PRESERVING SOIL HEALTH FOR SUSTAINABLE PRODUCTION

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The Governments active involvement in acknowledging the importance of managing soil health has created a major impetus for restoring and maintaining soil health. An enthusiasm has been generated and awareness is being created by mass awareness activities on World Soil Day (December 5) every year. Soil health cards are being distributed and location and crop-specific sustainable soil management practices are being popularized among the farmers for maintenance of soil health. Integration of Governmental policies, research institutes and extension agencies are needed for successful implementation of the soil health restoration and preservation initiatives.

Soil is a dynamic system, consisting of organic and mineral matters, air, water and living organisms along with their interactive processes. Soil is formed through a complex process which takes thousands of years to make an inch of soil. But it can easily be contaminated, eroded and destroyed in a very short span of time, if managed unscientifically. Increasing population and shrinking land resources for agriculture is tremendously increasing pressure on soil beyond the boundaries of sustainability. Our consumerism attitude or greed results in indiscriminate use of fertilizers, pesticides and land resource, which disturbs the harmony existing within the soil thereby affecting the physico-chemical properties of the soil system. Thus, there is a need to understand the soil health and the systems that affect it, so as to devise strategies for its sustainable use for providingthe human needs in the future.

Soil Health:

Soil health and soil quality are considered synonymous and can be used interchangeably. However, one key distinction is that soil quality includes both inherent and dynamic quality. The Soil Science Society of America defines soil health 'as the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation'.Soil health is like animal health where the soil sustains production depending upon the status of soil health attributes.

Soil health concept involves integration of physical, chemical and biological properties of a soil and role of this harmonious blend in sustaining growth, productivity and environmental security. Thus, soil is an ecosystem full of life that needs to be carefully managed to regain and maintain the ability to function optimally.

What is a Healthy Soil?

A soil that is able to optimally sustain its native/acquired productivity potential and render ecological services is said to be in good health. A healthy soil has the following characteristics.

- It has good soil tilt, i.e. crumbly, well structured, dark with good amount of organic matter, and possesses no hard pans.
- It has sufficient depth through which roots can grow to find water and available nutrients.
- It has good water storage and good drainage capabilities, e.g. it retains more water, but will also allow excess water to drain out from soil in case of heavy rain.
- It has sufficient nutrient supply, but not imbalanced or excess of nutrients to achieve optimal production and also for balanced cycling of nutrients within the ecosystem.

- It should contain abundant population of beneficial organisms that help in cycling of nutrients, decomposition of organic matter, maintenance of soil structure, biologically suppressing plant pests, etc.
- It should be free of potentially harmful chemicals and toxins.

Some of the common indicators used to determine the status of soil health are listed in Table 1.

Table 1. Common Indicators of Soil Health

Chemical Indicators	Physical Indicators	Biological Indicators
Soil pH	Soil texture	Microbial biomass
Soil electrical conductivity	Soil particle and bulk density	Population of soil micro and macro organisms
Organic matter content	Penetration resistance of soil	Soil enzyme activities
Total carbon and nitrogen	Aggregate stability	Pollutant detoxification
Cation exchange capacity	Soil water holdingcapacity	Soil respiration
Soil essential nutrient	Soil aeration and porosity	Soil pathogens
Heavy and toxic metals	Soil infiltration rate	

Current Status of Soil Health in India:

In India, about 18 and 15% of world's human and livestock population have to be supported by 2% of world's geographical area and 1.5% of forest and pasture land, respectively. This pressure has resulted in intensive agriculture, which in turn resulted in reduced soil fertility, low farm organic carbon content, deficiencies of nutrients, reduction in quality and availability of water, soil erosion and degradation leading to deterioration of soil health.

According to National Academy of Agriculture Sciences, out of a total of 142 Mha net sown area of India (2010) around 105 Mha farm land has been degraded by various factors like soil erosion

(85.7 Mha) out of which 73.3 Mha by water erosion and 12.4 Mha by wind erosion, followed by soil acidity, soil alkalinity/sodicity, soil salinity and water logging etc. In 2013-14, India has used 16.75 million tons of nitrogen, 5.63 million tons of phosphorus and 2.10 million tons of potash, but the crops still removed around 10 million tons of plant nutrients from the soil, thereby affecting soil health. Thus, adequate amount of organic and inorganic nutrients must be applied to the soil to maintain soil health.

Soil Health: Causes of Deterioration

A healthy soil promotes sustainable root-growth, ensures adequate retention and release of water and nutrients for crop growth, maintains soil biotic habitat and responds favorably to soil management/ agronomic practices. The principal reasons promoting soil health degradation are:-

Population pressure: Due to high population, the soils have to be exploited beyond carrying capacity to feed the proliferating humans and also for production of clothing material. In many cases, the fertile lands are also used to build houses, roads and other infrastructures. Typically, in developing countries like India where the population pressure is high and proportion of nutrient stress-free soils is low, native fertility is being mined more than it is being renewed causing impaired soil health.

Decline in forest and tree cover: Forest and tree cover prevent erosion, helps in soaking of precipitation/ rainfall and building the soil fertility. Therefore, the decline in forest and tree cover is leading to erosion of fertile soil layer, which causes loss of soil productivity.

Intensive soil farming: Intensive cropping system requires exhaustive tillage which breaks down soil organic carbon (SOC) to carbon dioxide and removes plant cover; this exposes the organic rich top soil to erosion by wind or water. Diminished level of SOC adversely affects soil physical condition and fertility. Indiscriminate and imbalanced use of chemical fertilizers and falling use of organic manures further hastens the processes of soil quality degradation.

Mounting use of pesticides: Intensification of agriculture is resulting in indiscriminate use of pesticide. These pesticides persist in the soil and residues influence the natural nutrient cycles due to deadening effect on soil organisms. Decline in soil organisms results in decreased organic matter dynamics, soil fertility and maintenance of air and food quality.

Strategies of Soil Health Management:

1. Conservation agriculture approaches:

- **Diversified crop rotations**: Use of different crops in crop rotations, particularly cereal-pulses system increases soil organic matter, nutrients and biodiversity in the soil. It also improves nutrient use efficiency, improves water quality and conserves soil water.
- **No tillage/Minimum soil disturbance**: As too much plowing helps in nutrient loss and causes soil erosion, no or minimum tillage is used for growing crops without disturbing the soil. It conserves water and improves water use efficiency. It increases soil organic matter and reduces soil erosion.
- **Residue retention/incorporation**: Applying plant residues to the soil surface to compensate for loss of residue due to excessive tillage. It increases soil organic matter, moderates soil temperature, conserves soil moisture and reduces erosion from soil and wind.

2. Nutrient management approaches:

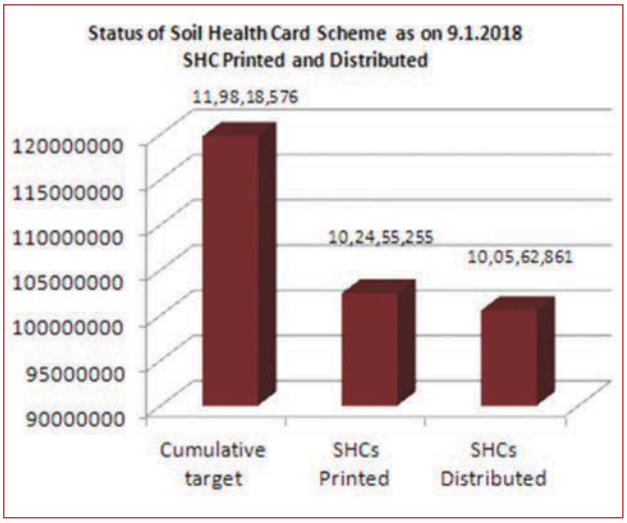
- **Balanced use of fertilizers**: Use of fertilizer has to be based on 4R principle: Right time, Right place, Right dose and Right source. Balanced use of fertilizers is defined as the timely application of all essential plant nutrients (primary, secondary and micronutrients) in readily available form, in optimum quantities and in the right proportion, through the correct method, suitable for specific soil/crop conditions. Balanced fertilization includes application of chemical fertilizers in conjunction with organic manures and bio-fertilizers. Appropriate soil amendments for acidic/alkaline soils need to be timely applied to improve soil health, thereby ensuring adequate availability of nutrients to plants at critical stages of growth.
- **Soil-test-based fertilizer recommendation**: It reduces the overuse of fertilizers and increases the fertilizer use efficiency. The right amount of fertilizer is calculated based on the soil test values and then it is applied in the right form.
- **Application of biofertilizers**: It helps in nitrogen fixing, phosphate solubilizing and mobilizing microbes or the microbial consortium to the crop plants has beneficial effect on crop growth, yield and soil fertility and sustainability in natural soil ecosystem.

Soil Health Card vis-à-vis Soil Health:

To combat excessive use of chemical fertilizers, Government of India has launched the Soil Health Management(SHM) Scheme under National Mission for Sustainable Agriculture with effect from 1st April 2014. It aims at promoting Integrated Nutrient Management (INM) through judicious use of chemical fertilizers including secondary and micro nutrients in conjunction with organic manures and bio-fertilizers for improving soil health and its productivity, strengthening of soil and fertilizer testing facilities to provide soil test based recommendations to farmers for improving soil fertility, ensuring quality control requirements of fertilizers, bio-fertilizers and organic fertilizers; upgradation of skill and knowledge of soil testing laboratory staff, extension staff and farmers through training and demonstrations; promoting organic farming practices etc.

Soil health card (SHC) is a practical report that can enable anyone interested in their soil to monitor soil health. It gives information on the status of soil with respect to 12 parameters, namely N,P,K (Macro-nutrients) ; S (Secondary-nutrient) ; Zn, Fe, Cu, Mn, Bo (Micro - nutrients) ; and pH, EC, OC (Physical parameters). Based on this, the SHC indicates fertilizer recommendations and soil amendment needed to maintain soil health in the long run. SHCs are producer friendly, quick, and require only basic tools. Results are obtained immediately, allowing the user to evaluate numerous fields quickly. National Informatics Centre has designed and developed the Soil Health Card Portal for generation of Soil Health Cards along with Fertilizers Recommendations (Refer http://www.soilhealth.dac.gov.in/).

Fig 1



(Source: http://www.soilhealth.dac.gov.in/Content/blue/soil/index.html)

Long term imbalance use of chemical fertilizer has resulted in skewed N:P:K use ratio. The ideal ratio of N:P:K in Indian context should be 4:2:1, but in 2013-14, it was reported to be 8.0:2.7:1.0. Due to boot polishing effects of urea or any nitrogenous fertilizers, farmers are tempted to use excessive urea, which is not required at all. This indiscriminate use of urea leads to ecological imbalance and is detrimental both to plant and human health. Site specific nutrient recommendation involving soil test based application of fertilizers is critical to enhance fertilizer use efficiency. Soil health card displays the nutrient status of a particular field. Recommendation of fertilizer based on SHC is both economically and environmentally beneficial, particularly for the nutrients like nitrogen whose use efficiency is very low. With the help of SHCs, we can optimize the dose of nitrogenous fertilizer and can curtail its overuse.

The GoI has taken a big initiative to issue soil health card for each of the farm holdings of the country (Fig 1).

The proper implementation of the SHC scheme will increase significantly the efficiency of costly and heavily subsidized fertilizers. It is the right time for the policy makers and the agricultural scientists to come forward and join hands to serve for the successful implementation of the programme. The importance of soil health and application of fertilizer based on soil health card is well understood. Accordingly, farmers are to be sensitized for the use of SHCs through elaborate outreach activities.

The Way Forward:

The Governments active involvement in acknowledging the importance of managing soil health has created a major impetus for restoring and maintaining soil health. An enthusiasm has been generated and awareness is being created by mass awareness activities on World Soil Day (December 5) every year. Soil health cards are being distributed, and location and crop-specific sustainable soil management practices are being popularized among the farmers for maintenance of soil health. Integration of Governmental policies, research institutes and extension agencies are needed for successful implementation of the soil health restoration and preservation initiatives.

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