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Arresting Soil Erosion in Hilly Terrains with Pigeonpea - The Chinese Experience

K. B. Saxena[1], R. V. Kumar[2]

[1]Former Principal Pigeonpea Breeder and [2]Former Senior Research Manager, ICRISAT. Patancheru, Telangana, India

[2]Presently at: 2, ICRISAT Colony, (Phase I), Bowenpally. Secunderabad. 500 009, Telangana, India

Abstract: ***Conservation of the nutrient-rich top soil is extremely important for sustaining agricultural productivity. It is now becoming a serious crop production constraint, particularly in the slopping hilly terrains. The ecology of such areas is rapidly deteriorating and their recovery seems extremely difficult. In southern China, where soil erosion is a serious issue, various plant species were unsuccessfully tried in the past to arrest the soil erosion. The Chinese scientists, in collaboration with ICRISAT, used late maturing pigeonpea cultivars to protect the fragile lands in Guangxi and Yunnan provinces. The planted area under pigeonpea in this system rapidly increased to 700 ha by 2001. This paper summarizes the methodologies used in soil conservation practices involving pigeonpea.***

1. Introduction

In southern China soil erosion is a serious concern (Fig1) and the recovery of ecology in such fragile lands is difficult due to long spells of high intensity rains, steep slopes and absence of vegetation. To control the soil losses, some forest tree species such as *Phyllanthus emblica* etc. were tried, but their growth was not fast enough to provide rapid ground coverage. Hence, an alternative was needed. In this context, the Government of China, in collaboration with ICRISAT, explored the use pigeonpea germplasm. The highlights of this exercise are discussed here.

Pigeonpea was introduced in to China from India about 1500 years ago (Zhoujie, 1997) and traditionally, it was used for folk medicine and lac production. The Chinese scientists opined that pigeonpea could be used for soil conservation in the hilly terrains because of its drought tolerance, ability to grow well in nutritionally degraded soils, and rapid canopy development.

Advantages of growing pigeonpea

Soil amelioration: Like other legumes pigeonpea plants also play a significant role in enriching soil profile (Saxena, 2008). They fix about 40 kg N/ha atmospheric nitrogen and part of it is used by the crop itself while the rest is left in the field. Pigeonpea roots are also known to release the soil-bound phosphorus and make it available to the crop. Besides these, pigeonpea also plays an important role in the recycling of soil nutrients. Deep roots of pigeonpea plants absorb the leached nutrients, which are settled in deeper soil layers, and bring them to the top of soil profile through massive leaf fall at maturity.

Rapid canopy and root development: Pigeonpea is perennial and photo-sensitive species, and these traits stimulate plant biomass growth by accumulating the photosynthates into its roots, stems and branches. These stored food reserves also provide plants the ability to regenerate following the short spells of various types of stresses.

Phenotypic plasticity: Pigeonpea plants are unique and have great capacity to respond positively to space, planting dates, moisture availability, and soil fertility. These external factors induce irreversible changes in plant growth parameters. For instance, the high plant population induces upright canopy with few branches, while under wide spacing the plants spread in all directions and produce more branches and biomass. This 'plastic nature' of pigeonpea plants is useful under field situations. In case, if a portion of plant population is lost due to germination issue or seedling mortality, then the remaining plants produce additional branches and fill the vacant field spaces and compensate for the plant losses.

Soil conservation technologies using pigeonpea

To control soil erosion in Guangxi and Yunnan provinces, the Government agencies are adopting various measures, but still the loss of top soil and landslides are continuing during rainy months and soon after (Fig 1). In the on-farm trials involving pigeonpea, the late maturing cultivars like ICP 7035 and ICPL 87119 were found highly adapted and produced large biomass even when sown in heavily eroded soils. Hence, pigeonpea was selected for large-scale soil conservation trials in different ecologies. Various approaches used in this endeavour are briefly described here.

Arresting soil erosion in fields with mild slopes: Land areas with mild slopes are generally located in valleys and plateaus. These may be irrigated or rain-fed. In most fields vegetable, cereals, or fruits are cultivated. With the intervention of local scientists, the farmers were encouraged to introduce pigeonpea as an inter-crop with the objective of improving the soil health in the long run.

Arresting soil erosion on steep slopes: The hilly terrains with steep slopes have become unfit for agriculture due to heavy loss of the fertile top soil, which over the time also induce land slide (Fig 1). Such lands are invariably left fallow. In some areas, however, trees are transplanted by forest department in the hope of providing good ground cover in future; but the success is not up to the mark and the soil erosion is continuing. Each year a specific land area is identified for aforestation and grown with pigeonpea (Fig 2). After a period of 3-4 years it is released for cultivating some early maturing food crops.

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Arresting soil erosion on highly eroded hills: In the areas characterized by steep slopes and high intensity rains with least ground cover, the soil erosion is very high and the ground surface has lost almost all the top soil. In such areas of Guangxi province, pigeonpea was sown to establish some vegetation. In this topography pigeonpea seeds were sown in the spaces available between the boulders where some soil was available. In each such space 5-10 seeds were dibbled with no inputs. Surprisingly, the pigeonpea plants grew normally and had healthy canopy development (Fig 3). As the season advanced a vigorous canopy developed and provided good ground coverage. These areas are left unattended for the entire season, and a follow-up sowing of pigeonpea is undertaken in the spots where pigeonpea plants were killed or grazed.

Arresting soil losses on the slopping road sides: On the slopping road sides, the soil erosion is heavy to very heavy. In rural areas the roads are constructed by cutting the edges of hills; and this leaves loose soil at one side and excavated hill on the other. These sites are prone to heavy erosion, particularly in the absence of any vegetation. In these areas the sowings of pigeonpea seeds is also not easy due to practical difficulties in sowing and the quantum of work load. Therefore, the technicians use a simple method of broadcasting the seed. For this purpose, before the commencement of raining season, the pigeonpea seed lots are taken in an open pickup van and driven slowly along the roads. The seeds are thrown (broadcasted) manually on the slopping sides of the road. The scientists estimated that about 60-70% seed quantity is lost to run-off and birds, and the rest germinate (Li Zenghong, pers. comm.). During rains the seeds germinate and plants grow nicely and start covering the ground (Fig 4). This crop is left to grow on its own with no inputs or cultural practices. At maturity, seeds from the plants are not harvested and the pods are allowed to shatter. In the second year both, the self-sown seeds along with one year old plants start providing ground coverage to help in reducing soil erosion. Such cycles continue to manage the loss of soils from the road sides.

Protecting river banks from soil erosion: Heavy soil erosion from the river banks and nearby areas is quite common, especially, during and soon after the rains. The presence of high moisture and sandy soils facilitate heavy soil losses. Trials with pigeonpea for preserving the top soil were highly successful because of its vigorous and rapid canopy development (Fig. 4). The soft soil and high soil moisture on the river banks help the pigeonpea plants in developing strong and deep root system which help in holding the soil together.

Alternative uses of pigeonpea developed in China

Besides its primary use for reducing soil erosion, the pigeonpea was also used for other purposes (Chaohong et al., 2001).

Pigeonpea plants are good host for raring lac insect (*Kerria lacca* Kerr.). Each year farmers harvest high yields (750 kg/ha) of quality lac resin. In order to produce high quality white mushroom fungus (*Agaricus bisporus*) the pigeonpea plant parts including seeds are mixed in the culture medium to replace the paddy straw. According to Bao Shiying (pers. comm.) the mushrooms produced on this medium were bigger, attractive and nutritionally superior.

In the post rainy season, feeding domestic animals with nutritive fodder is an issue. During these months use of pigeonpea fodder has given a relief to farmers. A fodder mixture of grasses and pigeonpea foliage was found good for direct feeding and as silos. Pigeonpea seeds are also used to prepare various food products for local consumption. The fresh immature seeds are sold as fresh vegetable; while the grains are eaten as snacks.

2. Conclusions

In 2001, using ICRISAT germplasm, the pigeonpea crop was sown in about 700 ha of forest lands in Yunnan province alone. This success encouraged the scientists; and they also identified pigeonpea as key aforestation species for other mega projects such as (i) Protection of Forests in the Upper-middle Reaches of Yangzi River (ii) Protection of Forests in Lancangjiang River, and (iii) Protection of Natural Forests.

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Figure 1: A generalized view of soil erosion in hilly terrain

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Figure 2: Pigeonpea on the hills

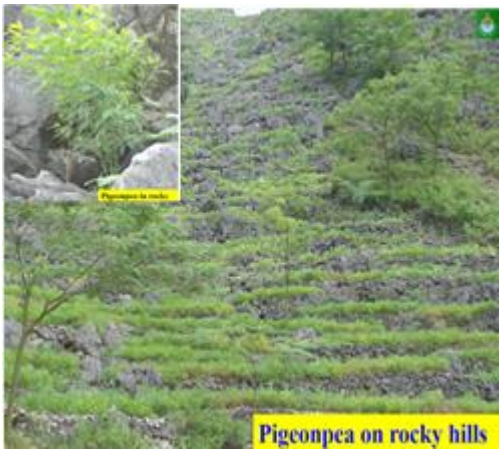

Figure 3: Pigeonpea on steep slope

Figure 4: Pigeonpea on river bank

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