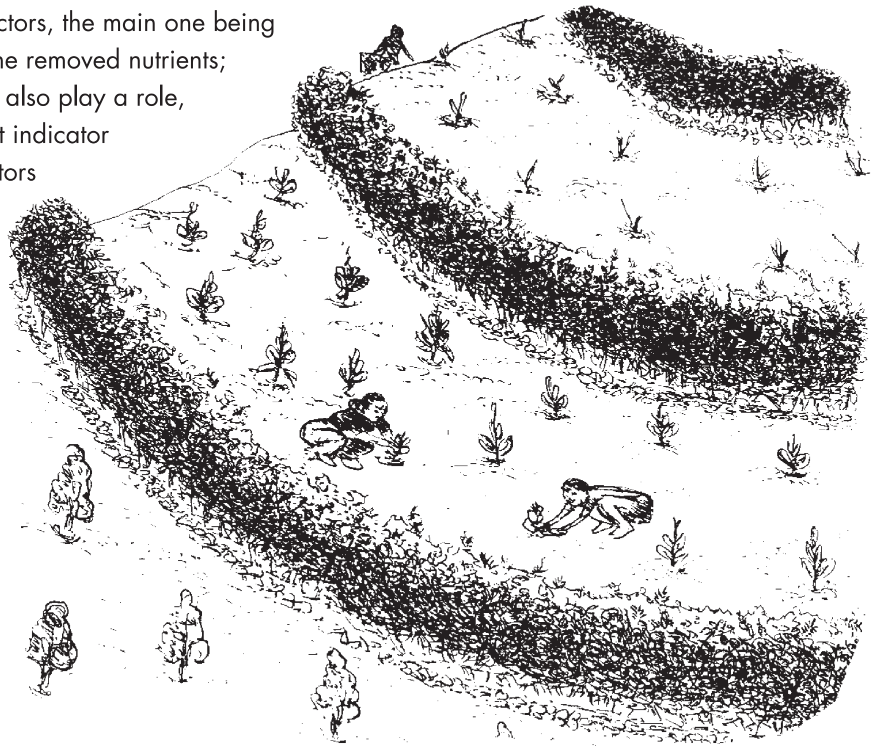
ICIMOD

FOR MOUNTAINS AND PEOPLE

Soil Management

Soil erosion, soil degradation and declining soil fertility are widely regarded as major problems threatening the sustainable use of sloping agricultural land in the Hindu Kush-Himalayan region. Soil erosion reduces the rooting zone depth and quality and is the most pervasive long term cause of soil productivity loss. The primary causes of soil erosion are excessive or poor tillage practices that leave bare soil exposed to the eroding forces of water and wind. Decline in soil fertility is a natural process that results from various factors, the main one being the growing and removal of crops without replacing the removed nutrients; nutrient loss through soil erosion and nutrient leaching also play a role, particularly on sloping land. Soil status is an important indicator of land productivity and one of the most important factors contributing to crop yield. Prevention of erosion and management of soil fertility are among the most important issues in agricultural production; but maintaining soil fertility for sustainable crop production is a great challenge.



The soil management activities at the Godavari site focus on various methods for reducing erosion and improving soil fertility that do not require large inputs, are not based on the use of inorganic fertiliser, and can be used by individual farmers with few resources. The major practices are described below.

Conservation Farming

The basic principle of conservation tillage is to maintain a cover on the soil surface of residues (mulching) or vegetation that helps retain soil and water. The improved soil and water conservation results in the preservation of top soil and soil organic matter. Conservation tillage has two basic advantages: (1) conserving soil, water, and soil organic matter resources and (2) reducing the need for costly inputs while maintaining or improving crop yield and profits. The higher yields under conservation tillage systems are generally attributed to the increased soil water content resulting from increased infiltration, decreased run-off, and decreased evaporation. Using conservation tillage systems, growers can start using more intensive crop rotations with fewer summer fallow periods or increase crop yields within traditional cropping systems. Converting to more intensive cropping systems, greatly increases the efficiency of use of precipitation with less water loss below the root zone and less potential for nitrate leaching.

Agroforestry

One of the bases for establishing sustainable farming systems is to integrate nitrogen-fixing plants into the system, whether in the form of crop rotation or as perennial plants. In mountain areas, the most common farming approach is to use a mixed crop-livestock agroforestry system. This can be made considerably more successful if nitrogen-fixing plants (NFPs), especially those that occur naturally in the environment, are deliberately incorporated into the system. NFPs are one of the cheapest and best sources of organic manure, they add nitrogen to the soil through the action of the microbes or microorganisms in their specialised root nodules and through the decay of their nitrogen-rich foliage. Generally, NFPs do not require extra fertiliser for growth; they are often pioneer species on degraded land and can be an important source of cash crops. Nitrogen-fixing herb, shrub, and tree species can be used to maintain soil fertility in agroforestry systems, to increase forest productivity, and to improve soils at degraded and eroded sites prior to introduction of other species. Both uses are demonstrated at the Godavari site.

Sloping Agricultural Land Technology (SALT) (Map Site 3.1)

Sloping agricultural land technology (SALT), otherwise known as contour hedgerow intercropping (agroforestry) technology (CHIAT), is a system in which dense hedgerows of fast growing perennial nitrogen-fixing tree or shrub species are planted along contour lines thus creating a living barrier that traps sediments and gradually transforms the sloping land to terraced land. The nitrogen-fixing hedgerows lining the terrace help improve soil fertility through nitrogen fixation at the roots and incorporation of the hedgerow trimmings into the soil. The hedgerows both markedly reduce soil erosion and contribute to improving and/or maintaining soil fertility. The technology was developed by the Mindanao Baptist Rural Life Centre, internationally known by the name of its sister affiliate Asian Rural Life Development Foundation (ARLDF), on a marginal site in Kinua Kusan, Mindanao Island, in the Philippines.

SALT has been studied in considerable detail at the Godavari site. The aim was first to determine whether this method, originally developed for tropical areas, could be used in the cooler climate of the HKH mid hills, and second to discover the optimum conditions for establishment and use of nitrogen-fixing hedgerows. Detailed investigations have been made of the impact of SALT on soil erosion, water runoff, and soil fertility; the conditions for establishment; appropriate nitrogen-fixing hedgerow species for mid-hill areas; crop/hedgerow combinations; and potential competition between crops and hedgerows. SALT offers a potentially very valuable method for controlling soil erosion and increasing soil fertility in the HKH mid-hills. It can be established on farmland slopes with gradients ranging from 5 to 25 per cent or more. Various SALT plots are demonstrated at different locations in the Godavari site, and training in the technique has been and is offered at regular intervals.

Green Manure/Cover Crops/Mulching (Map Site 3.2)

Green manure is a growing cover crop of annual plants (or other growing plant material) that is dug into the soil to improve or restore fertility and soil texture. These plants are generally grown on fallow land and then dug into the soil before crops (or ornamental plants) are planted, although in some cases plants are grown in one place and the foliage and roots dug into the soil or used as mulch material in another. The cover crops used for green manure are mainly legumes. The crops both cover and protect the soil while growing, and add nutrients to improve fertility. Cover crops can add over thirty tonnes of organic matter and two hundred kilogrammes of nitrogen per hectare of land in a year. A number of different green manure cover crops are being tested at the site for suitability and impact.

Shelter/Protection Belts (Map Site 3.3)

Planting and maintenance of shelter or protection belts is another important method of soil and water management. Shelter belts are composed of ground vegetation cover, for example trees and bushes, that provide shelter to crops from very hot sun and desiccating dry winds. They also provide a pathway for run-off of excess water during heavy (monsoon) rains that is protected from erosion by the vegetation. Thus they help to control runoff, conserve soil, improve water percolation into the soil, conserve moisture, and provide sediment-free water downstream.

Composting (Map Site 3.4a-c)

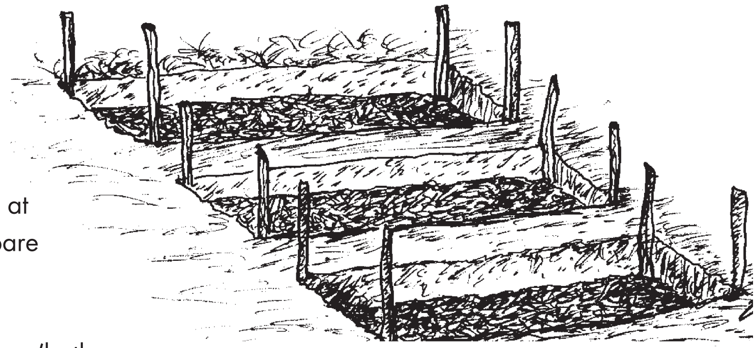
Biodynamic composting (Map Site 3.4a)

Biodynamic composting is a faster way of producing compost. Here the compost is made on the surface, rather than in the traditional pit. The heap is energised using a set of preparations that both enhance the nutrient content of the compost and hasten the decomposition process. The compost heap is built on a flat site away from tree shade and water logging. A rectangle around 2m wide and 4m long is marked out (the actual size depending on the biomass availability). A ‘wind tunnel’ of logs is placed lengthwise in the middle of the rectangle. The rectangle is covered with a first layer of dry matter about 22cm thick which is then drenched and completely covered with cow dung slurry or goat manure. This is covered with a 15cm thick layer of green matter, which is sprinkled with water and covered with a thin layer of soil. The third layer again consists of 15cm of dry matter which is sprinkled with water and 30 kg of rock phosphate (which enhances decomposition and provides phosphorous). The fourth layer is again 15 cm of green matter which is sprinkled with water and covered with a layer of 30 kg crushed slaked lime (which also enhances decomposition). The fifth layer is more dry matter which is sprinkled with water and with cow dung slurry or goat manure. The sixth and final layer is 22 cm of green matter which is sprinkled with water and completely covered with cow dung or goat manure. The heap is plastered with a mixture of soil and cow dung (3:1) over the top and sides.

The final height of the compost heap is just over a metre. Any cracks in the plaster are immediately sealed with plastering slurry. Samples can be taken from 2-3 sides of the heap to check whether the compost is ready. The sample is crushed and smelt. A smell like forest soil indicates that degradation is 70-80% complete and the compost ready for use. Generally, compost is ready within 8-12 weeks (depending on the time of year).

Effective microorganisms (EM) technology and EM composting (Map Site 3.4b)

'Effective microorganisms technology' is a method developed by Professor T. Higa of Japan in which a mixed culture of beneficial microorganisms (primarily photosynthetic and lactic acid bacteria, yeasts, actinomycetes, and fermenting fungi) is applied as an innoculant to increase the microbial diversity of soils. This improves the soil quality and health, which improves the growth, yield, and quality of crops. In the variant being tested at ICIMOD it is combined with composting, to make an easy to prepare and very effective organic fertiliser.

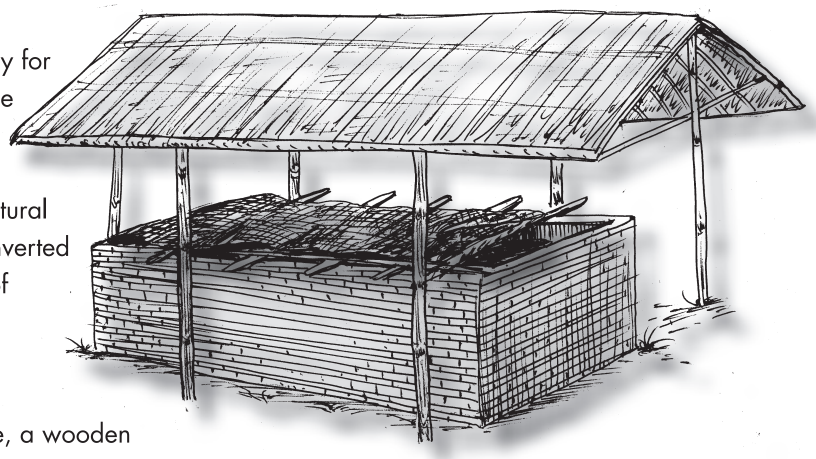


Composting is a largely biological process in which microorganisms (both aerobic and anaerobic) decompose organic matter and lower the carbon-nitrogen ratio of refuse resulting in a final product of well-rotted compost. Compost has a high content of organic matter and important nutrients and is very useful for soil conservation and improving and maintaining soil fertility. In cooler climates, however, and with coarse material, the process of composting can be quite slow.

The EM composting method uses effective microorganisms and molasses to speed up the composting process and provide an improved compost product. Vegetation, especially weeds from cropping alleys and unwanted (exotic) forest weeds like banmara (*Euphatorium adenophorum*), is chopped and mixed with a small amount of goat manure and fermented organic matter containing beneficial microorganisms, and 1% of a solution of EM in molasses. The mixture is placed in piles on the ground. In the summer, it transforms into mature compost in 5-6 weeks.

Pusa vermicomposting (Map Site 3.4c)

Vermicomposting, or worm composting is a simple technology for converting biodegradable waste into organic manure with the help of earthworms (the red worm *Eisenia foetida*) with no pile turning, no smell, and fast production of compost. The earthworms are bred in a mix of cow dung, soil, and agricultural residues or pre-decomposed leaf-litter. The whole mass is converted into casts or vermicompost, which can be used on all types of plants in vegetable beds, landscaping areas, or lawns.



A 3m long, 1.25m wide, and 1m high pit is constructed with bricks on a moist and/or shaded site. If brick is not available, a wooden box or bamboo bin can also be used. To facilitate drainage and prevent the worms digging into the soil, the base of the pit is covered with an 8 cm thick layer of sand. This is covered with a 15cm thick layer of dry cow dung crushed into small pieces, followed by a layer of pre-decomposed degradable dry biomass and another thick layer of crushed dry cow dung. Finally the heap is covered with a thin layer of soil and the worms are poured on top.

A thatched roof should be built over the pit to maintain 40-50% moisture and 20-30°C temperature. Regular watering is needed to maintain the optimum moisture level. After 5-6 weeks, the top layer is removed and piled in one corner of the pit. After a few days, the newly exposed earthworms have burrowed down and the next top layer can be harvested. About 600 to 1000 worms can convert 45 kg of wet biomass in a week yielding about 25 kg of vermicompost. The earthworms are removed when all the compost has been taken out, and can be stored in moist paddy straw or a jute bag for later use. Vermicompost can be applied to any crop at any stage.

International Centre for Integrated Mountain Development
Demonstration and Training Centre at Godavari
GPO Box 3226, Khumaltar, Lalitpur, Kathmandu, Nepal

Tel +977-1-5003222 **Fax** +977-1-5003299
Email info@icimod.org **Web** www.icimod.org
Godavari Site Tel +977-1-5560289/5560991