

The Development of Ecological Agriculture in Ladakh and Strategies for Sustainable Development

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Ecological agriculture is the art of cultivating land on a sustainable basis, where human beings in cooperation with nature use a holistic approach, intensively using renewable resources like sunlight, soil, water, vegetation and animals. Sustainable development in this context means enhancing the capability of agricultural activities, integrated harmoniously with rural development, to sustain life now and in the future by maintaining and enhancing natural cycles and biological diversity.

Ladakh is a cold desert, posing both mechanical and biological limitations on development activities. Factors like high altitude, low oxygen, extremely cold weather and low humidity are major obstacles for human beings and biological diversification. Life in Ladakh is particularly difficult for old and poor people during the long winters. Especially in villages the availability of green vegetables and fruit in winter remains a dream.

In Ladakh, man and nature have worked together to green the desert and bring biological diversity. Unlike some other parts of the world, the desert in Ladakh is not the result of human intervention, but due to low rain and snowfall. Rather than causing desertification, human activity in Ladakh has converted the desert into cultivable land. The situation of every village in the lap of a mountain, depending on water from the glaciers above, is an example of the creation of an ecosystem by human beings. Communities have created a self-reliant farming system in which almost every need is provided for from one's own farm. It is a simple way of life where there is practically no waste as everything is recycled. Moreover, almost all agricultural and animal products are free from chemical preservatives and pesticides.

Leaving the land

In the course of the past three decades, Ladakh and its people have been going through gradual changes affecting culture and traditions, language, dress, architecture and construction. Social values are in decline and family structure has also changed. Most importantly, agriculture and animal husbandry have been neglected and no longer form the main source of income for many families. There has been no improvement in agriculture, but rather a deterioration, partly due to negligence in cultivation and care for the soil.

Seeds and agricultural tools have not changed for centuries. When agricultural innovation was introduced all over India, Ladakh's economy was shifting slowly from agriculture to non-farming activities such as army service, government employment and tourism. Consequently, Ladakh's traditional organic agricultural practices remain largely intact. Today's dependence on imports should not be prolonged indefinitely. Agriculture is the only sustainable way of life in Ladakh, and we must ensure that we do not in the meantime lose the genetic material and cultivation techniques due to a neglect of farming.

In the past, agriculture was very profitable and the status of a village family was always ranked according to their landholdings. During the past two to three decades the situation has taken a turn and suddenly agriculture is no longer profitable. Gladly, this change appears to be temporary, as things have improved somewhat in the past few years. This improvement could be attributed to the job market being saturated together with an increase in population, forcing people to go back to the land. This trend can be expected to continue in the future, and accordingly we need to devise ways to make life on the land economically more viable, and ecologically sustainable.

Conventional farming

Farming systems and other types of business in advanced countries have diminished self-reliance and have resulted in environmental pollution, health hazards, unemployment and the elimination of small farmers. The negative impact of conventional development is clear and is unacceptable. All over the world, especially in the advanced countries, questions are being raised about the need to rethink agriculture and marketing systems, which appear to be heading for disaster. However, there has been little achievement in terms of changes in policy. It is now time to ask whether it is feasible or desirable to

gradually and determinedly rearrange agriculture to the methods of organic farming, based on self-reliance and ecology.

Conventional agriculture based on chemical methods has entered an economic and ecological crisis. In many countries in the South pesticide use is virtually unregulated and millions of people yearly are subjected to acute poisoning. Many farmers do not like to use chemical fertilisers, but in a highly urbanised world where nutrient cycles have been badly disrupted it has become difficult to avoid their use. When we all lived on the land, it was easy to recycle nutrients. In many countries there is now a net outflow of grain. The only way we can replace those nutrients on such large scales is to use either chemical or mineral fertilisers. If we cannot figure out some way of expanding the food supply in a rapid and sustained manner, we will face real trouble in the future. Food security is now a major issue, and a sustainable ratio between food and population is essential, without causing environmental problems. In developing countries in particular population growth now outpaces increases in grain production. In India, only a few years back we were proud to be self-sufficient and the government boasted of good stocks, but in 1996 the country had to import wheat.

Ecological agriculture in Ladakh today

In Ladakh, ecological agriculture is a way of life and it is integrated with the local culture and traditions. As much as seventy-one percent of the population are dependent on agriculture and related activities. Almost every household keeps some livestock, and livestock products are produced almost only organically. Yet, there are several factors that negatively affect ecological agriculture in Ladakh:

1. import of wheat and rice for sale at subsidised rates by the government;
2. import of chemical fertilisers for sale at subsidised rates;
3. creation/availability of wage employment in sectors such as tourism, transport, government service, army, etc.;
4. land degradation;
5. declining profitability of agriculture due to the collapse of the integrated animal husbandry-farming system;
6. high population growth.

Addressing this situation should not be based on the blind adoption of new techniques and programmes, but by the refinement of existing ones combined with the careful introduction of new programmes that generate income

Table 1. Irrigation Potential Created

<i>Name of Canal</i>	<i>Command Area/Potential in Hectares</i>
Igoo-Phey	4,800
Lakjung Thang	325
Kuri-Charasa	130
Durbuk	190
Anlay Pongog	200
Nuruchan	160
Dakpa Thang	26
Tirith	68
Sasoma	146
Bushal Thang	150
Abi Canal	463
Ranbirpore	460
Total	7,188 (present total cropped area is 10,000 ha)

Source: Irrigation and Flood Control Department 1997

and improve living standards without damaging the environment. Several initiatives in this direction have already been taken by government and NGOs in the region:

a) Proper planning for use of available irrigation potential

The government has created a lot of irrigation potential and has developed land for cultivation in most villages, but so far communities have taken little interest in the utilisation and cultivation of the land. There appear to be two main reasons for this. First, working the land is not economically attractive; second, the villages face a labour shortage.

The need of the moment is to help people realise the importance of sustainability through the proper utilisation of land and water. Both the availability and potentiality of land and water resources are considerable (Table 1). These un- or under-utilised resources are Ladakh's main economic potential, especially if they are used for high-value products like vegetable seeds, pashmina, and apricot. The most significant obstacles are limitations

Table 2. Plantations 1956-1997

Land Ownership	Area in Hectares	No. of Plants
Forest Department	3,377	10,545,897
Private Land	521	1,355,490
Sand Dune Stabilisation	528	1,373,000
Total	4,426	13,274,000

due to weather, short summers, low availability of genetic materials, non-availability of technologies suitable to the area.

b) Afforestation

There has been great success in this area in the last 15-20 years. The number of plants has gone up and tree coverage has increased significantly everywhere in Ladakh. Statistics on planting carried out in the past forty years are given in *Table 2*.

c) Pasture and fodder development

Little has been done on pasture development, whereas the promotion of fodder crops, especially alfalfa (*medicago stiva* and *fulcata*) has been very successful, due to a good market for fodder as the Army and the Department of Animal Husbandry and Sheep Husbandry purchase considerable quantities at good rates.

d) Horticulture

Serving both food and fuel, horticulture is one of the most important development projects. At present, the cultivation of fruits and vegetables is largely limited to villages situated on road sides in Khaltse, Leh and in the northwest of Nubra. Halman varieties of apricots are dried, and are considered a luxury fruit and sold at very high prices on the world market. Unfortunately, Ladakhi apricots lack proper post-harvest processing, especially drying methods, which results in unclean, unappealing products.

Table 3. Fruit Plant Population

Type of Plant	Population	Annual Yield (met.tons)
Apple	95,000	2,900
Apricot	139,000	1,200 fresh, 350 dried
Walnut	4,500	90

Source: Horticulture Department 1997.

The number of fruit plants, especially apple, has increased in the last 15-20 years and today people are planting apples in areas where fruits are not traditionally grown. See *Table 3* for details.

The introduction of strawberries and grapes in greenhouses may bring a revolution in fruit production, especially for local consumption and marketing. There is indeed great scope for the development and cultivation of other fruits such as almond and seabuckthorn. The major problem is post-harvest processing. Lots of apricots and apples go to waste as farmers cannot preserve and sell at an economical price. The local potential for jams, juices, etc, is considerable given the market of tourists and army personnel.

e) Encouragement of greenhouses

One way of increasing returns from the same cultivatable land is to extend the growing season. Due to its high altitude and position in the rain shadow of the Himalayan range, Ladakh has a very high number of sunny days, giving great potential for greenhouses. Only recently, in the late 1970s, greenhouses were introduced in the region, but they have become tremendously popular. During the past five years 9734 small greenhouses — covered with polythene rather than glass and each covering 512 sq. feet — have been constructed in Leh district (Horticulture Department 1997).

The potential of greenhouses can be further developed by (i) the construction of large green houses to produce off-season vegetables during autumn and spring; (ii) production of tropical vegetables under controlled conditions; (iii) raising early seedlings and producing seeds; (iv) fruit cultivation in greenhouses.

Table 4. Present Livestock Population and Production

<i>Species</i>	<i>Population</i>	<i>Year</i>	<i>Production (tons)</i>
Changra goats	170,000	1997	33 tons of pashmina
Malra goats	65,000	1997	150 tons of wool 580 tons of meat 12,000 tons of milk
Mal Lug Sheep/CB	71,000	1997	
Angora Cross-breds	10,000	1997	
Merino Cross-breds	32,000	1997	
Yaks	15,800	1994-95	
Cattle local	27,600	1994-95	
Jersey Crossbred	5,600	1994-95	
Dzo, Dzomo	11,700	1994-95	
Yak, Drimo	12,800	1994-95	

f) Livestock development

Domestic animals in Ladakh are highly adapted to the adverse conditions such as high altitude, cold weather, and low availability of fodder during the winter months. In the course of the past two decades cross-breeding of local cows with the Jersey breed has taken place and has been quite successful in the Leh area. Milk produced in these villages comes to Leh for sale, as there is a high demand for fresh milk. Present livestock figures are given in *Table 4*. The mountainous environment and size of the area provides great scope for the development of highly adapted animals such as yak and Changra goats for the production of meat and pashmina. At present production from animals constitutes a high percentage of the annual income of Ladakh. Increase in milk and butter production by increasing the number and genetic potential of the cattle in the district is also possible.

g) Adding value to pashmina and wool

Ladakh produces thirty-three tons of pashmina ('cashmere') and 170 tons of wool annually. Attempts have been made by government and NGOs to process the pashmina fiber locally, but due to dehairing problems, development has been limited. Recently some NGOs have brought manual dehairing machines and if this proves successful, it will provide a great boost to local pashmina processing.

At present ninety percent of raw pashmina and a large quantity of local wool are sold out of the region without any value addition. Processing locally will create many jobs during winter and will improve the incomes of village households.

Relatively Neglected Aspects

Although considerable efforts have been taken to improve agriculture and animal husbandry in the region, as the preceding overview illustrates, a number of dimensions and aspects have hitherto been relatively neglected. These include:

1) Improvement of soil fertility

Soil productivity in the district has declined due to improper soil management. The best method of maintaining and improving soil productivity is through organic farming. Intrinsicly, the soil in Ladakh is poor in organic matter. There is little or no vegetation in most of the land, and consequently organic matter in the soil is negligible. Lack of moisture and heat hinder decomposition of what little organic matter the soil contains. Given these conditions, it is necessary to apply more decomposed organic matter than is the case elsewhere in the country. Plants normally require some twenty different elements, and organic matter can provide almost all these essential elements. Chemical fertilisers currently used in Ladakh contain only three chemical elements: nitrogen, potash and dia ammonium phosphates. Because of the absence of all the essential micro elements, land treated with such chemical fertilisers does not remain fertile and productive.

Most of the organic manure in Ladakh at present is procured from animal sheds and human toilets. Unfortunately, neither source of organic matter provides proper decomposition, leaving beneficial effects for the soil low, while at the same time creating problems like disease and proliferation of weeds. The average yield of crops, of course, depends on soil productivity,

and the gap between the potential and actual yields of seeds has increased in Ladakh over the past decades. Yields, in other words, have declined. The question is how organic manure can be produced in quantities sufficient for present cultivatable land and the new command areas likely to come under the plough in future. Especially in view of this increase in scale, better methods of managing the soil, in addition to regular application of traditional animal and human manure, are needed. Such methods could include, for example, the planting of nitrogen fixing plants, green fertilising, and crop rotation.

2) Soil conversion measures

Several techniques can be applied to help bring new land under cultivation. These include the introduction of sprinkle irrigation; contour dyking; shelter belt plantation/wind breaks; gully plugging, etc.; as well as the further improvement of existing practices such as planting, terracing, protection dykes, and land levelling.

3) Techniques of water management

While the amount of cultivatable land of a village is determined by the availability of water in the spring, especially from April to June, much water goes to waste in the winter, autumn and mid-summer. The present irrigation system causes considerable loss of water and the erosion of top soil, which need to be controlled. Sprinkle and drip irrigation, the utilisation of mulch, and other moisture conservation techniques such as the construction of percolation structures, water harvesting tanks, artificial glaciers, etc., would be useful.

4) Improvement of obsolete or inefficient implements and technologies

Unless careful improvement is made to existing tools and technology, people will be tempted to opt for high-tech solutions which will undermine self-reliance.

5) Vegetable and fruit preservation techniques

As mentioned above, availability of fruits and vegetables during the long winters is a serious problem in Ladakh, making preservation an important

Table 5. Import of Ration Supplies through Food and Supplies Department

Commodity	Receipts in Quintals			
	1993	1994	1995	1996
Rice	37,848	40,001	38,838	50,000
Flour	37,040	34,782	38,900	47,283
Sugar	4,154	5,375	5,011	5,000
Kerosene oil	1,358,000	1,295,000	1,797,000	2,180,000

Supplies of subsidised rations started on a small scale in Ladakh during the 1950s. At that time, it was just rice which was supplied, and only on the occasion of major festivals. The current calculated requirement for an estimated population of 98,000 is: Rice/Wheat/Barley: 14 kg per month; Total requirement: 16,464 tons. Local production: 7,800 tons. To be imported: 8,664 tons.

concern. Steps that need to be taken include the construction of vegetable cellars; introduction of solar dryers; promotion of jam, juice and pickle manufacturing.

Some controversial issues

While there is widespread agreement and support can be assumed for many of the measures suggested so far, there are a number of areas where opinions vary. These include:

Reduction in import and distribution of subsidised food grains

At present a large quantity of food is imported annually and distributed by the government at subsidised rates (see *Table 5*). In addition, local traders import some of the same commodities. In Leh district, the whole population of 21,000 families are registered as recipients of rations equivalent to the full annual requirements of these families (see *Table 6 and Table 7*).

It is necessary that we phase out the import of rice which is sold at subsidised rates (see *Table 8*). Secondly, the import of wheat and flour should be stopped and replaced with locally purchased, competitively priced wheat and flour.

Table 6. Ration Card Holders in Leh District

	<i>Leh</i>	<i>Nubra</i>	<i>Khaltse</i>	<i>Nyoma & Durbuk</i>	<i>District</i>
Government Employees	29,000	850	1,300	1,200	32,350
Agri-Farmers	14,500	14,600	15,500	19,000	63,600
Others	3,500				3,500
Total	14500	14,450	16,800	20,200	98,450

Table 7. Ration Allowances per Month

	<i>Rice</i>	<i>Flour</i>
Government employees	8 kg	6 kg
Agri-farmers	4 kg	6 kg

Table 8. Rates of Subsidised Commodities - 1996

Rice	Rs. 6.23 per kg
Wheat flour	Rs. 3.88 per kg
Sugar	Rs. 10.50 per kg
Salt	Rs. 5.30 per kg
Kerosene oil	Rs. 3.00 per litre

Source: Food and Supplies Department 1997.

Table 9. Annual Vegetable Production

Land under vegetables	860 hectares
Total annual production	8,000 metric tons
Total value	35 million rupees

Source: Agriculture and Cooperative Department 1997.

Export of vegetables to Indian cities during the summer months

There is great scope to produce a variety of vegetables on a large-scale to be marketed in metropolitan cities like Delhi. Especially during the summer months, Ladakhi vegetables could be sold there at a good price. The main issue is to link up with the right agents in Delhi and to improve the supply of high quality vegetables through better packing and transport.

In summer, there is an overproduction of vegetables like cabbage, cauliflower, peas, carrots and turnips in Ladakh. Trucks coming to Leh in their thousands carrying supplies for the Army and civilian population generally return empty. At present, locally grown vegetables are supplied mostly for Army and tourist consumption. However, the latter market in particular is unreliable, as seen in the period 1990-95 as a consequence of some local problems. Also, troops were withdrawn from border areas after the improvement of relations with China. The possibility of selling vegetables in Delhi and other major cities should be explored, thereby creating a more dependable market and increasing the scope for Ladakhi produce. At present, rates paid by the Army are very low when compared to the open market and Delhi. Some figures on annual vegetable production and utilisation are given in *Table 9*.

Some current issues

Combination of livestock and farming

As mentioned, there has been a decline in the number of livestock in the entire Ladakh region, except Changthang. This has contributed to the deterioration of soil fertility and the overall economy of farms.

Table 10. Chemical Fertiliser Use

Type/Year	1971	1996
Urea	487 quintals	4,259 quintals
Dia Ammonium Phosphate	324 quintals	1,316 quintals
Murad of Potash	159 quintals	nil

Source: Cooperative Department 1997.

Table 11. Import of Petroleum Products - 1996

Product	Quantity Imported	Sale rate
Diesel oil	300,000 litres	Rs. 9.71
Petrol	650,000 litres	Rs. 22.96
LPG (Indian Oil)	109,000 cylinders	Rs. 115 per cylinder
LPG (Hindustan Petroleum)	45,000 cylinders	Rs. 115 per cylinder

Source: Food and Supplies Department 1997.

Integrated pest management

In order to reduce health hazards, a planned programme needs to be devised and implemented for integrated pest management to move away from heavy dependence on pesticides.

Seed production

One of the best economic uses of the land would be the production of different vegetable seeds. Ladakh, due to its climatic and geographical conditions, can produce high-value crops and seed which are qualitatively better, giving few health problems. It would be of utmost importance to produce standard quality high-value seeds under the strict guidance and supervision of experts. At present, seed production has begun on a small scale at Leh, but large-scale production would require the assurance of a

readily available market. In addition, seed testing and certification facilities would have to be created.

Use of chemical fertilisers and pesticides

Ladakh has begun to depend on chemical fertilisers and pesticides (see *Tables 10 and 11*). The application of chemical fertilisers to the soil causes deterioration of its physical properties and disturbs the natural cycles important for soil texture, microbial activities, soil aeration, etc.

Chemical fertilisers in effect act as sterilisers of the soil, reducing biological activity. Until recently, fertilisers were regarded as controlled items, sold at a uniform price throughout the country. In 1996, however, DAP has been de-controlled and its price has suddenly shot up. All transportation to district headquarters is subsidised by the Government of India, while onward transportation to the villages is subsidised by the district administration. These continued subsidies make fertilisers relatively, and artificially cheap. Their prolonged use, however, after an initial boost to yield, has adverse effects, forcing application of larger quantities, and causing a decline in soil fertility.

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