From the Desk of General Secretary

If the conservation of natural resources goes wrong, nothing else will go right

- M.S. Swaminathan

The theme "Conservation Technologies for Smart Agriculture" seems to me as postlude of the earlier theme "Climate Smart Agriculture". Conservation technologies are at the central core of sustainable agriculture, providing dynamic solutions to the obstacles confronted in the way of increasing food production without damaging the eco-system or depleting natural resources for future generations. The farming system based conservation technologies is not low-output agriculture. It provides comparable yields to intensive conventional farming and relies on the sustainable use of high-input technologies.

No culture can be called smart if it does not conserve its natural-resources well, and agriculture is not an exception. Agriculture remains un-smart if it is wasteful and harmful. High yield cannot be the sole virtue of modern agriculture. Conventional mode of intensive agriculture, largely characterized by tillage, achieves its production goals but simultaneously degrades the natural resources and leaves soil vulnerable to erosion. Continuous farming with conventional tillage and burning crop residues has depleted the soil resource base and intensified soil degradation with concomitant decreases in crop production capacity. Conventional tillage has also made agriculture a major contributor to global warming due to increasing greenhouse gas (GHG) emissions. Soil and vegetation on the earth's land surface store three times as much carbon as is present in the earth's atmosphere. Land clearing and soil degradation turn these valuable carbon sink into a major source of GHG emissions. Today, no environmentally aware nation can bow to the inevitability of water and wind erosion reducing agriculture's natural capital and degrading priceless soil, in the face of the climate change from bad to worst with the concentration of CO_2 in the atmosphere hitting a new high of 405.5 parts per million (ppm) in 2017.

When we talk about making agriculture smart, it's essentially about agricultural approaches according to balance of yield, costs, environmental and economic sustainability and social equity. It's about using advanced technologies for farming activities by reducing human efforts and by making maximum utilization of the available resources and maintaining them at reclaimable levels. Thus, smart agricultural systems not only support high productivity and are cost-efficient but also preserve biodiversity and safeguard the environment. It relies on practices that help in targeted use of inputs to maintain ecological equilibrium and encourage natural regenerative processes. Smart agriculture includes automation systems and sensing devices which are used in monitoring and controlling the progress in agricultural activities like yield monitoring, field mapping, crop scouting, irrigation management and many more. The biggest obstacle for smart agricultural technologies spreading to more small-scale farmers worldwide has been limited access to such specialized technologies, equipment and machinery. Therefore, smart agriculture also has to be about actions required to modify and reorient prevailing agricultural systems to guarantee food security in the ever-changing climate by increasing efficiency of inputs such as labour, seeds and fertilizers. It has to offer the stakeholders the scope to identify agricultural plans suitable for respective regions.

As per the Food and Agriculture Organization (FAO), Conservation Agriculture (CA) is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. The FAO has determined three key principles for CA. The first key principle in CA is practicing minimum soil disturbance (just enough to get the seed into the ground) which is essential to maintaining minerals within the soil, stopping erosion, preventing water loss and saving soil organic levels for a longer period and still allow the soil to be productive for longer periods. It also reduces destruction of soil micro and macro-organism habitats. Zero tillage is ideal, but the system may involve controlled tillage in which no more than 20-25% of the soil surface is disturbed. The second key principle in CA is managing the top soil to create a permanent organic soil cover which allow for growth of organisms within the soil structure by maintaining a permanent or semi-permanent soil cover (using either a previous crop residue or specifically growing a cover crop for this purpose). Permanent soil cover with crop residues or mulch provides a constant source of fresh organic material, some of which is converted into stable carbon fractions that remain in the soil for millennia. This helps to keep the temperature and moisture levels of the soil at an optimum level. Many definitions of CA use 30% permanent organic soil cover as the minimum, but the ideal level of soil cover is site-specific. The third principle is the practicing diverse crop rotations to help combat the various biotic constraints. The rotation of different crops with different rooting patterns combined with minimal soil disturbance in zero-till systems promotes a more extensive network of root channels and macro pores in the soil. This helps in water infiltration to deeper depths. Where farmers do not have enough land to rotate crops, intercropping can be used. Legumes are recommended as rotational crops for their nitrogen-fixing functions. Despite high variability in the types of crops grown and specific management regimes, all forms of CA share these three core principles.

CA is a "win-win" situation for both farmers and the environment. The environmental benefits of CA include increase in water conservation due to the layer of organic matter and ground cover to help eliminate runoff and soil erosion. Mulches also protect the soil surface from extreme temperatures and greatly reduce surface evaporation, which is particularly important in tropical and sub-tropical climates. There is marked improvement of soil structure and rooting zone. Soil nutrient supplies and cycling are enhanced by the biochemical decomposition of organic crop residues at the soil surface that are also vital for feeding the soil microbes. Arable land under CA is more productive for much longer periods of time. Soil fertility is built up over time under CA and fewer fertilizer amendments are required to achieve optimal yields over time. CA enhances the biodiversity and natural biological processes above and below the ground surface which contribute to increase nutrient use efficiency and to improve and sustain crop production. No-till significantly reduces the use of tractors and other heavy farm machinery and thus diesel. Furthermore, the increased levels of soil organic matter and plant-available nitrogen typically found in CA soils greatly reduces the need for applying large amounts of chemical fertilizers, many of which require significant fossil fuel energy to process. Thus, overall fossil fuel use and GHG emissions are greatly reduced.

The major environmental issue in Indian Agriculture today is stubble/crop residue burning in the country's bread basket. The burning fields of Punjab and Haryana are playing havoc with the air quality in the Capital every year now. Stubble-burning not only creates significant air pollution but also dramatically increases mineralization rates, leading to the rapid depletion of soil organic matter and nutrients from the soil. Since crop residues are the principal element of permanent soil cover, they must never be burnt or otherwise removed from the soil surface as this often leaves the soil bare and unprotected, prone to erosion and valuable nutrients are lost from the system. CA practices enhance soil organic matter levels and nutrient availability by utilizing the previous crop residues or growing green manure/ cover crops (GMCCs) and keeping these residues as surface mulch. If crop residues are used as animal bedding that would be composted and applied to fields, there will be an increase in soil organic carbon from crop residues, but that does not assure a mitigation benefit over the alternative. Only residue retention presents a mitigation opportunity.

CA has come to be associated with a wide variety of systems, the common denominator being the absence of tillage. The main requirements of equipment in a CA system are a way to handle loose straw (cutting or moving aside), seed and fertilizer placement, furrow closing and soil compaction. "No tillage"(NT) is a CA agronomic practice for annual crops which leaves at least 30% of area covered by plant residues and seeds are placed through plant residues from previous crops using appropriate machineries. NT is bound to fail if suitable equipment is not available to drill seed into residues at proper depth for good germination. It is urgent that NT equipment is perfected and adapted according to land-situation. Locally-made low-cost seeders/ planters are needed and require a local market for repairing and technical services to farmers. Animal traction systems can be as simple as making a furrow for placement of seed through planters that can place seed and fertilizer even when residues are present. Small tractor of low horsepower with reduced weight, reduced draft requirements and reduced costs are helpful in NT. Expensive machinery like Multicrop zero-till ferti-seed drills fitted with inverted T openers, disc planters, punch planters, trash movers or roto-disc openers have been developed for seeding into loose residues. Farmers who do not own such machines can also avail them through Custom Hiring Center (CHC) – a subsidized service being provided for years now by the Department of Agriculture, Government of West Bengal. Manual systems can include practices that build hills (eg. The traditional Iroquois Indian "Three Sisters" system) or use hand held planters or planting sticks to get seed into the ground without tilling the soil.

NT and ZT are technical components used in CA that simply involve the absence of ploughing operations on the soil. To date, the most widely adopted resource conserving technology in the Indo-Gangetic Plains (IGP) has been zero-tillage (ZT) for wheat after rice. ZT primarily has had positive effects on the environment in the IGP by way of saving fossil fuel, water and reducing GHG emissions. However, CA is a wider concept than NT/ZT. To enhance NT/ZT's environmental sustainability, there is a need to use it as a stepping stone to CA and address the remaining challenges like including more crop rotations. NT or ZT does not necessarily leave residue mulch. Without the residue mulch many of the benefits of CA are lost or decreased in value. In spite of ZT's success in the IGP, the full environmental benefits offered by CA, including carbon sequestration, have yet to be fully utilized.

As much as CA can benefit the world, there are some problems that come with it. In spite of its many positive attributes, CA is not universally applicable and innovative approaches are necessary for promotion among small-scale farmers. Since CA takes time to build up enough organic matter, the process does not start to work overnight. But if producers make it through the first few years of production, results will start to become more satisfactory. Every farmer cannot financially turn from conventional farming to conservation. The process of CA takes time; when a producer first becomes a conservationist, the results can be a financial loss to them. It can be many years before a producer will start to see better yields than he/she has had previously. Another financial undertaking is purchasing of new equipment. When starting to use CA, a producer may have to buy new planters or drills in order to produce effectively. These financial tasks are ones that may impact whether or not a producer decides to switch to CA or not. Enhanced weed and pest problems during the "transition phase" to CA are a major problem for many farmers and a significant obstacle to widespread farmer adoption. Farmers typically report reduced levels of weed and pest problems under CA after a period of 4-5 years. Insufficient quantity of residues and the need for crop residues as livestock feed can turn out to be a constraint in the switch over to CA especially in the tropics.

CA requires a change in commitment and behaviour of all stakeholders. For farmers, mechanisms that encourage experimentation, learning and adaptation to local conditions are a prerequisite. CA can be well promoted through farmer field schools and other approaches that put farmers and their needs at the centre, rather than seeing them as mere recipients of advice. Probably the most effective way to promote CA is to demonstrate it through the experiences of successful adopters. Farmers may require concessions that allow them to participate without taking personal responsibility for crop failure. CA involves radical changes in what extension services do. Extension staff will need intensive training so that, they can learn the necessary technologies for awareness-creation campaigns. The mass media must be harnessed to support the campaign. Such revolutionary changes require teaching, not only on the farm itself but also within universities and colleges. CA sells itself when given a chance by a well-formulated national policy to encourage adoption. For policy-makers and institutional leaders, transformation of tillage to CA systems requires that they fully understand the larger economic, social and environmental benefits that these systems offer. Such transformations call for sustained policy and institutional support that provides both incentives and 'motivations' to encourage farmers to adopt components of CA practices and improve them over time.

In conclusion, I must say that certain smart approaches have been taken throughout the state of West Bengal starting from conservation of quality genetic resources of crop, intensification of farm mechanization in farmer's field, weather based forecasting, smart irrigation practices (through sprinkler, drip, rain water harvesting), zero tillage & reduced tillage, awareness campaign regarding the evil effects of burning of crop residues, land shaping especially in the saline tract, diversified cropping systems, organic farming, INM & IPM practices, financial boosting to the farmers threatened by the natural disaster and last but not the least use of mobile networking farmer's advisory services.

In the current volume of SATSA Mukhapatra-Annual Technical Issue we are looking into 'Conservation Technologies for Smart Agriculture' with the hope to be smart enough to conserve what we can't create and get the message right from the policy-makers desk to the peasant's farmstead....

Conservation is a state of harmony between men and land

- Aldo Leopold

(GOUTAM KUMAR BHOWMIK)