Rebuilding India's Soils

Time to change the discourse on soil fertility

Dr. GV Ramanjaneyulu[1]

The statement by the Finance Minister on 'Zero Budget Natural Farming' as an approach attracted several criticisms. Much of debates were around whether this shift will help in feeding the national needs of food and fibre. While few were around the efficacy of different non chemical and/or sustainable approaches to farming.

Before getting into the debates about whether ZBNF or Organic Farming or any other can meet the expectations and how scientific they are, lets first look into where do we stand in terms of farming and farming resources, and what are possible ways to address the needs.

The diverse challenges and constraints as growing population, increasing food, feed and fodder needs, natural resource degradation, climate change, shifts in land use patterns, increasing desertification, decreasing factor productivity, agriculture becoming economically unviable, increasing farmer suicides, growing small and marginal farmers demand a paradigm shift in formulating and implementing the agricultural programmes in India.Generating three centimetres of top soil takes 1,000 years, and if current rates of degradation continue all of the world's top soil could be gone within 60 years, a senior UN official said recently and Indian situation is not very different.

Humanity will reach the organic (biological) age or cease to exist

-H.P. Rusch

[1] Agricultural Scientist with Centre for Sustainable Agriculture working on natural/organic farming across the country and can be reached at ramoo@csa-india.org.

Land degradation assessment undertaken by the various Central and State agencies shows that about 148 m.ha to 180 m.ha of land is affected. The land degradation is in various forms like water and wind erosion, water logging, increased soil salinity/alkalinity/acidity, decreasing soil fertility and a complex of all these.

Loss of crop productivity, one of many negative impacts of soil erosion by water, has serious consequences for country's food, livelihood and environmental security. Major rainfed crops in India suffer an annual production loss of 13.4 Mt due to water erosion which amounts to a loss of Rs. 205.32 billion in monetary terms. About 5334 m.t. of soil is lost every year in India and the area affected is about 83 m.ha. In addition saline and sodic soils account for about 6 m.ha.

A recent study by Indian Institute of Soil Science (IISS) found that the soils of as many as 174 districts across 13 states were deficient in secondary nutrients like sulphur and micronutrients like zinc, boron, iron, manganese and copper which are impacting on the yields. Chemical fertilisers use is seen as the only major approach to build soil fertility.

A simple regression analysis between the foodgrain production and fertilizer consumption during 1960-61 to 1999-00 showed that the partial factor productivity of fertilizers has been continuously declining. The data available from some centres under the Project Directorate of Cropping Systems Research (PDCSR), Modipuram also indicate a reduction in crop response to fertilizer application, specially when balanced fertilization is not practiced. This is supported by the fact that the farmers in the rice-wheat cropping system belt (specially Punjab, Haryana and Western U.P.) are forced to apply more and more fertilizer to obtain the same crop yields as in the preceding years.

The data from the trials on the farmers' fields conducted by the PDCSR, Modipuram during 1999-2003 showed that the average response of cereals to fertilizer was 8-9 kg grain/kg fertilizer. The efficiency of fertilizer nitrogen is only 30-40% in rice and 50-60% in other cereals, while the efficiency of fertilizer phosphorus is 15-20% in most crops. The efficiency of K is 60-80%, while that for S is 8-12%. As regards the micronutrients, the efficiency of most of them is below 5% (NAAS, 2006).

The latest budget also allocated Rs. 79,900 for chemical fertiliser subsidy. The fertiliser subsidy caused its own distortions. For eg Punjab which has less than 1% area under cultivation consumes more than 12% of chemical fertilisers and hence 12% subsidy which roughly amounts to Rs. 8,000 cr. While there was lot of discussion around shifting towards balanced nutrition, the government of India runs a large program on Integrated Nutrient Management. The NPK use ratio is still at 6.7: 2.7:1 and soil organic matter is going down significantly and more than 66% of Indian soils rank low with in it 49% being very low.

Another important dimension of the problem is about the link between chemical fertiliser use and the contribution to climate change. This is particularly with the Nitrogenous Fertilisers. In the manufacturing of Nitrogenous fertilisers required high energy use to combine Nitrogen and Hydrogen in the air. Coal, Naptha are main sources of producing this energy. Total greenhouse gas emissions (GHG) from the manufacturing and transport of fertiliser are estimated at 6.7 kg CO2 equivalent (CO2, nitrous oxide and methane) per kg N. How long this can continue is a big question?

Estimates show that we have already reached peak use of coal reserves and petroleum products.We may run out of these in another 50-60 years. In addition to these emissions in production, in use there are losses. About 1.25 kg of N2O emitted per 100 kg of Nitrogen applied Globally, an average 50% of the nitrogen used in farming is lost to the environment as N2O to the air as a potent GHG (310 x CO2) and as nitrate polluting wells, rivers, and oceans Volatilization loss.

While, soil microbes can combine atmospheric nitrogen and hydrogen into the nitrates in symbiotic association with plants (e.g. Rhizobium) or independently (e.g. Azatobactor) at the normal temperature and pressure.

Phosphorus cannot be manufactured or destroyed, and there is no substitute or synthetic version of it available. In fact, there is plenty of phosphorus left on Earth. Animals and humans excrete almost 100 percent of the phosphorus they consume in food. Most of the phosphorus used in fertilizer comes from phosphate rock, a finite resource formed over millions of years in the earth's crust. Ninety percent of the world's

mined phosphate rock is used in agriculture and food production, mostly as fertilizer, less as animal feed and food additives.

Similarly, all other nutrients required for a healthy crop production are converted into available forms either from soil organic matter or the mineral matter. This can only happen in a situation where soil health is improved in terms of soil microbes which in turn requires soil organic matter. This is the basis for organic soil management.

While conventional agriculture science which largely assesses soil fertility as only chemical property and measure NPK and other nutrient content also assesses only the chemical properties of organic matter and argue that we need huge tonnage of biomass and it is impossible to achieve that. While all the available data sets show that chemical agriculture is no more an option but shift towards more sustainable and renewable sources of nutrients and sustaining the soil health is the only option.

This can be achieved by using the biological power. The biomass used in agriculture is either from plant source or animal source. More than half of the plant parts do not have economic use and can be easily recycled. Animals, particularly ruminants' host a variety of microorganisms (bacteria, fungi, and single-celled animals called protozoa) which digest cellulose, lignin and other plant material.

This makes a whole new energy source available to the animals. There's a lot of energy in cellulose, but most animals are simply unable to digest it because they don't have the necessary enzymes. This property of these enzymes secreted by the organisms to digest plant material is what is used in composting and other processes.

Among the microorganisms present in the dung all may not be useful for agriculture and similarly all may not survive outside the animal gut. The microorganisms which are culturable outside animal gut and are useful for the agriculture can be used for agriculture.

Among these beneficial microorganisms which can be cultured the following properties can be seen

- Cellulose, lignin and other material digesting bacteria which aid in composting
- Plant growth promoting bacteria like IAA (Indole Acetic Acid)
- Nutrient fixing and mobilising like nitrogen fixation, Phosphorus solubulising, ammonia production etc
- Anti fungal activity

The microorganisms present in the dung can be cultured by adding suitable nutrients. There are number of indigenous products like Jeevamrit, Panchagavya, Amritjal developed based on these principles.

The microorganisms present in the dung varies mostly based on the food they eat rather than breed. Even all the microorganisms present in the dung cannot be cultured. For agricultural purposes, culturable beneficial microorganisms are important. Centre for Sustainable Agriculture and many other organisations have done such studies to see if there is any big difference in the microbial content between different breeds of animals.

The differences were observed based on the food they eat. The foraging and fodder based animals have more useful bacteria (as they are used in digesting the food animal eats) while the stall fed, feed based animals may have lesser diversity of microorganisms. Lactating animals may have additional enzymes which non lactating or male animals may lack.

Based on this we suggest people to use

- An application of the organic matter in any form is important. It can be used as mulching, composting, crops residues or green manures.
- Dung from any animal (cow, ox, buffalo, desi or crossbred). Prefer animals which are foraging and feed on the green/dry organic matter than on grain or concentrates.
- Management of desi animals is easy as they are small in size, low in input requirement.
- Managing cow is easier compared to buffalo as cow has a thicker skin and manage their body temperature easily. Buffaloes on the contrary have thinner skin and cannot manage their body temperature. Either they have to be kept in huts/shed which provide shade or they tend to go and rest in water bodies/mud etc.

Therefore, instead of debating about whether natural farming is right or organic farming is right, instead of debating whether this shift can feed the world, we need to make a clear plan to rebuild India's soils.