

POTENTIAL FOR CONSERVATION FARMING IN THE DRY ZONE OF SRI LANKA

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National conservation policy in Sri Lanka is formulated on guide lines set out in the World Conservation Strategy:

1. to examine the present status of our national resources in relation to conservation and utilization;
2. to identify conservation objectives with particular emphasis on preservations of natural eco-systems, genetic diversity, endangered species and life support systems;
3. to examine causes of environmental degradation, and recommend measures to overcome them;
4. to propose guide-lines for use in policy making towards the integration of conservation and development; and
5. to recommend financial, legislative and administrative framework required to implement the national conservation strategy.

In respect of the conservation farming of arable crops in the dry zone of Sri Lanka, this strategy is directed primarily at evolving suitable systems of land use which are capable of maintaining sustained production, while minimising the depletion of natural resources such as forest and soil and the use of high cost energy inputs such as tractors, fertilizer and other agrochemicals.

BUSH FALLOW FARMING

In Sri Lanka we have one of the oldest systems of tropical agriculture practised in the world. It is a system based on the "tank-village", that is a village settlement grouped around an artificially constructed reservoir.

The early settlers from India introduced the art of irrigated rice cultivation and a knowledge of reservoir and channel construction originally developed in the Euphrates. The basic feature of this system was the construction of reservoirs by damming narrow valleys, rivers and streams. Rice was cultivated in the irrigated lowlands, other food crops on the rainfed uplands.

In the upland system of farming, patches of forest were burned and planted for a season or two. When the inherent fertility of the forest soils was exhausted, and competition from weeds became a problem, farmers abandoned the land, and repeated the same process in fresh jungle. R.O. Whyte, in his book "Rape of the Earth" favours bush fallow system for ensuring lasting

stability and fertility to tropical soils under human management. The consensus of opinion however is that it is extremely wasteful of good agricultural land, and is only permissible in areas where the population is sparse, living at bare subsistence level.

The bush fallow system which originated here over 2000 years ago has survived to the present day. Although the practice has hardly altered, the circumstances surrounding it have changed, upsetting the sociological balance during the last two or three decades. As population increased, so did the pressure on the forests. The safe fallow period of 10-15 years has consequently been reduced to 3, 4 and 5 years, with the result that soil fertility has diminished drastically, and problems of soil erosion and weed control have gathered momentum.

Even more disastrous is the fact that the forest cover has been reduced to the minimum safe level of 25%.

The situation is so serious that farmers are hard pressed for firewood, and for the first time in our history we have been compelled to import a good part of our timber requirements. What is the solution? The obvious answer is to replace the shifting-bush-fallow system with a stable form of upland agriculture. That this could be achieved in the irrigated uplands of the Mahaweli Project there is no doubt. But what of the 800,000 ha which lie outside the Mahaweli Scheme? What alternatives do we have to offer bush-fallow farmers in these areas? That is the problem which immediately concerns us.

STABLE FARMING SYSTEMS

Preliminary Investigations

Station Research

Preliminary investigations to develop a stable upland farming system commenced in the 1950s at the Maha Illuppallama Research Station (Abeyratne and Panabokke 1953 and Abeyratne, 1956). Different land classes were identified. The primary importance of weed control and the maintenance of soil fertility was firmly established. Non-inversion tillage implements, broad-based terraces and bunds, mulches, cover crops and intercropping were tested to minimise the weed problem and declining soil fertility. An integrated farming system of crop and animal husbandry was introduced to provide an important source of organic manure, a necessary money return during the dry months from June to September, and an important source of human food.

Dry Farming Project

The next step was to test the validity of this new farming system under the prevailing socio-environmental and logistic constraints of the average dry zone farmer. A Pilot Project of 40 ha was accordingly established in

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typical dry zone upland close to the Maha Illuppallama Research Station. (Fernando *et al* 1980).

Jungle was cleared, land graded and soil conserved. Farmers were selected on the basis of experience and landlessness. Each family was given 2.5 ha. A mixed farming system was adopted, which included the cultivation of semi-perennials like castor and fruit trees and a simple form of dairying, in addition to the traditional system of growing annual food crops only. The steady income received from the sale of semi-perennials and milk was meant to "buffer" the variable returns that could be expected from seasonal crops subject to the vagaries of the weather. Improved pasture or fodder was established in the imperfectly drained soils to serve as the main constituent of cattle feed. Traditional minimum tillage methods with mamoty were used for preparing the land, weeding and inter-cultivation.

During the three years between 1976-1978 when farm records were maintained, it was observed that the cropping intensities in the project registered 180 and 191 in contrast to 117 and 107 in nearby villages which adopted the traditional system. The annual gross income per farm family was over Rs. 8,000/-. This was far more than that earned by traditional farmers. It has also been demonstrated that farmers in the project who cultivated semi-perennials and raised milch cows earned substantially more than those who relied on traditional crops alone. These results indicated that a viable system of mixed farming could be substituted for bush-fallow cultivation.

Farmers, however, are still reluctant to settle down to a permanent farming system on the uplands, because of the continuing problems of weed control and diminishing soil fertility. The recent energy crisis has aggravated the situation by causing fertilizer and agrochemical prices to increase beyond the means of the average dry zone farmer.

Escalating tractor charges have been an additional constraint. It was necessary therefore to look for other ways and means of alleviating these constraints to the farmer.

Tillage Methods

Ideally, tropical soils should be disturbed as little as possible. Intensive tillage destroys soil structure, accelerates erosion, multiplies weed growth and ultimately impoverishes the land. Soil erosion is particularly severe at the onset of the rains in October when thunderstorms with intensities ranging from 25-50mm in 10-30 minutes are experienced. Soil loss measurements recorded at Maha Illuppallama during the growing season from October to December indicated that 22.2 mt/ha were lost in sorghum/pigeon pea mixture. These values were far in excess of the tolerance limit of 6.7 mt/ha/year.

Minimum Tillage

Conventional methods of tillage are tractor ploughing or disc-harrowing and hoeing with mamoty. In the present and foreseeable context of world inflation and the continuing energy crisis, high energy tractorisation would be out of the question for the majority of dry zone farmers, who would have to rely on minimum tillage. Although minimum tillage methods are advantageously low in energy, they take longer hours than tractor tillage. As a result, highland farmers find it extremely difficult to prepare their fields well in time for crop establishment and to pursue the post-preparatory weeding and cultivation practices so necessary for successful crop growth. Current farm mechanization research is therefore directed at designing and testing more efficient hand operated and animal drawn implements to increase the efficiency of minimum tillage methods. In this activity the Department of Agriculture Small Implements Research Project at Maha Illuppallama is assisted by the Federal Republic of Germany and the Canada International Development Agency. Mini-tillers with blades, tynes and discs, blade harrow, wheel hoe, Swiss hoe, three point cultivator and upland seeders are some of the small implements presently under test.

On-going Investigation

Zero Tillage

Meanwhile a method of zero tillage has also been tested to minimise soil erosion. In this method crop stubble and weed cover is destroyed by applying weedicides such as paraquat and glyphosate with a controlled droplet applicator. The crop is planted in the dead mulch using an auto-feed jab planter. When the crop germinates through the mulch, it is protected by one or more herbicidal sprays. At no time is the soil directly exposed to the sun and the pounding rain. This reduces soil capping, run-off and erosion, compared to traditional systems where the land is hoed (mamoty), ploughed or disced by tractor.

No-till and tillage methods were compared with five crops over five seasons at Maha Illuppallama. Although the comparative results flatter the zero tillage method, the high cost of pre-planting herbicides and the high water content of the spray solution involved (400-500 l/h) are constraints that have to be seriously considered in the further conduct of these trials.

A long term tillage trial carried out at Maha Illuppallama to compare the conventional methods of tillage and minimum tillage with the zero tillage method demonstrated no significant differences. The test crops used were maize, rice, chillie, cowpea and mungbean. The results are given in Table 1.

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TABLE 1 EFFECT OF ZERO TILLAGE, MINIMUM TILLAGE AND CONVENTIONAL TILLAGE ON CROP PERFORMANCE (kg)

<i>Tillage practices</i>		<i>Maize Maha 75,76</i>	<i>Cowpea Meda 1976</i>	<i>Chilli Yala 1976</i>	<i>Rice Maha 76/77</i>	<i>Mung Meda 1977</i>
1. Zero tillage (using paraquat) ...		3216	1367	1969	3323	1218
2. Minimum tillage: scraping with mamoty ...		3379	1191	1989	3896	1414
3. Ploughed after every crop ...		3568	1191	1918	3606	1226
4. Ploughed once a year ...		3379	1398	2058	3323	1180
5. Ploughed once in 2 years ...		3405	1368	1654	3265	1241

The physical properties of the soils were studied after 5 cropping seasons and the results are shown in Table 2.

TABLE 2 PHYSICAL PROPERTIES OF SOILS

<i>Tillage practices</i>		<i>Organic Matter %</i>	<i>Bulk Density g/cm³</i>	<i>Infil- tration Rate inch/hr.</i>
Zero tillage ...	...	2.82	1.59	0.69
Minimum tillage ...	...	1.93	1.56	0.66
Ploughed after every crop ...	...	1.93	1.56	0.72
Ploughed once a year ...	...	1.93	1.59	0.70
Ploughed once in two years ...	...	2.52	1.60	0.70

No differences between the tillage methods were observed in bulk density and infiltration rate. But high organic matter contents were recorded for treatments where zero tillage was practised and where the land was ploughed once in 2 years.

Mulching Methods

The use of crop residues and leguminous live mulches has also figured prominently in conservation farming research, both as a weed control and soil protection measure.

Crop Residues: Early experiments at Maha Illuppallama demonstrated quite clearly that the application of sunhemp mulch at the rate of 1,500-3,500 kg/ha remarkably reduced soil loss to 1.8-3.5 mt/ha/year, which is well below

the tolerance limit of 6.7 mt/ha/year. Later experiments with rice straw mulching of cowpea were also flattering as indicated in Table 3. Rice straw applied at 4t/ha and 8t/ha increased the yield of cowpea by 36% and 73% and reduced the dry weed count by 22% and 40% respectively, when compared with the unmulched control.

TABLE 3—YIELD OF COWPEA AND DRY WEED COUNT IN STRAW-MULCHED AND UNMULCHED CROPS

Treatment				Crop Yield (kg./ha)	Dry Weed Count g/m ²
No mulch	...	...	...	362	14.3
4t/ha mulch	...	...	...	491	11.1
8t/ha mulch	...	...	...	625	8.5
LSD (P-0.5)	...	...	...	65	1.4

Source: *Conservation Farming Workshop, Sri Lanka 1983.*

Live Mulch. Live mulch all has the potential to become an efficient alternative to manual, mechanical and chemical methods of weed control. It is a crop production technique in which a food crop is planted directly in a living low-growing leguminous cover with a minimum of soil disturbance. Although legume cover crops have been used extensively for maintaining soil conservation and soil fertility in plantation crops, these beneficial effects have not yet been extended to food production in a form acceptable to farmers. Preliminary investigations with maize at IITA, Nigeria and Maha Illuppallama, Sri Lanka, have been promising in respect of crop performance and weed control. *Pueraria phaseoloides* (Kudzu), *Phaseolus atropurpureus* (Siratro), *Centrosema pubescens* (Centro), *Phosphocarpus palustris*, *Mucuna utilis*, *Stylosanthes hamata*, and *Stylosanthes guianensis* are some of the live legumes which are being tried at Maha Illuppallama, together with chemical growth retardants such as CGH 47283 (Wijewardana and Weerakone 1983)

Avenue or Alley Cropping

All these efforts to find a solution to shifting cultivation have so far been directed at alternatives devoid of a tree-shrub component which is characteristic of the bush-fallow system. Bush-fallow depends to a large extent on the nutrient recycling ability of deep-rooted trees and shrubs for its effectiveness. An improved bush-fallow on these lines is probably the obvious answer.

In this connection, initial studies conducted at IITA (Lal, 1979) are worthy of consideration. The new concept, called alley or avenue cropping, retains, the basic features of a bush-fallow. The major modifications are: (1)

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selected species of fast growing small trees (usually legumes with nitrogen-fixing ability) replace the variable species of the naturally regenerated forest-fallow (2) trees are planted in rows, and food crops are cultivated in the alleys between the rows. (3) trees are pruned during the cropping season to permit adequate light intensity, leaves and twigs, are applied to the soil as mulch and nutrient source, while the bigger branches are used as stakes or firewood, (4) trees are allowed to recover during the dry off season, and develop new growth for use in the succeeding cropping season.

Promising results have been obtained at Maha Illuppalama (Handawela, Wijewardena and Weerakone, 1982) using Ipil-Ilpil and Glyricidia as the tree crops and maize as the intercrop.

It is still too early to make specific recommendations as the performance of alternative tree species has yet to be studied, along with investigations on the interaction between food crops and tree crops, optimum lopping heights, and the nutrient recycling capabilities of avenue crops.

Future Strategies

Forest Gardens

In the Kandy District of the mid-country wet zone upland rainfed agriculture is characterised by traditional forest gardens planted with several crop species. This system has been successfully modified by the Minor Export Crops Department to include a combination of several crops of varying stature and canopy size, planted in such a way as to make maximum use of land and solar energy without destroying soil fertility (Jacob *et al*, 1982). The crops are so selected as to meet the continued food and cash requirements of a family from one hectare of land, together with any other needs such as timber, firewood and forage for livestock. Crops include mango, banana, papaw, lime, avocado, coconut, arecanut, jak, breadfruit, nutmeg, clove, coffee and pepper.

Although the modified Kandyan Forest Garden has been specifically developed to suit the environmental conditions of the wet-mid-country, the concept of agro-forestry that is inherent in this system could very well be adapted to dry zone conditions. High canopied fruit, timber and fuel trees eg. mango, teak, margosa and halmilla could be planted with medium canopied shrubs such as Ipil-Ilpil and Gliricidia, papaw, castor, banana, and cassava, which in turn may be inter-cropped with low-canopied seasonal food crops. Considering all the advantages of the original bush fallow system, there is a strong claim to devote more research to developing systematised crop communities of this kind with the objective of converting existing marginal small farms into ecologically balanced and economically viable units of production having all the advantages of conservation farming.

The need for a system of agroforestry in upland dry zone farming was highlighted at the first Asian Regional Conservation Farming Workshop held at Maha Illuppallama from 17-25 January 1983, along with other cultural components such as minimum tillage, zero tillage, mulches and alley-cropping.

Animal Husbandry

This Workshop also emphasized the need to develop an integrated farming system combining crop and animal husbandry. Early experiments at Maha Illuppallama have shown that Indian-Sri Lanka Zebu crossbreds or Sri Lanka Zebu-Jersey Crosses are capable of producing 6-8 pints of milk a day on a diet of improved grasses alone, such as *Brachiaria*, *Pangola* and *Napier*. But unfortunately these grasses have to be propagated by cuttings. The high cost of transport and establishment, and the fact that grass has to compete with the planting of more important food and money crops has discouraged farmers from cultivating improved forage.

Current research is therefore directed at adopting a simpler and more convenient grass-seeding method. All the introduced improved grass varieties do not produce viable seed under local conditions. But some success has been obtained with the Hamil variety of guinea grass and important pasture legumes such as stylo and siratro. Seed of these varieties will be used for seeding farmers' fields in the Canada International Development Authority Project area, commencing in the Maha season 1983/84.

The successful raising of dairy cattle in the dry zone however is limited by yet another constraint; the incidence of *Haemorrhagic septicaemia*, a killer disease to which calves are particularly susceptible. There are serious doubts as to the effectiveness of the presently used oil-adjuvant vaccine in endemic areas. The feasibility of a potent live vaccine for field use is being tested in Sri Lanka by the Veterinary Research Institute. It is hoped that this vaccine will prove to be more successful.

CONCLUSION

In the prevailing context of a changing social and economic outlook, bush-fallows which once supported a subsistence type of farming have a more important role to play. Possible overproduction of rice, increasing profitability of other food crops of high cash value, and the urgent need to provide animal protein in the rural diet could make the highland allotment the chief source of income of the dry zone farmer. In regions where forest destruction is heavy, and where the pressure on land is already high, it would be of considerable advantage to have a farming system which simulates forest conditions with crop communities at different tier levels. Escalating costs of fertilizer, fossil energy, firewood and timber make it imperative that social forestry is accepted as part and parcel of the dry zone economy.

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The creation of a regional Asian network, which was initiated with the first Conservation Farming Workshop held at Maha Illuppallama in January 1983, should provide the necessary catalytic impact that is required to accelerate this program from the constitutional point of view. But unless a similar response is generated in the farming community very little will be achieved. Many reasons have been advanced for the farmer's reluctance to give up the old bush fallow system, among these his inability to contend with the weed problem and declining soil fertility on permanently cultivated upland. While admitting that these are serious limitations, we must not forget that probably the biggest handicap to the establishment of a stabilized farming system is the fact that farmers do not own the land. If farmers are to invest in and improve their holdings they cannot be allowed to languish as lessees of the state. That the Government is aware of this predicament, and is already taking remedial measures by granting title deeds to rice farmers (Swarnabhoomi Program) is a step in the right direction. If this same incentive is extended to *bona fide* bush-fallow cultivators there should be a more favourable response for switching from "slash and burn" methods to stabilized forms of upland farming.

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