Transforming the potential of small farms in Asia for food production

Food production in Asia is, to a surprisingly large extent, dependent on small farm systems and resilient farmers in environmentally challenging areas of the region. It will surprise many to know that about 2.6 billion resource-poor small farmers produce the bulk of the food that is consumed.

By C.Devendra

Agriculture's key function is food production, which in most parts of Asia, is dependent on small farm systems. Small farms are complex interrelationships between animals, crops and farming families, involving small land holdings and minimum resources of labour and capital, from which small farmers may or may not be able to derive a regular and adequate supply of food and an acceptable income and standard of living (Devendra, 1983; 1989).

Farmer feeding legumious forages and shrubs to a Bali cow in Bukit, Bali in the three strata forage system project

Characteristics of small farms

The characteristics of small farms include:-

- Relatively small land area (< 2 ha)
- Located in less accessible locations
- Low levels of inputs
- Diversified outputs
- Limited access to resources, services, technologies and micro credits
- Dependence on indigenous knowledge / and traditions
- Production of food mostly for home consumption and home food security
- Production of cash crops to generate income to meet household needs or to enhance tangible assets e.g. purchase of animals
- Rearing of animals but seldom more than two species of ruminants together
- Low economic efficiency, low transaction costs and dependence on unpaid family labour
- Poor access to market outlets, low bargaining power and poor marketing arrangements
- Environmental resilience and ecological balance.

Some small farms such as the integrated duck-pig-poultry-fish systems in China are models of efficiency.

Buffalo or "carabao" used for haulage and transportation of farm produce in the Philippines

Profile of small farmers

Small farmers are generally:

- Resource-poor
- Continuously exposed to hunger and poverty
- Able to adapt to and survive hardship
- Resistant to change and averse to risk-taking
- Excluded from major decision-making processes
- Ignorant of new technology
- Illiterate and unable to use extension materials.

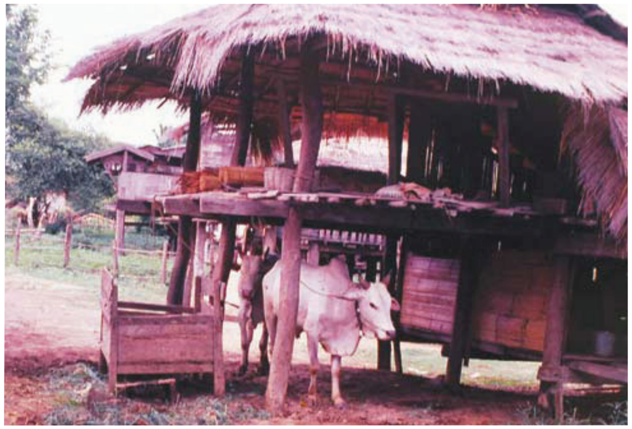
They live in a non-ending syndrome of poverty, adaptation, fragile lives, little hope, low life expectancy and low food security, in which human dignity is at stake (Devendra, 2010).

Small farmers may own 1-2 large ruminants, 4-6 small ruminants and /or a few pigs, poultry and ducks. Large ruminants are owned primarily for draught power and secondarily for meat. Animals also serve multi-purpose uses, including the supply of dung and urine, and for transportation. There is also prestige in the ownership of large ruminants, especially where they are used in sport as in Indonesia and Thailand. The animals are often fed from common property resources as in grazing in forest margins and waysides. In general, a complementary relationship exists between the animal and crop components.

Women often play major roles in decision-making in small farms. They tend to work more hours per day than men, and together with children are involved in household chores and in the management of small animals.

We need to improve farming systems in the face of changing conditions to ensure their viability not only for food production, but also to enable small farmers to become better stewards of the environment. Transformation goals should include the following:-

1. Adoption of productivity-enhancing technologies
2. Reduction of poverty
3. Enhancement of research capacity, and
4. Demonstration of environmental sustainability and food security.



Typical small farmer's house in Surin, Thailand. Note how the cattle are kept under the house for easy management and security reasons

The agricultural environment

The natural environment in agriculture includes crops, animals, land, water, forests and fisheries. Poorly managed agriculture can lead to serious environmental degradation and exacerbate poverty. Land and water will be the most limiting factors in the future. Climate change and its effects on total rainfall and temperature are two important variables that will determine to a very large extent the level of productivity (Devendra, 2012a).

Some 300 million small farmers, including landless ones, depend on animals. South Asia, Southeast and East Asia together account for 59 - 60% of livestock keepers in mixed small farms.

Agriculture is most successful in the irrigated areas of Asia which are considered "high potential". By comparison, the rain-fed 'less-favoured areas' (LFAs) produce much less, and have received little or no research and development (R&D) attention. In spite of meagre resources, small farmers mostly succeed in achieving complementary relationships between the animal and crop components in mixed farm enterprises. We need to improve our understanding of these LFAs, traditional farming systems and the indigenous knowledge associated with them, by spending time with such farmers to listen to and understand their aspirations, find out why they observe certain practices, and win their confidence before we can assess the potential for improvement. For example, in Nanjian county, Yunnan province in China, the resolution of major constraints resulted in significant increases in performance of the animals and in farm income (Devendra, 2005). I have myself visited several hundred small farms across Asia, and spent long hours of taking to farmers about their views, and winning their confidence. With over 30 years of experience in developing over 85 projects and 5 networks (e.g. Asian Farming Systems networks) across Asia, and working on small ruminants globally, I can safely say that by listening to farmers, identifying problems. setting priorities, and applying yield-enhancing technologies, we can, through interdisciplinary community-based efforts, close monitoring, and regular contact, achieve predictable and demonstrable success.

Traditional conservation of rice straw for dry season feeding in Kompong Thom, Cambodia

Rain-fed areas

Rain-fed areas are watered by rain only. They refer to all the lands that are not irrigated, variously referred to as *fragile, marginal, dry, waste, problem, threatened, range, less-favoured, low-potential lands*. They may be lowland or upland depending on elevation. Of these terms, *less favoured areas* (LFAs), is quite widely used.

Rain-fed areas have low agricultural potential because of low rainfall, often coupled with poor soils and steep slopes (Devendra, 2013).

- These areas have been by-passed by the Green Revolution.
- The poorest of the poor are found here
- These areas may be densely populated particularly with goats, sheep and camels, all of which are very adapted to semi-arid and arid areas with limited feeds.

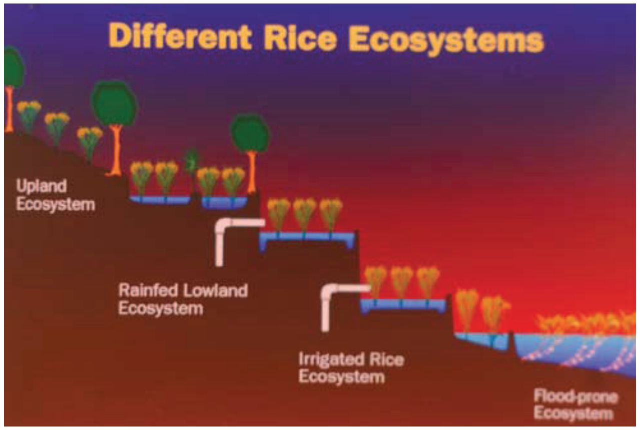
Crops and cropping systems

The relative importance of rain-fed agriculture is reflected in its proportion to total cultivated or arable land area. This ranges from nearly 63% in Indonesia to 97% in Cambodia. In South Asia the corresponding values are from 27% in Pakistan to 84% in Nepal. In Pakistan the arable land area is decreasing due to salinization and waterlogging: saline soils in year 2000 accounted for 6.2 million ha and waterlogged soils for 11.4 million ha. Even in mildly affected soils, yields of wheat, rice, sugarcane and cotton have been reduced by 59 – 68% (Devendra *et al.*, 2000).

Salinization is a major problem that has not been resolved. It has been reported that 10 – 24% of all irrigated land suffers from salinization. In India, about 7 million ha have been abandoned because of salts. Improved systems of irrigation are clearly necessary.

Alexandratos (1995) has calculated that rain-fed land suitable for cropping presently not utilized is 118 million ha in the Asian region.

In Asia both annual and perennial tree crops are grown, and both ruminants and non-ruminants are integrated into these systems. Examples of integrated annual crop-animal systems include:-



Different types of rice ecosystems in Asia

India : rice / wheat / cattle / sheep / goats

Indonesia : rice / buffalo /pigs / chickens / ducks / fish

Philippines : rice / vegetables / pigs / ducks / fish

Vietnam : vegetables / goats / pigs / ducks / fish

Examples of integrated perennial tree crop-animal systems include:

Indonesia : rubber / sheep

Malaysia : oil palm / cattle / goats

Philippine : coconuts / citrus / sheep / goats

Sri Lanka : coconut / fruits / cattle / goats

Thailand : cashew / citrus / sheep / goats

Rice-based systems are dominant, and as percentage of cropped land, the data is as follows:

Cambodia 88%. Lao PDR 80% and Myanmar 60%. Four different rice ecosystems are identifiable.

Animals

The integration of crops and animal production is well developed in the small farms in Asia where some 70-95% of ruminant animals are found on mixed farms in rain-fed areas. There is marked complementarity in resource use: draught animals to provide power, animal manure to feed plants, and crop residues to feed animals. The animals in small farms are usually indigenous breeds and are well adapted to their AEZs, which are agroecological zones defined by biophysical features. The species and breeds are distributed across all types of AEZs but in most cases, their potential production and economic traits have not been clearly defined.

In terms of adaptation, the value of a breed is reflected by its ability to adapt, grow and reproduce, especially where the quality of

grazing is declining. Buffaloes and goats have the capacity to digest fibrous feeds more efficiently than cattle and sheep. Buffaloes are extensively used for transport and haulage.

Water

The availability of water is the most critical factor in agriculture. Low water availability is a very pronounced problem in the rain-fed and drought-prone areas of South Asia, northern China and in parts of Thailand, Cambodia and Vietnam. In these situations the problem is increasingly exacerbated by decreasing rainfall and reduced length of the growing period, leading to reduced agricultural production especially of food staples.

Contour farming in Mindanao, Philippines

Research is needed to breed rice varieties that consume less water and are heat tolerant, and to develop other water-conserving management practices e.g. contour farming.

Excessive use of chemical pesticides and fertilizers results in contamination of underground water, and can cause ill health to humans.

As it is, agriculture is being criticized for using too much water. At the International Rice Research Institute in the Philippines, it has been reported that to produce 1 kg of rice, 4,700 litres of water are required; which is a huge input (Lampe1996). Clearly, research has to find ways and means to breed rice varieties that consume less water and to develop other water-conserving management practices. Recent analyses show that water use for livestock represents 31% of the total water used for agriculture. Given the significant variations in water availability in different AZEs across Asia, the need for water use efficiency becomes even more pressing.

The waning of agriculture

Demographic shifts, globalization, liberalization of trade and capital, changing consumer preferences and weak food chains seem to be contributing to waning interest in agriculture.

Small farm systems are particularly vulnerable. Some important indicators of decline are as follows-:

- Declining contribution of agriculture to gross domestic product (GDP) in many countries

Woman and children feeding native chicken in Bin Phouc Province, Vietnam

- Persistence of food deficits and of poverty coupled with rapid population growth
- Serious disparity in the supply and projected requirements for animal proteins
- Lack of improvement in production systems
- Poor market access for the owners and producers of animals and products
- Poor appreciation for local knowledge, traditional systems and protection of the environment, and
- Absence of a policy framework.

To check the decline…

To check the decline and to increase food production, the highest priority needs to be given to the application of improved technologies. There already exist a number of potentially important technologies, the replication of which can significantly increase agricultural productivity. These include:-

1. Three-strata forage system, TSS (Bali, Indonesia)
2. Food-feed inter-cropping (Philippines, Thailand, India)
3. Integration of ruminants with tree crops (Malaysia, Philippines, and Indonesia)
4. Effective utilization of crop by-products and non-conventional feed resources (most countries)
5. Strategic nutritional supplementation (most countries)
6. Rice-vegetable-ducks-fish integration (Indonesia, Philippines, Vietnam)
7. Sloping agriculture land technology (India, Nepal, Philippines)

8. Contour mixed farming involving coffee and forages (Mindanao in the Philippines).

The three-strata system for example, provides a technical basis for developing feed production all the year round in which there is integration of cash cropping and ruminant production (mainly cattle and goats). The system was developed for the low rainfall environment (600–900 mm annual rainfall and 4-8 months dry season) in Bali, Indonesia. The core area is the centre of the plot where maize, soya bean and cassava are grown. The peripheral area consists of three vegetation stratas: grasses and legumes for use during the wet season; shrub legumes for use during the middle of the dry season, and fodder trees for producing feed for the late dry season (Nitis *et al*., 1990).

The results were (i) increased forage production, (ii) higher stocking rates (3.2 animal units/ha) and total live weight gains of 375 kg/ha/year, compared with 2.1 animal units and 122 kg/ha/year in the non-TSS system, (iii) 90% more live weight that reached market weight 13% quicker (iv) 31% increase in income. (v) reduction in soil erosion by 57%, (vi) production of 1.5 tons/year of firewood, which met 64% of farmers' annual needs, (vii) integration of goats with cattle to further increase farmer incomes. The

The relationship between rainfall, irrigation, temperature, salinization and soil fertility

Rainfed agriculture is the term used for farming that relies entirely on rainfall for water. Farms may also be irrigated using water from rivers, lakes and wells, and deep underground water resources. Rain water is almost free of dissolved salts, but irrigation water, due to prior contact with soil, carries dissolved salts – mainly salts of sodium, potassium, calcium and magnesium.

Irrigation can, over a long period of application, result in salt build-up or salinization because as the water evaporates, the salts are left behind, eventually making the soil too salty for crops. This is most likely to happen in arid and semi-arid warm climates where evaporation rates are high and the rainfall is too low to flush out salts from the soil. The accumulated high salt content, if accompanied by heavy metal content, can also be toxic to animals.

In areas of high rainfall like Malaysia, salts in the soil are flushed out rapidly, resulting in low levels of potassium, calcium and magnesium. However, potassium, calcium and magnesium are necessary in low concentrations as plant nutrients. Hence in the humid tropics, agriculture has to deal with low soil fertility due to heavy leaching by rain.

Rainfed agriculture in Malaysia is the norm in coconut, rubber and oil palm plantations and also in shifting cultivation. To compensate for leaching in plantations, nutrients are supplied by periodic application of fertilizers.

But under shifting cultivation, mainly on hill slopes, practiced by peoples living in or close to forests, fertilizers are not supplied and the soil is exhausted of soil nutrients after one or two crops (usually hill rice, maize or cassava), due to the uptake by the crops and leaching by rain. The cultivators then abandon the land until its nutrient level is built up again by natural processes such as rain wash from surrounding areas. Such nutrients are stored in the plants that colonize the area and are made available by burning when the land is brought under cultivation again.

system has much potential for replication in the semi-arid areas in Sub-Saharan Africa, and in East and West Africa, Latin America and the Caribbean (Devendra, 2010).

Bali cattle integrated with oil palm in Johore, Malaysia

Systems that integrate tree crops with ruminants are often referred to as silvopastoral systems. The potential of these systems, is often underestimated and underutilised. The advantages, economic benefits and impacts resulting from the integration of ruminants with oil palm have recently been reviewed (Devendra, 2008). Currently only about 3 % of the 4.7 million hectares of land under oil palm is used for integration, but hopefully this area can be rapidly expanded. The benefits of integration with oil palms include (a) increased income from animal meat production (b) increased yield of oil palm fruit bunches by about 30 % (0.49 – 3.52 mt / ha / yr) and (c) savings in weeding costs.

This integration model can be applied to other tree crops like coconuts in the Philippines, Sri Lanka and South Asia, rubber in Indonesia, citrus in Thailand and Vietnam, and other tree crops in Africa, Latin America and the Caribbean.

In farming systems that produce cereals, the cereal straws and other crop residues form the base in feeding systems for ruminants in many countries, but some supplementation may be necessary. The supplements include good quality palm kernel cake or, more commonly, leguminous forages like *Leucaena leucocephala, Glyricidia sepium* and *Lablab purpureus*. Mineral mixtures are commonly added to feed mixtures.

Farmers take great pains to store and conserve the cereal straws during droughts, very high temperatures, or periods of feed shortage (Devendra & Leng, 2011). In the northern wheat belts of China, cattle growth rates on straw approached 0.9kg/day, or 75 % of the rate that could be achieved with similar animals and grain-based feed or diets (Cungen *et al*., 1999). The savings in production costs means that small farmers will have more disposable income for the family.

Asia has 93 million extremely poor people, surviving on below US $1.25/day. Furthermore, 100 million additional people are likely to be pushed back into poverty by exploding food crises and rising cost of production inputs (World Bank, 2011). Small farmers can, with better technology contribute to food security, improved livelihoods, and become more self-reliant. It is our social responsibility to promote this, goal.

A final factor of significance is the under-estimated role and contributions of women in agriculture. This topic is very important and would merit a separate discussion.

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