban migration, growing pressure on land, water, agrobiodiversity and firewood and natural disasters associated with climate change have been unfavourable to women in agriculture, and they have often not been able to take advantage of opportunities from new technologies, markets, or contract farming. The constraints and opportunities that women face in agriculture vary across regions and countries, depending on the socio-cultural and agroecological contexts. Despite many policy reforms both at the macro and micro level, gender issues have not received the attention as deserve. Hence, the current situation has to urgently change.

Information and Communication Technologies (ICTs) have revolutionized the way of our life. Women's participation in ICTs is important as the access to information is the key to empowerment. But, there are number of obstacles like non availability of locally relevant content, lack of opportunities for training in computer skills, illiteracy, domestic responsibilities, cultural restrictions on mobility and lesser economic power. In today's world, ICT can provide access to new information on market, trade, technology, investment and services related to education, health, nutrition and help farmers in taking rational decisions. Scientists and extension professionals should think of innovations in the use of ICT in rural areas, for bringing women into the mainstream of agricultural development and reducing gender disparity.

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President SCSI

COMBATING WATER SCARCITY DURING POST-MONSOON SEASON IN HIGHLANDS OF NORTH EAST INDIA

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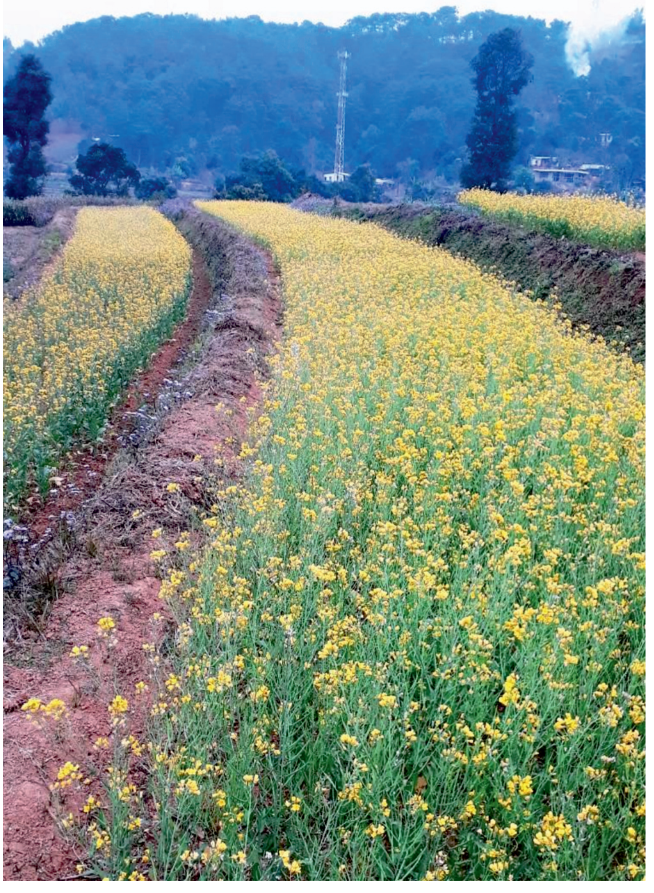
The North Eastern Hill (NEH) region of India is primarily under the acidic soil zone with high rainfall area. Majority of the fields in the region are situated across the hilly slopes with shallow and gravely soils. Best utilization of soil and water resources is of paramount importance for enhancing crop production. Despite of being high rainfall area, the NEH region faces severe water scarcity during post-monsoon season. The lack of irrigation facilities, short time lag after rice harvest for seed sowing and lack of soil test based fertilizer recommendations further aggravate the problem. The population growth in this region is rapid and food demands are speedily increasing but large chunk of the area remains fallow after the rainy season rice crop. This pressurizes the growers to produce more food per unit area. Introducing short duration climate resilient crops and harvesting water in rainy season and its utilization in lien period may be the viable options towards boosting-up crop production and efficient utilization of soil and water resources.

Adoption of zero tillage practice

It was realized that rice-fallow cropping system may be substituted by introducing short duration oilseed crops along with other possible measures with the hope that oilseeds will not only provide additional yield coupled with better land use efficiency but also will help the resource poor the tribal farmers of the region in improving the livelihood and nutritional security. Keeping this in view, the College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University, Umiam (Barapani) introduced rapeseed varieties: M-27 and TS-36; Yellow Sarson: Ragini (MYSL-203) and YSH-401; and mustard varieties: Pusa Agrani, Pusa Mahak, NRCHB-101 and NPJ-112 under zero tillage cultivation at farmers' field in six selected villages of Ri-Bhoi district under MGMG programme during *rabi* 2017. The yield performance was evaluated and compared with crops grown under conventional tillage.



Zero tillage cultivation of rapeseed

Since there was no rain throughout the crop period, the growth and yield parameters in all the rapeseed-mustard varieties were better in zero tillage than conventional tillage due to residual soil moisture after rice harvest. M-27 among the rapeseed varieties and Ragini (MYSL-203) among Yellow Sarson varieties gave the maximum average yield of 800-1000 kg ha^{-1} (range: 800 to 1400 kg ha^{-1}), whereas, NRCHB-101 among mustard varieties gave maximum average yield of 1020 kg ha^{-1} (range: 800 to 1100 kg ha^{-1}) under zero tillage cultivation. It indicated that rapeseed-mustard is a climate resilient crop which can be grown without water in the residual soil moisture. The farmers across the six villages improved their income by getting average net profit of Rs.27,388 ha^{-1} within three and half months with a low investment of Rs.13,412 ha^{-1}. By adopting zero tillage, the farmers can increase the productivity, reduce cost of cultivation thereby increasing the cropping intensity and earning an additional income for themselves with less efforts. Zero tillage also helped in timely sowing (October-November), conserved soil moisture and required less water, saved tillage cost and time, and the soil was protected from erosion due to the retention of surface residues and reduced organic matter depletion.

Modified bamboo drip irrigation system suitable for field crops

The bamboo drip irrigation system, traditionally used for irrigating plantation crops from stream water, has been further refined and modified to increase water use efficiency and to irrigate field crops apart from plantation crops. Since the region faces lot of water scarcity during dry period, and as most of the crops are cultivated in upland condition, water harvesting tanks (*Jalkunds*) at the top of the hills can be the solution of this problem. During wet period, water can be collected by making small ponds or tanks and can be saved for dry spell. Since water in bamboo drip irrigation is actually conveyed from higher elevation to the downstream with the help of gravity up to plantation crops, water harvesting tank should also be constructed at the top of the hills or above the cultivated crops so that water can be easily conveyed through bamboo with the help of gravity.

Bamboos are laid down from the water source which is the mainline and from there lateral line bamboos are connected. Bamboos are laid just above the properly spaced crop plants with the hole so that water can just drip on the particular plant only. The height of bamboo placed above the plant should be enough for the farmers to move under for inter-culture operations like manual weeding. Both the end of the mainline should be closed. Holes are made in the mainline through that water is conveyed to the laterals. The laterals also consist of small holes just above the individual plant to drip water. For efficient utilization of water, tying of some woolen thread with the cap in the holes of the laterals is also recommended to manage the speed of drip or to irrigate only the desired particular crop area. If the wetting is completed, it can be pulled down for seizing the flow of water for its efficient utilization. In the mainline, holes can be either closed with the help of mud or thread just like in the laterals for seizing the flow with respect to particular plant. It leads to better utilization of rainwater which would have been washed out if not harvested during rainy season. It has also been observed that about 25-30% water can be saved by modified bamboo drip irrigation followed by straw mulching, although it is cost effective only for cash crops like potato, capsicum, tomato, strawberry, etc. which are grown with definite spacing.

RELIABLE CRITERIA FOR IDENTIFICATION OF ALUMINIUM (AL) TOXICITY IN ACID SOILS

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Aluminium (Al) toxicity is a serious constraint to crop production in many regions around the world. Approximately 84 per cent of the soils in the North Eastern Hill (NEH) region of India are acidic in reaction, having toxicity of aluminium. The first step is, therefore to identify the problem. Should we use exchangeable (KCl-extractable) Al, Al-saturation percentage, or soil-solution Al concentration (or activity of the various Al species)?

Aluminium is not an essential element for either plants or animals. Most of the farmers have heard that too much aluminium (Al) can be harmful to plants. However, many may not be aware that there are multiple forms of Al in the soil and most of them are not directly harmful to plants. There are also multiple methods of testing the soil for these various forms of Al and several different ways to use these soil test results. Therefore, farmer should understand how Al can affect crop plants.

Available Aluminium

This test determines the amount of the "available" or easily soluble Al (Al^{+3}). Farmers can use this result to evaluate the potential of Al toxicity to their crop. This is not a routine test and must be specifically requested.

Mehlich 3-Al

It is extracted with the same chemical solution that is used in determining many plant nutrients. Mehlich (M)-3 is a stronger extracting solution than used for available Al, so the results are much larger values. The M 3-Al result has no relationship to "available Al".

Aluminium toxicity

Excess soluble/available aluminium (Al^{+3}) is toxic to plants and causes multiple other problems. Some of the more important problems include:

1. Direct toxicity, primarily seen as stunted roots
2. Reduces the availability of phosphorus (P), through the formation of Al-P compounds
3. Reduces the availability of sulphur (S), through the formation of Al-S compounds
4. Reduces the availability of other nutrient cations through competitive interaction

The primary damage caused by excess Al^{+3} is damage to plant roots. Diagnosing this type of damage requires that farmer inspect the root systems of their crops or other plants. Of course, when plants have damaged root systems, many other above-ground symptoms are likely to appear. One of the most common will be P-deficiency. However, since Al-toxicity occurs in strongly acid soils, plants may also exhibit deficiency symptoms of calcium (Ca), magnesium (Mg), or other nutrients. There might be symptoms of manganese (Mn) toxicity, which is common when the soil pH is too low. Finally, poor root development reduces the plants ability to absorb water. Plant problems that damage the roots are difficult to diagnose with leaf analysis. This is because the uptake of these toxins is somewhat self-limiting, due to the root damage that they cause. This is most common with Al and copper (Cu) toxicities. Very little Al^{+3} in the soil solution is required to cause damage to most plants. Since Al is the most abundant element in the soil, but the soluble Al^{+3} is the toxic form, we need to know how much Al^{+3} is present in the soil and what controls its availability to plants. The availability of Al^{+3} is not completely understood, but certain soil factors are known to have a significant effect.

1. The total amount of Al present in a particular soil type
2. The soil pH
3. The types and amounts of clay in the soil
4. Soil organic matter

The soil pH is probably the single most important management factor controlling the amount of Al^{+3} in the soil solution. Soluble Al is present in the soil when the pH begins to drop below pH 6.0. However, it is inconsequential in the vast majority of soils until the pH drops below pH 5.5. Even then, it is rarely a problem until the soil pH drops below pH 5.0. However, the amount of soluble Al increases dramatically in nearly all soils as the soil pH drops below pH 5.0. In these extremely acid soils, only those species adapted to acid soils (such as pineapples, tea, coffee, and acid-loving ornamentals) or the few crop species bred to tolerate high soil Al levels can be expected to do well.

Acid sub-soil

Some soils have extremely acid sub-soils. These soils present special problems. While normal lime applications and tillage will easily correct the topsoil, lime is not mobile enough to have a significant or quick effect on subsoil acidity. When tillage is not an option, acid sub-soils become more of a problem to deal with. Lime that is surface applied or applied with only shallow incorporation affects only the top couple of inches of soil, or however deep the shallow incorporation was. If lime cannot be incorporated throughout the rooting zone of the upcoming crop, then another approach must be taken. Gypsum ($CaSO_4$) is the best solution to reduce the toxic effects of sub-soil Al^{+3} in these situations. Gypsum is not a liming agent, because it cannot neutralize acid. However, the excess Ca applied with the gypsum is a competitive cation to the toxic Al^{+3} and causes the Al^{+3} to be leached into greater soil depths (assuming enough water passes through the subsoil). Neither the lime nor the gypsum is an instant

solution to excess Al^{+3}. Depending on the nature and particle size of lime, it could require up to 18 months for the lime to completely react and neutralize the acid soil. Gypsum could work faster, depending on how fast it can be leached through the subsoil.

In brief, soils differ in the amount of potentially soluble Al. Some soils can contain different amounts and types of clay, and different amounts of organic matter (OM). Different clay types can affect both the potential amounts of Al available to go into solution, as well as the amount of Al^{+3} that can be "fixed" or tied-up, after it is formed. Certain compounds in soil OM have the ability to form Al-chelates which are unavailable to plants, thus removing some of the Al^{+3} from the soil solution. All of this simply means that some farmers will have more or less difficult time in reducing the amount of Al^{+3} in their soils.

Soil aluminium saturation

Since Al^{+3} is a soluble cation, it can be evaluated by percent saturation of the soil CEC, in the same way as the major nutrient cations. Like these other cations, Al^{+3} is held on the negative sites of clay and OM (adsorbed). This adsorbed Al^{+3} is called exchangeable Al. Some of the exchangeable Al^{+3} is released into the soil solution. This "free" Al^{+3} in solution is the form that damages plants. However, the adsorbed Al^{+3} provide a ready source of additional Al^{+3} to recharge the soil solution. Like the nutrient cations, the percent of the soil CEC that is occupied by exchangeable Al^{+3} is called the percent Al saturation and it is an indicator of the reserve Al^{+3} that must be counteracted if toxicity is to be reduced or eliminated. When the exchangeable Al (per cent saturation) is greater than 60 per cent, there is a large increase in the soil solution Al^{+3}. This and previous information illustrate how both methods of evaluating soil Al have a value, and may be needed. However, these give us somewhat different information, and finally:

- Do not use Mehlich 3-Al to evaluate potential Al toxicity. It is only used to convert Mehlich 3-P into Morgan-P.
- When the soil is more acidic (pH is below 5.0), soluble Al is almost certainly a problem.
- When the soil pH is increased to be (between 5.0 and 5.5), soluble Al likely a small problem.
- When the soil pH is (5.5 and 6.0), soluble Al is not likely to be a significant problem.
- When the soil pH is above 6.0, soluble Al is almost certainly not a problem.
- Lime is the solution to excess soluble Al in the topsoil.
- Gypsum may be needed to correct excess soluble Al in the sub-soil.

BIOREMEDIATION OF INORGANIC SOIL POLLUTANTS

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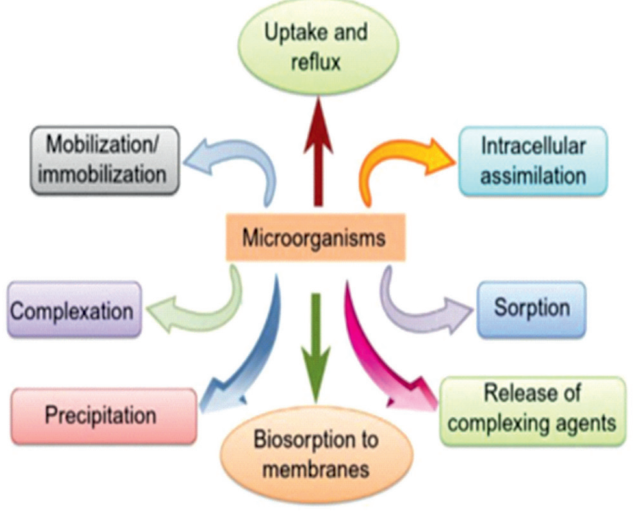
Inorganic pollutants are released into the environment due to activities of mining, industry, transportation and urban activities. Among the inorganic pollutants, heavy metals are having the prime place and affected the system most. Heavy metals are not biodegradable with higher persistence in wastewater treatment and their toxicity, particularly in high concentrations, has become a serious global issue. The pollutants are lead, chromium, cadmium, mercury, selenium, zinc, arsenic, cobalt, copper and nickel. These pollutants can enter into the soil system through poor agricultural management practices, improper industrial effluent discharge, landfill leakage, unauthorized dumping of household wastes, dry and wet deposition, volcanic eruption and industrial emissions. Agriculture practices in the peri-urban areas are very much severely affected by the problem of soil heavy metal contamination. The unscientific disposal of untreated or undertreated effluents has contributed significantly in the accumulation of heavy metals in soil and water bodies. Soil contamination with excessive amount of metals can result in decreased soil microbial activity, soil fertility, and overall soil quality, and significant reduction in crop yield and even the entry of toxic materials into the food chain. Environmental risks associated with inorganic pollutants vary widely due to several complex interactions at both intracellular and extracellular levels. Toxic heavy metals and metalloids interact quite strongly with soil constituents as compared to salts of alkali metals, rate of which however, depend on the element and their speciation. Although their mobility in soil is low, these elements disrupt biochemical processes in organisms even at low concentration affecting physiological activities. Although it is necessary to clean up contaminated sites, the application of environmental remediation strategies is often very expensive and intrusive.

At present, bioremediation is the most effective management system that can deal with polluted environment and recover contaminated sites. Bioremediation technology is normally targeted to remove heavy metals, radio nuclides, organic waste, pesticides etc. from polluted sites or industrial discharges through biological means. It is of relatively low-cost, low-technology, with high public acceptance and can often be carried out on site. The result of remediation depends upon type of contaminants, time duration and methodology. Bioremediation has emerged as the most promising approach for cleaning up many environmental pollutants among all the technologies. Recent interest has been on use of biomass of fungi, algae and bacteria as an absorbent material to remove heavy metals. Renewable biomass of various microorganisms may prove an environment friendly alternate to physico-chemical remediation processes and be considered for its ability to serve as biotrap for heavy metals. Biotraps are any organisms (living or non-living) or component of organism which can bind with or alter the form of, a toxic metal and allowing its removal and recovery from polluted water or soil, or rendering it harmless. Use of microbial adsorbents such as bacteria, fungi, algae and some agricultural wastes that emerged as an eco-friendly and effective material option could offer potential inexpensive alternatives to the conventional adsorbents. There are several mechanisms of bioremediation as biosorption, metal-microbe interactions, bioaccumulation, biomineralisation, biotransformation and bioleaching. Microorganisms remove the heavy metals from soil by using chemicals for their growth and development.



The response of microorganisms towards toxic heavy metals is very important for reclamation of polluted sites. Microorganism requires the optimum temperature, nutrients and amount of oxygen for their growth. Physiology of microbes is affected by heavy metals in several ways but many of them survived under theses stresses. Bacteria have evolved several mechanisms for their survival under metal-stressed environment, by which they can immobilize, mobilize or transform metals rendering them inactive to tolerate the uptake of heavy metal ions. Number of bacteria and fungi are used for heavy metal removal having different mechanisms such as efflux transporters where the efflux of heavy metals is primarily facilitated. Microorganisms secrete a wide array of iron-chelating compounds termed as siderophores these siderophores not only have a high affinity for iron but also bind other metal ions outside the cell. Binding by specific proteins is also useful mechanism for bioremediation. The phytoremediation approach involving hyperaccumulating plants to clean up the legacy contamination including metal and salts are promising as the contaminants are completely removed from the soil system. The microbial approach alone may not be effective but when it is linked to phytoremediation approaches then the efficiency of this approach increased.

The eco-friendly and cheap approach of using microbes and useful plant species for remediation of contaminated soils is essentially required for present and future agricultural development. The promising results of the studies on bioremediation suggest benefits of this approach over physical and chemical remediation. The technique needs to be disseminated and made adaptable for wide areas for effective outcome in near future.

ARTIFICIAL INTELLIGENCE IMPACTING AGRICULTURE

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The Artificial Intelligence (AI) application in farming is bringing sustainability and vibrancy in future farming. Through digital agriculture, where technologies such as Artificial Intelligence (AI), Cloud Machine Learning, Satellite Imagery and advanced analytics are empowering small-holder farmers to increase their income through higher crop yield and greater price control. The growth of artificial intelligence in agriculture is primarily driven by the increasing demand for agricultural production due to the increasing population, rising adoption of information management systems and new technologies for improving crop productivity, and increasing by implementing deep learning techniques, and growing initiatives by governments worldwide supporting the adoption of modern agricultural techniques. The only restraint in the growth of artificial intelligence in agriculture market is the high cost of gathering precise field data. Artificial intelligence can boost the efficiency of daily operations in a traditional farm and maximize production volume and minimize the possibility of failure due to natural disasters, system errors, and other factors by acquiring data on growth, the weather, and agricultural equipment.

The challenge of how we will feed the exploding world population in the future in a sustainable, cost-effective and environmentally friendly way for agricultural revolution. Although, we have many resources available in the country but still challenges are much bigger. The climate change is already impacting the agricultural production around the world. The Artificial Intelligence (AI) will have a crucial role to play in helping to meet the food demands of a growing global population. The opportunities provided by precision farming and the importance of developing smart connectivity to enable it. Many companies around the world have stepped up their efforts to speed up Artificial Intelligence (AI) application in agriculture. The technology termed as Artificial Intelligence (AI) is connecting and integrating objects, people, information and systems for intelligent production and service. The mechanized agriculture in the developed countries has considerably increased output per unit of land but still more output is required for sustainable demand of food for the future.

The emergence of new age technologies like Artificial Intelligence (AI), Cloud Machine Learning, Satellite Imagery and advanced analytics are creating an ecosystem for smart farming. Fusion of all this technology is enabling farmers achieve higher average yield and better price control. AI sowing app to recommend sowing date, land preparation, soil test-based fertilization, farm yard manure application, seed treatment, optimum sowing depth and more to farmers which has resulted in 30% increase in average crop yield per hectare. Technology can also be used to identify optimal sowing period, historic climate data, real time Moisture Adequacy Data from daily rainfall and soil moisture to build predictability and provide inputs to farmers on ideal sowing time. To identify potential pest attacks, Microsoft in collaboration with United Phosphorus Limited is building a Pest Risk Prediction API that leverages AI and machine learning to indicate in advance, the risk of pest attack. Based on the weather condition and crop growth stage, pest attacks are predicted as High, Medium or Low.

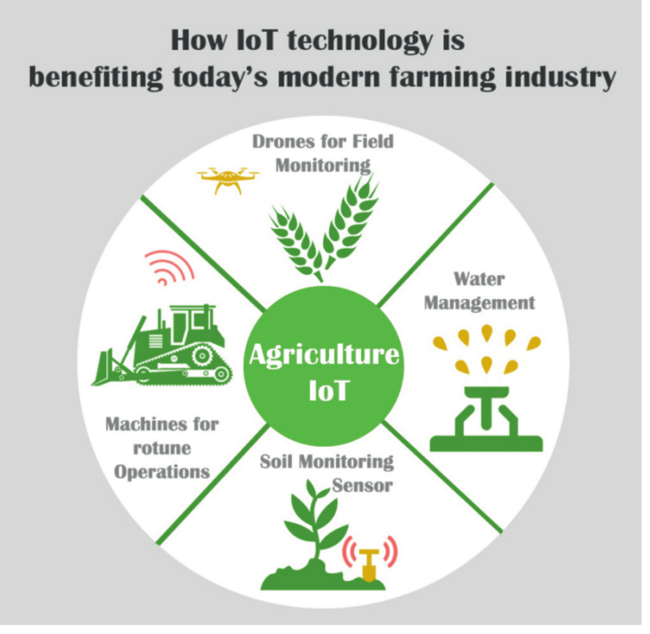
With the help of artificial intelligence, farmers are now able to grow better crops and look after their animals while saving time and energy. The combination of artificial intelligence and big data will move this industry towards digitalization. But our farmers' awareness of artificial intelligence was found to be almost negligible. Only few farmers were aware about artificial intelligence aspects like drones and robotics etc. It implies need to generate awareness and create infrastructure to meet this imperative technological need to revamp Indian agricultural sector.

Through digital transformation in agriculture, the information like environment, soil fertility, moisture content in the soil, crop growth and their health status and occurrences of weeds will be gathered. Acquisition of this real-time information would occur through the use of artificial intelligence and big data analytics and the data would be stored in a cloud database. Drones monitor the condition of the soil and determine whether it needs watering or seeding, while sensors in and around the cattle check their health and nutrition. Cameras monitor vegetables and fruits are being taught to recognize irregularities or problems such as dehydration and unwelcome insects.

Secondly, we get the prediction for future action for farming and its management. It forecasts future conditions/problems by taking into account previous year's data and current weather conditions which are already stored in the cloud database. The database would take these fluctuations into account and predict the total demand in the economy for a certain crop. There would also be a database storing the records of information such as number and type of seeds purchased by each farmer. It would also record the sowing of those seeds. The farmers would purchase the total seeds according to the forecast demand of that crop. The supply of the number of seeds would be regulated by the Government.

Importance of AI

There is a rapid adoption of Artificial Intelligence (AI) and Machine Learning (ML) in agriculture in terms of agricultural products and in-field farming techniques. Cognitive computing in particular, is all set to become the most disruptive technology in agriculture services as it can understand, learn, and respond to different situations (based on learning) to increase efficiency.



Providing some of these solutions as a service like chatbot or other conversational platform to all the farmers will help them keep pace with technological advancements as well as apply the same in their daily farming to reap the benefits of this service. Currently, Microsoft is working with 175 farmers in Andhra Pradesh, India to provide advisory services for sowing, land, fertilizer and so on. This initiative has already resulted in 30% higher yield per hectare on an average compared to last year. There are five areas where the use of AI solutions can benefit agriculture.

Indian agriculture has been traditionally rain dependent and climate change has made farmers extremely vulnerable to crop loss. Insights from AI through the agriculture life cycle will help reduce uncertainty and risk in agriculture operations. Use of AI in agriculture can potentially transform the lives of millions of farmers in India and world over. Shifting weather patterns such as increase in temperature, changes in precipitation levels, and ground water density, can affect farmers, especially those who are dependent on timely rains for their crops. Leveraging the cloud and AI to predict advisories for sowing, pest control and commodity pricing, is a major initiative towards creating increased income and providing stability for the agricultural community.

Microsoft in collaboration with ICRISAT, developed an AI sowing App powered by Microsoft Cortana Intelligence Suite including Machine Learning and Power BI. The app sends sowing advisories to participating farmers on the optimal date to sow. The best thing of this app is that the farmers don't need to install any sensors in their fields or incur any capital expenditure. All they need is a feature phone capable of receiving text messages. Microsoft has also developed a multivariate agricultural commodity price forecasting model to predict future commodity arrival and the corresponding prices. The model uses remote sensing data from geo-stationary satellite images to predict crop yields through every stage of farming. This data along with other inputs such as historical sowing area, production, yield, weather, among other datasets, are used in an elastic-net framework to predict the timing of arrival of grains in the market as well as their quantum, which would determine their pricing.

Challenges

The Artificial Intelligence (AI) application in farming is bringing sustainability and vibrancy in future farming. Through digital agriculture, where technologies such as Artificial Intelligence (AI), Cloud Machine Learning, Satellite Imagery and advanced analytics are empowering small-holder farmers to increase their income through higher crop yield and greater price control. The growth of artificial intelligence in agriculture is primarily driven by the increasing demand for agricultural production due to the increasing population, rising adoption of information management systems and new technologies for improving crop productivity, and increasing by implementing deep learning techniques, and growing initiatives by governments worldwide supporting the adoption of modern agricultural techniques. The only restraint in the growth of artificial intelligence in agriculture market is the high cost of gathering precise field data. Artificial intelligence can boost the efficiency of daily operations in a traditional farm and maximize production volume and minimize the possibility of failure due to natural disasters, system errors, and other factors by acquiring data on growth, the weather, and agricultural equipment. be an optimal one because of changes in external parameters AI systems also need a lot of data to train machines and to make precise predictions. In case of vast agricultural land, though spatial data can be gathered easily, temporal data is hard to get. For example, most of the crop-specific data can be obtained only once in a year when the crops are growing. Since the data infrastructure takes time to mature, it requires a significant amount of time to build a robust machine learning model. This is one reason why Artificial Intelligence (AI) sees a lot of use in agronomic products such as seeds, fertilizer, pesticides and so on rather than in-field precision solutions.

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