

Climate-smart agronomical practices for increasing agricultural production

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Climate-smart agronomic practices are being introduced to minimize abrupt changes in weather conditions like ambient temperature, rainfall pattern, wind velocity, relative humidity etc, which are prevailing in any country or state over a long-time span. These smart practices include several dimensions, viz. water smart, weather smart, nutrient smart, crop and cropping smart, energy smart, carbon smart and knowledge smart technologies. The impact of climate change or variability on agriculture livelihood could be minimized through various interventions under these smart dimensions. Several climate smart technologies related to agriculture have been successfully demonstrated by various ICAR Institutes and State Agricultural Universities which can be effectively implemented at farmers' field within the particular locality. Moreover, climate smart agronomic practices not only increase the production and productivity of various agricultural commodities but, also improve the conservation of natural resources.

Keywords: Agronomical practices, Climate-smart agriculture, Natural resource conservation

THE nation's population is growing at an increasing rate, but increase in food production doesn't matches with that rate. Besides that, climate change as well as natural resource degradation are also inversely correlated with each other and badly affect sustainable food production. Degradation of natural resources, which includes soil erosion, excessive groundwater use, carbon mining and the burning of carbon sinks (such as fossil fuels), has a catastrophic impact on the agricultural production system. Climate change is emphasized because of its distinctive characteristics, such as rising temperatures, changing precipitation patterns, frequent extreme weather events, the losses of ecological services and decline in biodiversity. These two are the primary threats to sustainable agriculture and they must be minimized urgently before they get out of hand. Although boosting food grain production for increasing populations is seen as an opportunity

by farmers but population pressure is still a constraint for any sustainable development. However, by enhancing farmers' capacity for adaptation as well as agricultural production system, resilience and resource use effectiveness, threats can be lessened. In other words, when integrated agricultural practices are used, all types of farms should become climate smarter since they can use all available resources more effectively and sustainably. For addressing the threats and opportunities, climate smart agriculture approach has to be introduced in this traditional system.

Climate smart agriculture (CSA)

A strategy for restructuring the agricultural production systems and food value chains to support sustainable development and assure food security in the context of climate change is known as Climate Smart Agriculture. Climate smart agriculture (CSA) has three

main objectives like sustainably increase agricultural productivity and incomes, adapt and build resilience to climate change and reduce greenhouse gas emissions. Agricultural producers, policy makers and researchers make decisions at the local, subnational, national and global levels about short- and long-term strategies to address climate change while taking these objectives into consideration. Climate smart agriculture aims to boost long-term productivity, improve farmers' resilience, lower greenhouse gas emissions from agriculture and increase carbon sequestration. Climate smart agriculture is an integrated strategy for creating the technical, policy and financial circumstances necessary to ensure sustainable agricultural growth for food security in climate change situation. It combines the economic, social and environmental facts of sustainable development by concurrently addressing the issues of food security and climate change.

Dimensions of climate smart agriculture

Several agronomic smarter technologies, which have greater use efficiency to make more resourceful, are grouped into different dimensions under CSA. The major dimensions of CSA are:

Water smart: Direct-Seeded Rice (DSR), raised bed planting, system of rice intensification (SRI), drip irrigation especially for fruit and vegetable crops and sprinkler irrigation are the most important water-smart technologies in agriculture. This is a water saving technology introduced for minimizing the huge utilization of water during rice cultivation. In case of transplanted rice, water requirement is categorized into several stages of cultivation, whereas cultivation through DSR completely removes the puddling operation which saves water. Only a thin film of water or saturated field condition with water has to be maintained over the growing season. Compared to transplanted puddled rice, DSR has many benefits with less water requirement (30–40%) and greenhouse gas emissions. SRI technology helps in saving huge amount of water due to non-requirement of ponding water in field. Raised bed of planting for maize crop is the best method of maize cultivation during monsoon season both in excess and limited water conditions. Thus, it saves 20–30% of water compared to traditional method of cultivation. Besides that, furrow irrigated raised bed (FIRB) system has been popular for wheat cultivation which is also very much effective for saving of water by 25–40%. The drip irrigation is popularized for irrigating the fruit crop or in orchard. It conserves water up to 40–70% as compared to flood method and it has highest water-use efficiency (WUE), i.e. around 90%. Watering of crops through sprinkler irrigation is quite efficient water saving technology. Rainwater harvesting, aquifer recharge, *in-situ* moisture conservation, mulching and drainage management can also be identified as significant elements of water smart CSA. Direct seeded rice var. Anjali, rice straw mulch in

cucumber var. Jampur, sprinkler irrigation in greengram var. HUM 16 and PDM 84-139 and sprinkler irrigation in chickpea var. PG 186 are the recognized water smart crop varieties.

Weather smart: The components of the weather-smart dimension include real-time weather monitoring, weather forecasting, weather-based crop advisory services, weather-fluctuation-based crop insurance, climate awareness and climate-smart housing for livestock. These tools are most important for planning any agricultural activities like crop planning, field management, irrigation scheduling, harvesting of crops etc. In these climate change situations, weather has changed frequently and without using smart tools, farmers can't complete their agricultural operations.

Nutrient smart: The primary goal of nutrient smart technology is the judicious utilization of nutrients to increase nutrient use efficiency (NUE), reduce nutrient losses and restrict fixing in unavailable forms. Real-time nitrogen management or precision nutrient management simultaneously increases NUE, lowers N-fertilizer losses (which decreases groundwater contamination), ensures higher crop production (by satisfying demand-based needs) and reduces N₂O emissions. Green manuring (GM), brown manuring (BM), site-specific nutrient management (SSNM), nitrogen application based on leaf colour charts (LCC), soil test-based crop response (STCR) and soil health card-based nutrient management are the major tools of nutrient-smart approach under CSA practices. However, precisely nutrient management is mostly depending on '5 R' concepts, i.e. right time, right dose, right place, right manner and right source using above described nutrient smart tools. Besides that, integrated nutrient management (INM) through managing all possible sources of nutrients (organic and inorganic sources along with bio-fertilizer inoculation) have been applied for crop needs and to increase the NUE.

Application of bio-fertilizer in rice var. MTU 7029 and soil test based nutrient application in cucumber are the examples of nutrient smart technologies.

Crop and cropping system smart: It has been recommended to grow short duration crops (pulses) and varieties, drought resistant crops (millets) and varieties, and flood resistant varieties for getting resilience against climate change. However, cropping systems like intercropping (cereal + legume), mixed cropping and alley cropping (type of agroforestry) are also considered as smart cropping systems under CSA. However, some drought tolerant varieties are also included under crop smart dimensions, viz. rice (var. Jogesh and Sahabhagi dhan), brinjal (var. VNR 218), cotton (var. Shalimar), arhar (var. PRG 176), salt tolerant rice varieties (CARI Dhan 5, SR 26B, CSR 36 and Usar Dhan 3). Flood tolerant rice varieties are var. Swarna Sub 1 (temporary submergence tolerant) and Pratiksha. In addition, some of the varieties like hybrid maize var. Kaveri, sweet corn var. Sugar 75, mustard var. Pusa Bold, gram var. Pusa 362, french bean var. FE 51 and Anupama are used in crop diversification. Disease and pest resistant rice var. Pratikshya, tomato var. Arka Rakshak, short duration greengram var. IPM 02-3, short duration rice var. GB 1/Panth 18, Jogesh are the examples of smart varieties.

Energy smart: Various operations consume specific amounts of energy, and some of those are considered as non-renewable sources of energy. So, energy dissipation is one of the most significant issues in climate change scenario. For instance, zero tillage operations can replace the number of operations like preparatory tillage, mulching, sowing operations and fertilizer application with one operation performed by zero till-cum-ferti-drill. Hence, it has been recognized that zero tillage machineries are very much efficient for resource conservation in terms of energy smart dimensions commonly known as RCTs (resource conservation technology). Zero



Tractor operated seed drill for DSR

Source: Nayagarh KVK, Odisha



Drought tolerant rice var. Swarna Shreya

Source: Jharsuguda KVK, Odisha

tillage in wheat var. DBW39 and HD 2967, improved variety of maize + zero tillage technology and sowing of rice with power tiller are considered as energy smart technologies as well as carbon-smart technology.

Carbon smart: Improved soil organic carbon (SOC) is the urgent task for increasing NUE, maintaining soil productivity potential and securing sustainable environment. But, soil organic matter (SOM) and SOC have declined over time. Crop residue burning trend is one of the strongest reasons for creating alarming situations, viz. polluted environment, degraded soil conditions, stagnation of crop yield and hampering different edaphic factors. To recover from this situation, resource conserving technology and integrated nutrient management (INM) strategies should be adopted. Alongside, application of organic matters into the fields can improve the carbon content in the existing soil.

Knowledge smart: Application of information and communication

technologies (ICT) can assist in overcoming problems in agricultural development, dissemination of information, awareness and education about agriculture. Advance warning of bad weather conditions, allowing farmers to take protective measures, pricing and market data are available in real time through ICT. Soil testing software, marketing information services, online internet searching, SMS broadcasting services, weather and disease forecast, voice mail/email, internet searching, agri-portal, video conferencing, and cell phone smart devices are very much effective for transmission of information and awareness to the farmers. Moreover, internet of things and machine learning are also used in agriculture in soil fertility evaluation, irrigation scheduling, etc are all examples of knowledge smart technology.

Increase in agricultural production using climate smart practices

Smart agronomic practices substantially minimize the bad impact of climatic variability (uneven

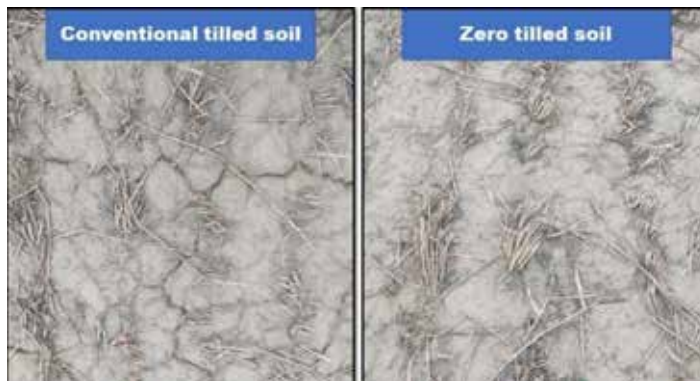
distribution of rainfall, sudden changes of weather parameters, early withdrawal of rainfall, late onset of monsoon and prolonged dry spell) on crop productivity. These climate smart practices enhance the crop productivity through a number of ways:

- Water smart technologies increase the water-use efficiency of crops with substantial reduction of water loss. Drip irrigation system improves the crop yield by 25–100% with the possible reason of no fertile soil degradation and retardation of essential minerals lost through deep percolation.
- Different climate smart crops, varieties and cropping systems improved agricultural productivity by minimizing climatic aberrations and escaping challenging climatic situations. Multiple cropping systems give at least yield in any climatic aberration situation or may be described under cropping insurance scheme.
- Leaf colour chart, a form of



Use of Leaf Colour Chart (LCC) in rice field

Source: Malda KVK, West Bengal



Structural changes of soil

Source: ICAR-NDRI, Karnal

nutrient-smart technology, effectively regulates nutrients-particularly nitrogen through reducing the need of nitrogen.

- Through the effective use of nutrients, soil organic carbon has the capability to increase dry matter accumulation that is directly related to the yield of various crops.
- Dissipation of energy by several farm activities is positively correlated with the crop yield. Minimum utilization of energy through the energy smart technology has created a strong relationship with maximum production.

Government scheme for irrigation system

The Government of India took several initiatives which were related to water smart agricultural technologies. During the year 2015, Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) was launched and it was highlighted to provide end-to-end solutions in irrigation

supply chain, e.g. water sources, distribution network and farm level applications. The scheme created protective irrigation by harnessing rain water at micro level through Jal Sanchay and Jal Sinchan. The different components of the PMKSY are 'Accelerated Irrigation Benefit Programme' for focusing on faster completion of earlier irrigation projects; 'Har Khet Ko Pani' for focussing on source augmentation, diversion of water, distribution, ground water development, lift irrigation, supplementing rainwater harvesting, repair, restoration, renovation of traditional water bodies etc; 'Per Drop More Crop' for focusing on micro level storage structures, efficient water conveyance and application, precision irrigation systems, topping up of input cost, secondary storage, water lifting devices and watershed development for focussing on ridge area treatment, drainage-line treatment, soil and moisture conservation, water harvesting

structure, livelihood support activities and other watershed works. The above schemes are available to intending farmers.

SUMMARY

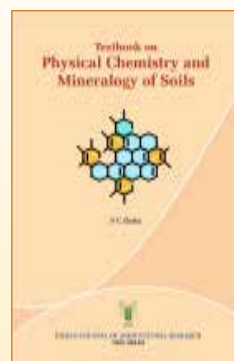
Changes of population growth, climate, availability of agricultural land, livelihood of people and biodiversity/natural resources degradation etc. are putting immense pressure on food security. In this situation, various smart agronomical interventions, viz. water smart, weather smart, nutrient smart, crop and cropping smart, energy smart, carbon smart and knowledge smart practices can be adopted to increase agricultural production and productivity as a whole through conserving natural resources.

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Textbook on Physical Chemistry and Mineralogy of Soils

Physical chemistry of soil and soil mineralogy are the two pillars which form the basic foundation of soil science. Once the students become familiar with these basic concepts, they can easily understand the other properties of the soil, say physical and biological properties, pedology and soil fertility. To become an expert of soil fertility, comprehensive knowledge of all the soil properties is essential which in turn is supported by the knowledge of physical chemistry of soils and soil mineralogy.

The present Textbook on 'Physical Chemistry and Mineralogy of Soils' has been written very cogently by the author who has been a teacher with an experience of nearly four decades of teaching in a premier Institute that is ICAR-Indian Agricultural Research Institute. The book includes all the topics prescribed by ICAR for the Postgraduate students of Soil Science. The introductory chapter describes basic definitions of soil science. Chapters like 'Bonding in solid structures', 'Elements of crystallography', 'Chemical thermodynamics' and 'Electrochemistry of soils and clays' are basic in nature and have been dealt very lucidly for easy understanding of students. Two chapters on characterisation of soil minerals are practical oriented. Other chapters focus on the structures of soil minerals, weathering and formation of minerals in soil environment, adsorption and ion exchange on soil colloids, double layer theory of soil colloids—its evolution and application, chemisorption and precipitation reactions in soil, soil organic colloids and their properties and chemistry of submerged soil. This book will be very much useful for the Postgraduate students of Soil Science.



TECHNICAL SPECIFICATIONS

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