

Diversified Farming Systems - Learning from past to move into future

Diversity is being lost rapidly both in nature and culture, including agriculture. But, all is not lost yet. Realising the benefits and also as a reliable option in fragile ecosystems, communities are still nurturing diversity. This article highlights issues, available and potential options as well as barriers.

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During the last 50 years we have been losing diversity at an alarming rate, both in nature and in culture, including agriculture. If it was for clearing greenery for roads and railways in the beginning, in mid 60's it was by promoting monocultures of rice and wheat, large doses of synthetic fertilisers and biocides. As a result, soils which were repositories of wide range of micro flora and macro fauna, got impoverished and destroyed. As water too got polluted, hundreds of fish, frog, shrimp, crab, snail species etc, living in rice fields and surrounding water bodies, got destroyed. They were rich sources of protein for the rural poor. With advent of mechanization, trees and shrubs in between crop fields were cleared to enable free movement of tractors and power tillers. Gradually, the need for and possibilities of raising strong bullocks and buffaloes affected; local breeds of diverse livestock disappeared, often through active collaboration and sometimes coercion with the state authorities. Imported plants and animal genetic materials, for instance vegetables and fruits, advertised as 'miracles' were expanded through loans and subsidies. With reference to livestock, farmers could not buy indigenous breeds. Exotic short cycle pulpwood species were promoted by forest departments initially for planting on degraded land – gradually were extended to farmland, wetlands and forests, sometimes even replacing multi-utility natural forests. Diversity, at the level of genes, species and ecosystem has therefore threatened by mainstream development; whatever exists today is not because of but in spite of development planners. A national biodiversity action plan is formulated but remains stillborn.

Diversifying cropping system is a goal of the agricultural department but the real message is: 'stop growing less profitable food crops, grow flowers, fruits, spices instead for sale to retail chains or supermarkets in city or even better to export houses'. This diversification has nothing to do with achieving self sufficiency, reducing pollution or erosion of soil and of livelihoods.

Where then, can we find diversity?

Much of the diversity is lost (or has been handed over to multinational corporations, who use it to breed new hybrids and claim patent rights), whatever remains is in the hand of small and marginal farmers, especially those who live in too dry, too wet or too remote areas and who mainly grow food for themselves.

Indigenous tribes living in forested regions in hilly areas of India (mainly north east India, eastern or Western Ghats and in Himalayan midhills) still practice jhum / podu / slash and burn farming. In these farming systems 15-20 or more cereals, legumes, cucurbits, oilseeds and tubers are planted together in patches that are cleared among forested area. Farmers also harvest wild herbs,

tubers, mushroom etc. In 3-4 years, trees start to grow back and the plot is abandoned, and a new plot is cleared and planted. These farms are now becoming less productive, because land is scarce and farmers often have to return to the same plot after only 5-6 years (or even less) rather than the 12-15 year rotations observed in the past. Forest authorities have tried to outlaw these people, or replace their farms with monocultures of pineapple, banana, citrus fruits etc. Farmers in India, Nepal, Thailand, Cambodia and Vietnam nurture and grow major and minor millets, rice beans, pigeon pea and cowpeas, dolichos beans, horsegram and kidney bean varieties as well as many varieties of gourds. *Dioscorea* yams, jack beans etc from forest are nurtured rather than cultivated. Traditional varieties of upland rice, maize, grain amaranth and buckwheat are often the main food grains cultivated. Many tree leaves are used as food or fodder. These communities hardly use any spices or vegetable oil, food is usually eaten raw, or boiled or roasted.

Diversity is still alive in the Home Gardens, both in the hills and in plains. Home gardens are usually small and are primarily for self consumption. Often, they are managed by women and children based and the choices are based on food preferences rather than market prices. In a home garden, vegetables, decorative plants, culinary and medicinal herbs, fruit and other trees, domestic animals, birds and sometimes bees, frogs and fish etc are raised.

A typical backyard garden in West Bengal would have small fruit trees like guava, lemon, banana, pomello, coconut, arecanut etc. In the drier regions custard apple, jujube, pomegranate are more common. Mango, hog apple, elephant apple, wood apple etc are also found in larger plots. For the fences, thorny or non browsable species are preferred. Flowering plants such as *hibiscus*, *nycanthes*, *nerium*; bitter leaf plants such as *vasak*, *vitex negundo*; thorny cactus etc are commonly planted on fences. Stumps of *erythrina*, *lannea*, *coromandelica*, drumstick or moringa are often used as fence post in the moist areas. *Sesbania grandiflora*, arecanut tree etc are planted along fence. Yams or sword beans use them as climbing support. Cultivated or wild variety of ivy gourd, yam beans, hyacinth bean, bitter gourd etc are also used as part of fence. Leafy vegetables commonly planted are, amaranthus (many varieties) basella, sweet or bitter leaf jutes, sour leaf roselle or kenag, curry leaf, drum stick, tavo leaf etc. Many kind of gourd leaves, bean leaves are also eaten but this varies according to region – the highest number of varieties consumed are in Kerala, West Bengal, Assam, North East Indian states. Pumpkins, Melons, Gourds, Brinjals, Tomatoes, Okra / ladies finger, pole and bush beans are preferred vegetables. Taro and sweet potato, elephant foot yam, cocoyam, cassava, *diasco vea* / climbing yams, arrow roots are the preferred tubers in home gardens as most of them are vegetatively propagated. Many indigenous varieties have survived in these courtyard / backyard / home gardens. Chillies, ginger, turmeric, bunching onions, many varieties of basil, mint, lemon grass and other aromatic plants are often grown under the shade of larger trees / shrubs. Many households have a small fish pond, few goats, pigs, chickens, ducks etc (mostly indigenous ones) which are raised mainly on crop residues and household wastes. Larger scale households have cows, buffaloes as well. In peri-urban areas, home gardens have increasingly become monoculture orchards of banana, papaya, limes and lemon, guava, coconut etc or have been overtaken by short cycle plantations of pulp woods such as

eucalyptus, casurina, *acacia auriculiformis* etc. Lately, medicinal plant monocultures, bio-diesel plantations or mono species fruit tree plantations, subsidised by some or other agency are invading the traditional bio-diverse home gardens.

The third area where biodiversity has survived somewhat are small farms in flood prone and drought prone areas, as the external input intensive, market led, hybrid – seed based packages have mostly failed in these disaster / stress prone areas.

In flood prone regions, rice is the main food grain. In rice field, along bunds and canal edges, the only trees seen are babool / *acacia nilotica*, some varieties of *sesbania* and *caesalpania* etc as they can tolerate waterlogged soils. Few palm trees, Jamun or wood apple trees, neem and sissou trees, rain-trees, soursop shrubs, ficus trees and shrubs may also be present.

The diversity is mainly in aquatic plants, most of which grow voluntarily and are harvested from rice fields or wet lands and their edges as food, fodder or medicinal plants.

In the rice fields of coastal India, 30-40 kinds of edible herbs are found in large quantities; 'Kalmi (*Ipanea*), 'thankuni' (*Centella asiatica*); 'brahmi', 'Sushni', 'kanchire', 'kulekhara', etc are even sold in some town and city markets of West Bengal.

During rainy season all the wetlands and paddy fields get connected, wherever agrichemical use is less, a wide range of fish (mainly insect eating mud fishes), frogs, snails and crabs, shrimps breed in or migrate through the farms. Farmers have developed a wide range of traps (mostly bamboo cages) to harvest this diversity. Some are consumed immediately; some are nurtured in a jar ditch or pond to be consumed later.

Many aquatic weeds such as duckweed, azolla etc are used as duck or pig feed; some are used as mulch or compost material, some as fuel. Water chestnut, water lily, lotus etc. are cultivated in wetlands as food plants and their seeds, stems etc are both consumed locally and sold in nearby markets.

The main plant rice / paddy itself has many varieties, adapted to deep water, saline soil, late rain etc. Rice varieties were also selected for their aroma, shape, texture, taste etc. Even now 150-180 varieties of rice are known / used by small farmers living in Sunderban delta and coastal east midnapore districts of Bengal. Every part of rice plant has many uses or the by-products too are valuables as food or fodder. Rice straw is used as roofing material, to make ropes and paddy storage bins, as winter bedding material for cattle, as substrate for mushroom cultivation, as cattle fodder, as packaging material, as construction material etc. The rice hull is used as fuel, as incubation / insulation material for hatching eggs, as mulch or soil amendment material (especially in charcoal form), as colouring agent in pottery etc. Broken rice and rice bran is used as feed for fish, duck, chicken, pig. Various food items are made from rice powder; puffed rice, popped rice, flattened rice etc are still popular snacks in Bengal. Rice beer is liked by farmers, though the technology used has not developed much as state authorities consider this as illegal / immoral to brew liquor.

In the rainfed / low rainfall regions, maize, sorghum, pearl millet, finger millet have remained as the main food grain (though rice and wheat have entered into many kitchens via public distribution system). Pigeon pea, black gram, chick pea, horse gram in the plains and rice bean in the hills are the main pulses of dry regions grown together or in rotation with cereals. Niger, sesame, safflower, mustard linseed, castor, groundnut etc are the main oilseeds.

Small farmers in Central India and in hilly regions have practiced mixed planting over many centuries. Land is ploughed only once

a year and fast maturing, slow maturing and very slow maturing grains, vegetables, spices etc were inter planted. Only a few of these systems have survived as the seeds and associated knowledge has eroded.

In dryland farms and bunds and surroundings the trees that are commonly seen are babuls, flame of the forest, kendu or tendu, Palmyra, date palm etc. More common are thorny shrubs and bushes with inedible leaves such as castor, various cassia plants with milky saps (often poisonous / medicinal), agave etc together with a wide range of grasses.

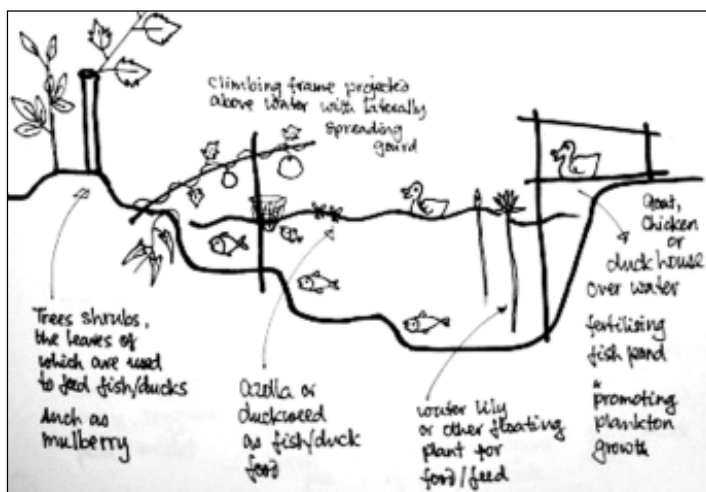
In low rainfall areas, some of the edible weeds are prickly amaranth, lambs quarter, ivy gourd etc – with limited availability. Main strategy of the small holders is to raise animals / birds that can convert low quality vegetation into human food. A wide range of insects and small reptiles are also used as food or feed in the dry regions. Wherever there are forests, roots and tubers, mushrooms, tree leaves, flowers and fruits / seeds supplement the diet especially of low income households.

Our misplaced priorities

In India, we have dramatically increased food supply but have achieved only marginal success in reducing malnourishment, hunger and indebtedness. This is because of (a) common lands, forests, grasslands, wet lands have been degraded or commercialized (b) farmlands have become mono-crop based and soils are eroded / poisoned / exhausted (c) our research has focused on more of the same and high external input reliant hybrid plants and animals (d) indigenous communities have always been seen as 'beneficiaries', 'backward' never as source of knowledge or partners in progress (e) cropping and farming systems are not designed to take advantage of local climate and biodiversity.

Farms of future will have to be *Cost effective* - as farmers will have to deal with open markets, where support prices will not be guaranteed by Government; *Energy efficient* - as fossil fuel prices and electricity charges are likely to keep rising; *Water efficient* - as sources, are drying up and resources are increasingly being privatized; *Productive* - both in forms of land and labour as the prices will keep rising; *Resilient* - yielding a minimum quantity despite soil degradation and climatic variation and regenerative; as many natural ecosystems such as forests, wetlands etc won't be able to perform their ecological functions. To achieve these objectives:

- Farms will need to be multi-storey arrangements, some combination of plants (seasonal / perennial) animals and aquatic life, insects and micro-organisms.
- Farms will need to be well integrated or zero waste. All crop and animal residue will need to be utilized through multi step processes often using a bio-digester, gasifier, fermenter to accelerate nutrient release. Bio-activators, earthworms, algae etc., will also have to play a role.
- Use of renewable water and renewable energy will have to be maximized, use of synthetic fertilisers will have to be reduced drastically and use of synthetic biocides totally stopped. Use of plastics and other persistent organic pollutants also have to be minimized.
- Farms will have to be designed to take advantage of local landform, soil and climate as well as biodiversity and cultural diversity. Top down extension systems and lab to land approach will have to be replaced by participatory action research and participatory technology development / assessment approaches.



- Farmers / gardeners have to be supported to work in mutual cooperation groups especially for soil and water conservation work, social fencing around farms and forests / plantations, seed banks and emergency grain reserve management, water harvesting and water sharing etc.
- Diversity of nature and culture will have to be actively restored and celebrated. Many plants, insects, birds etc that are perceived to be weeds and pests and therefore problems will have to be turned around and studied as possibilities / potentials. Based on these and on underutilised crop residues, animal wastes and by products, non timber forest produce etc, a wide range of micro enterprises can be started to strengthen livelihood options (both through vertical and horizontal expansion.)

Commonly managed seed collections, gram reserves (mostly paddy), revolving funds, small irrigation systems have also been tried with but not in very large scale. Same is true for food and NTFP processing / marketing.

Barriers for scaling up of diversified farming systems

- Those who live close to their land are more likely to succeed. In floodplains, people often live far from their farmlands. Lands are often fragmented.
- Large numbers of farmers are share-croppers and cannot redesign / reshape their farms, even if loans are made available.

Highlights of some ideas tried successfully are as follows:

	High rainfall region	Low rainfall region
Home gardens	<ul style="list-style-type: none"> - Raised beds or deep ditches system. - Floating nurseries and herb gardens. - Multi storey living fences and orchards. - Small multi-utility ditches / ponds 	<ul style="list-style-type: none"> - Roofwater collection, trickle irrigation (subsoil) - Climbing frame with live poles - Drought tolerant trees and shrubs for supplementary feeds (birds and animals) - Strategic food reserves (roots, tubers, edible leaves etc)
Small farms / crop fields	<ul style="list-style-type: none"> - Rice / duck / Fish farming with azolla - Vermicompost using aquatic weeds and biogas slums - No till potato with deep mulch (mainly in coastal zones) - Relay cropping of legumes, oilseeds, spices and herbs etc. 	<ul style="list-style-type: none"> - Multi step, water harvesting ponds with trees, shrubs on bunds. - Rainfed, row-intercrops of cereals, legumes oilseeds. - Raising vegetables, legumes on field bunds during monsoon - Mushroom culture in winter
Common lands	<ul style="list-style-type: none"> - Multi species / multilevel good forests (community lands and leased private land) Vegetable growing by groups of women and children 	<ul style="list-style-type: none"> - Community managed multi utility woodlots on roadside, canal bank, pond bank etc - Biodiversity plantation in waste lands, graveyards, cremation grounds etc

- Credit for land shaping, tree planting, integrating small indigenous birds/animals/fish etc are usually not available, especially to small holders. Credit from institutional sources is almost always linked to high-external input bases, high return, high-risk ventures and in most situation insurance is not available or is linked only to commercial crops.
- Unless farmers in the neighbourhood cooperate, it is very difficult for few farmers to change cropping pattern and integrate animals / birds/ fish etc., as they are vulnerable to pollution, poaching etc.

To promote diversified integrated farming, ecological techniques need to be combined with social engineering and backed up by reliable information and training / advisory services, along with credit / insurance and processing / marketing support. Farmers' organisations and civil society organisations concerned about food and livelihood security need to cooperate and collaborate towards this future.

Based on three decades of working experience with diverse communities as trainer / advisor / designer in many parts of India, South Asia and South east Asia in diverse agro-climatic regions and agro-ecosystems, got involved in combining various principles and techniques of diversified farming systems. If we combine the principles and techniques / technologies of traditional home gardens / agro forestry, hill and dryland mixed farming, rice based lowland farming etc., along with modern knowledge and techniques of soil and water conservation, use of biological fertilisers and botanical pest control agents, biogas and producer gas generation, raising of multipurpose trees and shrubs in agro forests, live fences, food forests etc., both food insecurity and poverty can be drastically reduced.

The editors or author may be contacted for few more illustrations of options.

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