

Developing land-based infrastructure

to mitigate the challenges of soil productivity per unit land

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Since beginning until 1950 or so, global food production growth resulted entirely from expanding the cultivation area. The world began systematically to raise land productivity as the frontiers of agricultural settlement disappeared. Looking back, the greatest progress in eradicating hunger, a tremendous pressure on farming lands consequently resulted into poor soils with low productivity besides degrading the natural ecosystem. Present article focusses on the key causes and impacts of poor soil productivity in farming and the technological promotion and action plan for achieving development of land-based infrastructure.

Keywords: Land productivity, Policies, Soil productivity, Technologies

Poor land productivity: Causes and impacts

While food production has risen dramatically, the degradation of agricultural lands has been high. Majority areas of the cropland, grassland, woodland and forest are now seriously degraded. Global warming led climate change issues such as droughts, floods, heatwaves, cyclones etc., are further aggravating this worst scenario. To be specific, water and wind erosion are the two major problems which are severely destructing the structure of the soil along with its fertility. As a result, there is a poor crop yield and biomass production. Additionally, soil acidity, salinity, sodicity and alkalinity are also widespread; resulting in over-exploitation of water tables and soil fertility reduction. In India, rainfed farming occupies almost 56% of net sown area contributing 44% of food grain production. Soils of these regions are often prone to several biophysical and socio-economic constraints which limit the overall crop productivity, majorly due to frequent droughts, floods, soil

degradation, low nutrient use efficiency. Indian agriculture is highly vulnerable to vagaries of weather. Majority of the small and marginal farmers are farming under rainfed situation with less input and low water availability, uncertain monsoons and inadequate irrigation facilities. In addition, burgeoning population through urban expansion has become another biggest problem for land degradation, removing large areas of the best agricultural land from production.

Growing food in limited land is now a serious challenge to the farmers. This is creating an immense pressure on land. Further, low crop yields and low levels of industrialization compound the problem of population pressure on agricultural land in India though the land-human ratio is better compared to some of the developed countries like Japan, the Netherlands, Belgium and China. Raising productivity per unit of land should be the main engine of agricultural growth as virtually all cultivable land is farmed.

Technological promotion for the development of land-based infrastructure

Promoting new technologies involving resource utilization, waste recycling, conservation of soil nutrients and moisture is the need of the hour for improving agricultural productivity. These services have declined over time due to chronic underfunding of infrastructure and operations, no replacement of aging researchers or broad access to state-of-the-art technologies. Nutrient management technologies such as site specific nutrient management (SSNM), integrated nutrient management (INM), integrated soil fertility management (ISFM), and integrated soil-crop system management (ISCM) integrate the chemical fertilizers with organic amendments such as farmyard manure, vermi-compost etc., that aid in provision of maintaining soil fertility and providing plants with an optimum level of nutrients to sustain the yield productivity besides benefiting zero adverse impact on agro-ecosystem quality by balanced

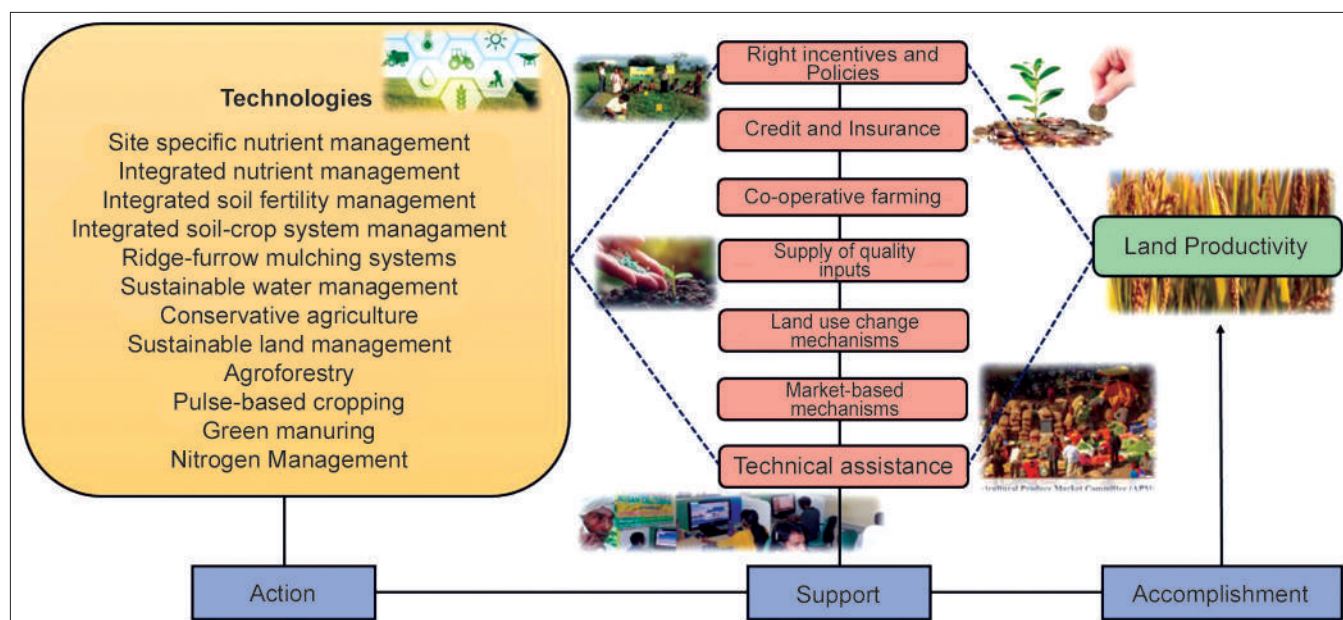


Fig. 1. A framework of action plan for the development of land-based infrastructure

fertilization. These technologies enhance the availability of applied as well as native soil nutrients; synchronize the nutrient demand of the crop with nutrient supply; minimize the antagonistic effects resulting from hidden deficiencies and nutrient imbalance; improve the physical, chemical and biological functioning of soil; minimize the deterioration of soil, water and ecosystem by promoting carbon sequestration, and reduce nutrient losses to ground and surface water bodies and to atmosphere. Improved irrigation management through piped conveyance, better on-farm management of water, and use of more efficient water delivery mechanisms such as drip irrigation, micro-irrigation is among the actions that could be taken. Such proficient technologies are ways to radically enhance the productivity of irrigation ('more crop per drop'). Incentives to pump less water such as levying electricity charges or community monitoring of use is important. Ridge-furrow mulching system also helps in conserving soil moisture from losses through excess solar heat. Conservation tillage involved with minimum soil disturbance, permanent soil residue cover (at least 30%) and diversified cropping systems (at least 3) improves the soil biodiversity and a natural biological diversity that enhances the water and

nutrient use efficiency ultimately sustaining the crop production. Zero-tillage management can effectively reduce the carbon footprints. Agroforestry system that combines trees with livestock and crops on the same area of land, enables effective utilization of existing resources specially in case of small shareholder farmers who have limited land available. For example, they can cultivate all grain and vegetable crops in between the trees which produce fruit, nuts and wood and the trees in turn provide shade for livestock that provide meat and milk.

In fact, agroforestry is an effective tool to reduce atmospheric carbon dioxide (CO₂) concentrations in the atmosphere that mitigate the climate change and its impacts. A pulse-based cropping system provides its maximum benefits to the farmers through soil fertility restoration. Deep rooting, atmospheric nitrogen (N₂) fixation, leaf shedding ability and mobilization of insoluble soil nutrients are some of the unique characteristics of pulses. All together helps in improving the micro-environment of the soil. Inclusion of pulses in cereal based system improves the soil health and conserve the natural resources and agricultural sustainability. Green manuring through sesbania, horse gram, green gram etc., incorporates the C input in large amount that acts as an energy

source for the microorganisms that significantly enhances the overall soil health. Nitrogen management is most important to protect the soil from toxicity/deficiency and ground water pollution as N is highly prone to losses such as leaching, denitrification, volatilization, microbial assimilation etc. Split application through top-dressing, foliar spraying, recommendation through soil test based approach or through leaf color chart analysis helps to efficiently manage the nitrogen requirement of the crop besides saving the excess investments by the farmer.

National and international programs and policies for land restoration

Government of India have launched several soil health management programmes such as Soil Health Card (SHC) scheme in 2015 to determine the soil fertility status and recommending the actual nutrient dose for crop requirement. A Neem-Coated Urea (NCU) policy was initiated in March 2015 advising all fertilizer urea manufactured in the country or imported will have to be coated with neem oil at the rate of 0.5 kg/tonne which helps in slow release of fertilizer N during the crop growth period. The National Project on Organic Farming (NPOF) was introduced in 2004 to encourage and promote the farmers for organic

cultivation by supplying the nutrients through organic amendments such as farmyard manure, vermicompost etc. Recently, Sikkim state was recognized as an *Organic State* of India. The Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) was rolled out in 2015 to invest in irrigation facilities at the field level. The National Agroforestry Policy (NAP) was introduced in 2014 for protecting the soil from erosion, improving the soil organic carbon (SOC) stock and enhancing the overall crop yields with additional incomes. The National Innovations on Climate Resilient Agriculture (NICRA) program was developed to strengthen the resilience of farmers to the adversities of climate change through climate-smart agriculture. A '4 per 1000/4 per mile' concept was initiated by the United Nations Framework Convention on Climate Change (UNFCCC) also recognized the importance of SOC in improving the land productivity and achieving sustainability in agriculture system. Technologies such as agroforestry, conservation agriculture system intensification (CASI) based

farming, and landscape management are highly accepted under this plan for improving profile SOC.

However, encouraging farmers to diversify to higher value commodities will be a significant factor for higher agricultural growth, particularly in rainfed areas where poverty is high. Developing markets, agricultural credit and public expenditures and improving access to rural finance for farmers, are the biggest needs to deal with low productivity. Agricultural policies have a profound impact on land-use patterns. Site-specific decisions on subsidizing the production of certain crops or inputs encourage the producers to make their contributions in areas where there is an obvious national need. Involvement of all stakeholders such as farmers, private organizations, government, researchers, policy makers etc., is critical for simultaneous action and promotion of land improvement technologies. A framework of action plan for the development of land-based infrastructure has been illustrated in Fig. 1.

In light of the projected growth in

human population and agriculture production, intense use of land cannot be ignored on the issue of soil degradation. Paralleling the effort to quickly alleviate/revert the degraded lands is the need for the world's affluent to balance the livelihood security and environmental stability. Developing the land-based infrastructure through efficient technologies enables harnessing of soil nutrients with crop growth that ultimately achieves the maximum yields and doubling of farmers' income. However, active participation of stakeholders with proper framework and decision making play a pivotal role in land restoration.

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Success story

Farmers participatory *rabi* onion seed and seedling production in district Bageshwar, Uttarakhand

Onion crop in Uttarakhand is grown in an area of 4.08 thousand ha area with the production of 41.6 thousand MT. But the productivity of onion in Uttarakhand is only 10.2 MT per ha, which is far below with respect to the average national productivity of 16.98 MT per ha. One of the major causes for this low productivity is bolting. ICAR-VPKAS, Almora has developed and released a *rabi* season onion variety namely VL Piaz 3 which does not lead to bolting in the crop. But its expansion to the farmers' fields was slow, because of the limited availability of quality seed and planting material. Considering the importance of this variety for district Bageshwar, farmer to farmer extension approach was applied for the production and spreading of VL Piaz 3 seed and seedlings by KVK, Bageshwar by conducting various activities comprising training, demonstrations and field days by involving 684 farmers. The average yield of the farmers' practice was only 156 q/ha, whereas the onion yield of demonstration was 276 q/ha. Efforts of KVK for the past six years motivated 11 farmers from different villages to go for seed and seedlings production of *rabi* onion variety VL Piaz 3. All 11 farmers together produced 2.46 q of onion seed, 60,70,000 onion seedlings and sold to 6,302 farmers within the district and also adjoining districts of Bageshwar (Uttarakhand) thereby gained ₹ 6,59,800 as net income per season. Impact of these efforts reflected directly in the form of onion yield enhancement by 76% as well as reduced the problem of bolting.



Seed production of *Rabi* onion variety VL Piaz 3