Innovations in Soil Development and Land Use Planning of Jatashankar Campus (2001-2011)

The land allocated to Samaj Pragati Sahayog in 2001 in the Jatashankar village of Bagli tehsil, of Dewas District in MP had many challenges. The land, measuring 2.7 hectares was totally barren with the black cotton top soil having been dug and carried away over the years by brick makers. The residual soil was typical '*murram*', with the organic carbon at less than 0.2 %. This region being at the fringes of the Deccan Trap, underlain by basalt hard rock, witnessed an average soil depth at 2 feet. The only water supply came from a shallow well with meagre water inflows after the rainy season. Attempts of boring tube wells failed due to lack of underlying aquifers.

Fig1. Jatashankar Campus, left 2001. right 2011

At the very beginning, around 1998, a geological assessment of the subsoil of this land was done.
On the basis of that buildings were constructed on low soil depth-hard rock zones and relatively deeper soil-soft rock zones were kept for plantation and other purposes.
The task ahead was greening of the barren land around the buildings. The steps taken over the years included mainly doable methods of enhancing **Soil Organic Carbon (SOC)**, conservation of water and plantation of fruit shrubs and trees, ornamental and forest trees, suited for the local dryland conditions.

The interventions have been briefly described in the following sections.

Plantation of fruit and flowering shrubs and trees:
As mentioned, the soil depth here is low and therefore, for all plantations pits had to be dug. The pits on an average were waist deep, i.e around 3.5 to 4 feet deep and of 5 feet diameter. As the campus was barren, without much biomass, these pits used to be dug much before the rainy season and filled gradually with a mix of soil and cowdung slurry treated biomass, using our daily kitchen vegetable residue and weeds and fallen leaves collected from elsewhere. The biomass was mixed with cowdung slurry for rapid conversion to compost. After every filling, a layer of soil would be put on the top of the fill. This became necessary as exposed compost in dryland areas gets combusted slowly by the mix of strong solar heat and dry/low moisture conditions. The soil layer thus prevents **solarisation** and also conserves moisture.

Fig2 Plantation pits prepared by gradual filling of dug pits with soil and compost material

Enhancement of Soil Organic Carbon:

The SOC of soil around the pits in an orchard was developed by continuously ploughing back the weeds and/or agri-residue after harvest. If possible weeds were also used for composting by biodung heap method. The weeds were mixed with cowdung slurry, heaped and then covered with a layer of soil-cowdung mix. Another fruitful technique was making ***'sanjeevak'***, a liquid compost, and applying at the roots of the plants. *Sanjeevak* is made by mixing, in a drum or plastic lined pit, cowdung, cow urine, 'besan' and molasses (10kg:10litre:1kg:1Kg) in about 100 litre water, allowing it to ferment for a week and making it up to 200litre. If available, FYM has also been applied sometimes. Continuous use of these simple practices helped in transforming the poor *'murram'* soil into a loam type soil rich in SOC. In these interventions the guidance of Dr. OP Sharma, Soil scientist, JNKVV, Indore was of great value. Besides these organic carbon additives to soil, great care was taken to provide, as far as possible, continuous plant cover by initially growing crops between the rows as mentioned below in

Fig3 a) Recycling of weeds b) Weed biodung heap c) 'Sanjeevak'

the section on agriculture. As the saplings grew into trees, their canopy provided the plant cover. However, in exposed regions we still grow pigeonpea in 'khareef' and rapeseed 'rayda' in rabi mainly for plant cover to prevent solarisation of the hard earned gain in SOC. This was specially recommended by the great mathematician turned agri-scientist, late Professor Dr. Dhabolkar.

Plantation planning:

Plantations were done keeping in mind proper land use. Along the boundaries, plants of some economic importance as**, jatropha, bamboo, glyricidia** were planted.

Fig 4. Boundary plantation of jatropha, bamboo glyricidia etc

Various fruit plants were tried and the hardy plants for sustained yields, for this area, have been found to be **guava, lemon varieties, custard apple, 'chikoo', mulberry and pomegrenate.**

Fig 5. Some locally suitable fruit plants, guava, lemon, custard apple, pomegranate

A major problem of this area is sudden death of horticultural plants in peak summer even if the plants are watered sufficiently. This seems to be due to the heat shock rendered by exposure to hot winds, commonly termed as 'loo' or 'lapat'. Mango plants are specially susceptible to these 'heat strokes'. We devised the use of wind breakers to check this mortality. Interspersing flowering shrubs as nerium, and trees as of drum sticks, around the plot and between the rows of fruit shrubs and trees provides major protection. These species need very little water, can withstand high temperatures and act as wind breakers.

Fig6. Plants as some flowering shrubs, glyricidia, drum stick trees interspersed with fruit plants act as wind breakers protecting the fruit plants from hot summer winds

Some plots near the boundaries have been developed as **'forest' patches**. It had been observed that the goat dung used here as a manure contained seeds of many forest plant species. This is because the goats are taken for grazing to the nearby forests. The advantage of this method is that goat dung contains ready to germinate, otherwise recalcitrant, seeds processed in the guts of these animals. Therefore, goat dung was randomly broadcast in some tilled and levelled peripheral areas before the rains. Left as such, these spots have developed into dense forest patches with *'behra', 'babool', 'awla'* and some other forest species.

Fig7. Forest patch developed by broadcasting goat-dung manure which contains seeds of some forest trees processed in goat gut. A dense patch of 'behra' growing trees can be seen here.

Extensive plantation of *Aloe vera* used for the therapeutic value of its gel and '*Awla-Behra-Harra'*, the three components of '*trifala*', have been done. Similarly, *Vitiver*, globally recommended for its high potential of carbon sequestering have also been planted on bunds and boundaries of orchard plots.

Fig8. *Vitiver* has high potential for Carbon sequestering

Agriculture: During the initial few years, inbetween the rows of saplings, crops as soybean, corn, pigeonpea etc were grown in the *khareef* rainy season and gram, drought resistant wheat with 'rayeda' (rapeseed), in the winter *rabi* season. The drought resistant wheat varieties as *'malwa shakti', 'navin chandausi'* etc, developed by the IARI, wheat research centre, Indore, give enough yield even with just two irrigations after sowing. A special trait of these wheat varieties is that these are also heat resistant and can withstand the heat during the later periods of grain formation. Therefore, these varieties are specially designed for this region and adjoining *'nimar'* area as the weather becomes quite hot during pre harvest time, unlike Haryana and Punjab. The main purpose of doing some agriculture was to develop the soil. Plant-soil interactions are known to improve soil texture. Further, direct ploughing back of the agri-residue after khareef harvest and recycling of the rabi post harvest residue after composting enhanced soil organic carbon. With the growth of the saplings and gradual development of canopy, major agri interventions were withdrawn and now mainly local pigeonpea, *'lal tuar'* is sown in the rainy season and in the available area *'rayda'* is sown in winter season. Both can grow on meagre available soil water and do not need any irrigation. The main reason for growing these crops is to provide plant cover and minimize loss of SOC through solarisation, as was recommended long back by Professor Dr. Dhabolkar.

Water Conservation interventions:

As mentioned at the beginning, besides poor soil and low soil depth, a major constraint was and is dearth of sufficient water resource, both in terms of deep aquifers and shallow ground water levels.
Therefore, water and soil conservation were of utmost importance right from the start. An added feature is that the Jatashankar village has a slope running south-east to north-west and our land is nearly in the middle of this slope. During rains, especially heavy rains, high velocity runoff would wash away much of whatever soil was available and destroy existing plantation. Therefore, right from the beginning extensive and planned bunding of the land was done alongwith plantation activities, for *in situ* soil and water conservation. Major interventions included making of a strong bund on the eastern boundary grading northwards across the path of runoff, to partly divert the oncoming gushing water, and digging of an east to north-west deep drain along the runoff to channelise and regulate the flow as far as possible.

At the plantation level, after the rains, water conservation efforts are started. A method of time proven advantage has been providing water to each fruit plant and tree sapling through a water-filled earthenware vessel or *'matka'* placed in a pit near the root zone. For this, a pit large enough to accommodate a 25 litre

'matka' is dug in the plantation bed near where the sapling is to be planted. The *'matka'* is put in this pit and covered with soil except the top, which is covered with a removable lid. It is filled with water and the sapling is planted. The transpiration pull of the sapling draws water through the pores of the vessel. No hole is made in the pot. Water is filled every week in the 25 litre vessel. This intervention saves a lot of water as it prevents unnecessary surface evaporation which occurs if the plantation bed is directly watered.

Fig 9. Sunken earthen ware vessel, 'matka' for water supply, a means of water conservation.

Another useful method for water conservation has been growing vegetables in soil beds lined with plastic. In this technique, a bed, 20 feet long, 3 to 4 feet wide and 2 feet deep is dug and lined all along with a thick plastic sheet. Soil mixed with compost is filled over the plastic, moistened with required amount of water and seeds are sown in case of vegetables as cucurbits, beans, okhra, spinach etc and seedlings are planted in case of vegetables as cabbage, cauliflower, tomato, brinjal etc. Comparative studies have indicated massive water conservation in this protocol. Thus, for equal productivity of same number of similar vegetables grown in 100 sq m plots simultaneously, the water requirement in litres per week are1800 for flood irrigation, 1400 for drip irrigation and only 600 for this method.

Conclusions:

For greening of barren land in the hot drylands with low water availability, enhancement and maintenance of SOC, optimised use of water, selection of plants and properly designed plantation to prevent mortality of planted saplings seem to be the necessary interventions