Farming for North East with technology options for sustainable feeding the populace

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Green technology can be used as environmental healing technology that reduces environmental damages created by the products and technologies for peoples' conveniences. It is broadly recognized that sustainability has environmental, economic and social dimensions. Creating a robust agriculture and food system is not a new challenge of course. The need to make agriculture more sustainable has been the focus of attention. However, current concerns about food security have reinvigorated this debate and underpin the importance of sustaining the earth's productive capacity in the long term. Some of the characteristics one would look for in a more sustainable agricultural sector include achieving increased efficiency of resource use, including the use of inputs (especially organic fertilizer, energy from fossil fuels, and water) whilst maintaining or increasing yields; achieving significant decreases in emissions of greenhouse gases (especially methane and nitrous oxide), increased carbon sequestration, and other climate change objectives, including contributions to renewable energy supply; achieving decreased losses of nutrients to the environment (especially ammonia, nitrate and phosphorus), closing cycles to a greater degree than currently; conserving and increasing agricultural natural capital (especially soil organic matter, supporting, regulating and cultural ecosystem services from farmland and farmland biodiversity); achieving economically viable farming with less reliance on public subsidy; contributing to the maintenance of the social fabric in rural areas, including appropriate levels of employment in the local context. This chapter presents options for sustainably increasing agricultural productivity whilst supporting key actions to facilitate agriculture-related climate change adaptation and mitigation and biodiversity conservation.

Organic farming

Organic farming can be described as a production system that sustains the health of soils, ecosystems and people, by relying on ecological processes, biodiversity and nutrient cycles adapted to local conditions, rather than the use of external inputs. It aims to combine tradition, innovation and science. Organic farms are part of a controlled certification system that aims to guarantee the standards for consumers who pay a premium for the labeled produce. Key organic farming techniques include a reliance on organic fertilizers (manure and compost) and nutrient cycling through the use of diversified crop rotations, predominantly biological pest control methods, and no use of synthetic pesticides, fertilizers or GMOs. It is more easily reconciled with extensive farming in less-favored areas or medium intensive mixed farming systems.

Conservation agriculture

Conservation agriculture is a production system based on the three principles of minimal or no mechanical soil disturbance through zero or reduced tillage, permanent organic-matter soil cover, and diversified crop rotations. It aims to prevent soil degradation and preserve and enhance soil fertility by strengthening natural biological processes above and below ground, and it can significantly reduce GHGs emissions because of reduced energy use and reduced oxidation of soil carbon. It has a high relevance for larger-scale farming as well as extensive farming in less favored areas. It is a way to achieve goals of enhanced productivity and profitability while protecting natural resources and environment, an example of a *win-win* situation. In the conventional systems, while soil tillage is a necessary requirement to produce a crop, tillage does not form a part of this strategy. In the conventional system involving intensive tillage, there is a gradual decline in soil organic matter through accelerated oxidation and burning of crop residues causing pollution, green house gases emission and loss of valuable plant nutrients. Surface mulch application presents opportunities for utilising a range of organic or other wastes that may benefit crop, soil and water relations.

Precision agriculture

It is the spatially variable management of crop production in order to optimize the application of inputs (fertilizers, lime, seeds and pesticides) to the right places at the right times. Its key objectives are to apply crop management measures more accurately both spatially and quantitatively according to crop needs and local conditions, thereby using resources more efficiently, increasing yields, and reducing the environmental impacts of excessive input use. Precision crop management may use data collected by sensors in the field and adjust application rates directly, or information from surveys and field maps to pre-adjust application rates, or a *combination* of both approaches. Precision livestock farming uses electronic tagging and software to make efficient decisions about feeding, reproduction, slaughtering etc. It fits best with intensive larger-scale crop and livestock farming, and less so with other systems. Reducing/ optimizing use of chemical fertilizer is an important component of precision agriculture. It includes optimizing the rate, placement and timing of fertilizer. Reducing the amounts of mineral fertilizers below the economic optimum may be suitable in some areas and produce greater benefits for climate change mitigation, although not as a general principle, due to potentially displaced food production.

Mixed crop-livestock production/integrated farming

It describes farming in which livestock and crops are produced within a co-ordinated framework, according to the principles that farm operations should be linked to create closed loops, including the internal use of crop products for feed, management of farm waste for fertilization, and the diversification of farm production. Approaches may include the integration of forage crops into crop rotations, and integrated nutrient management combining livestock manure, compost, green manures and mineral fertilizers. Integrated crop-livestock systems are most suited to medium intensive mixed-farming systems. In each case, the principles of these production systems have to be adapted to local environmental and economic conditions. Under present agricultural scenario, reducing land holding and declining factor productivity, integrated farming system appears to be the best option for enhancing the land productivity and ensuring livelihood security of small and marginal farmers.

Agroforestry

Agroforestry is an integrated land use system that combines cultivation of trees and shrubs with annual crops and/or livestock on the same land, with the aim of benefiting from the complementarities. It is suitable for extensive farming in less favored areas as well as semi-subsistence farming, and not for large-scale crop and corporate farming.

Extensive pasture management

In situations where this management option is planned for carbon sequestration and adaptation benefits, it should focus on adjusting grazing rates and introducing rotational grazing to avoid soil erosion and optimize vegetation growth; where it is planned for biodiversity benefits, it may require greater decreases in grazing rates and conversion to mixed livestock grazing (*e.g.* sheep and horses), or more intensive grazing rates for certain types of grasslands.

Integrated pest management (IPM)

Identifying IPM as a knowledge intensive approach dichotomous to conventional chemical intensive approach best serves the purpose. IPM, especially through initiative like *farmer field school* programs, where farmers are envisaged experts with their expertise emanating from routine hits and trials, interactions, and trainings, have both empowered farmers and maintained agricultural and environmental. IPM can be used to manage all kinds of pests anywhere in urban, agricultural, and wild land or natural areas.

Diversified farming systems

It may define as a system of agricultural production that, through a range of practices, incorporates agro biodiversity across multiple spatial and/or temporal scales. Diversified farming systems share much in common with organic, multifunctional, sustainable, and agro ecological management approaches and outcomes. The key indicators of a diversified farming system is that diversification across ecological, spatial and temporal scales serves as the mechanism for maintaining and regenerating the biotic interactions and in turn, the ecosystem services- *e.g.*, soil quality, nitrogen fixation, pollination, and pest control- that provide critical inputs to agriculture.

Innovative production systems for global agriculture

System of Rice Intensification (SRI) provides a new approach to rice cultivation which is less water intensive, saves paddy seeds and requires lower application of chemicals and fertilizers and performs extremely well under organic management. SRI has major advantages over the conventional paddy cultivation. It requires only half the water per hectare compared to conventional farming practices. This is extremely important in view of the water crises facing the country. Increased productivity leads to increase in farmers' income.

Use a wider range of livestock breeds including traditional varieties

This option conserves livestock genetic diversity but also brings benefits for grassland management through the use of breeds that are adapted to grazing on rough forage in all seasons, including grazing in particularly wet or dry conditions.

Biofuels technology

Biofuels as bio-ethanol and bio diesel have the potential to assume an important portfolio in future energy platter. Caution is mandatory in evaluating biofuels as green agricultural technology. Food security concerns and risks to environment and biodiversity are parameters that necessarily need to be accessed while analyzing sustainability linkage of agriculture and biofuels. Also, conversion of wasteland to farmland with some crop options can be viewed as positive impacts.

Biogas technology

Biogas (i.e. methane plus other gas) is the product of anaerobic digestion using organic matters, slurry, food waste and other green residue by methanogenic bacteria. Biogas qualifies on the merits that this technology utilizes organic agricultural waste and converts it to fuel and fertilizer. Direct impacts of biogas are fuel-wood, agriculture residue, livestock manure, and kerosene savings. Biogas slurry is rich in nutrients leading to substantial increases in soil fertility and crop production have also been observed. Biogas also solves the problem of indoor air pollution and improves household or communal sanitation.

Biomass technology

Agriculture residues and wastes are converted to electric and thermal energy through processes like combustion, gasification, and cogeneration. Biomass technologies compliment mainstream crop production and reduce or completely replace consumption of traditional fuel.

Diversifying crop rotations

It includes crop rotations with or without legumes. The use of rotations with legumes brings particular benefits for nitrogen fixation, and legume crops often host more diverse and beneficial invertebrate populations, such as pollinators.

Crop residue management

In-field practices such as incorporation of straw in soil. When the crop residues are retained on soil surface in combination with no tillage, it initiates processes that lead to improved soil quality and overall resource enhancement. Benefits of crop residues retention and management have been demonstrated through its large-scale adoption in many socioeconomic and agro-ecological situations in different countries the world over.

Restricting agricultural activities on slopes/contour farming

It include a ban on the growing of row crops, such as maize, potatoes, sugar beet, and sunflowers on slopes above a specific gradient. Contour farming is the alignment of soil activities (ploughing, furrowing, planting *etc.*) with contours in order to slow soil erosion and increase water infiltration.

Conversion of arable land to grassland

In situations where this management action is planned for mitigation and adaptation benefits, it must target specific soils in high risk zones. Where it is planned for biodiversity benefits, the conversion should introduce species-rich permanent grassland.

Use of Information and Communication Technology (ICT)

Organizations are using ICT to reduce carbon emissions and develop and support business models with a green focus. It is believed that the use of ICT improves energy efficiency in the economy, starting with buildings, lighting and the power grid. ICT enables economy a green behavior.

Farm mechanization

With advances in mechanization, farmers can more efficiently tend to their crops and produce more with less manpower. In modern times, powered machinery has replaced many jobs formerly carried out by working animals such as oxen, horses and mules.

Mobile technology

Mobile technology can enable farmers to increase their yields by connecting them through text messages and help lines to agricultural market information, best practices, and extension services designed to meet their localized needs

Conclusions

Technologies for sustainable agriculture cover the whole spectrum of farming systems. All farming systems, from intensive conventional farming to organic farming, have the potential to be locally sustainable. Whether they are in practice depends on farmers adopting the appropriate technology and management practices in the specific ago-ecological environment within the right policy framework. There is no unique system that can be identified as sustainable, and no single path to sustainability. There can be a co-existence of more-intensive farming system with more-extensive systems that overall provide environmental benefits, while meeting demands for food.

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