NEPAL'S EXPERIENCE IN HILL AGRICULTURAL DEVELOPMENT

MINISTRY OF FOOD AND AGRICULTURE
HIS MAJESTY'S GOVERNMENT

NEPAL'S EXPERIENCE IN HILL AGRICULTURAL DEVELOPMENT

21

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SEMINAR ON
NEPAL'S EXPERIENCE IN HILL
AGRICULTURAL DEVELOPMENT

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Preface

The Ministry of Food and Agriculture (MFA) of His Majesty's Government of Nepal, in co-operation with the Agricultural Development Council (A/D/C) organized a Seminar on Nepal's Experience in Hill Agricultural Development in Kathmandu from 30 March to 3 April 1981. The following are the objectives of the Seminar:

(1) to make an indepth study of the constraints and to identify ways and means to overcome such constraints in hill agricultural development;

(2) to investigate the problems of technology transfer and adoption in various hill agricultural development projects;

(3) to explore the need for institutional innovations in the process of hill agricultural development; and

(4) to exchange experiences on hill agricultural development with neighbouring countries in South and Southeast Asia.

An Organizing Committee for this Seminar was set up in September 1980. It consisted of the following five members:

(1) Dr. T.N. Pant
Joint Secretary
Planning Division, MFA – Chairman

(2) Mr. P.N. Rana
Director-General
Department of Agriculture, MFA – Member

(3) Mr. I.R. Misra
Director-General
Department of Food and Agricultural
Marketing Services, MFA – Member

(4) Mr. S.B. Nepali
Senior Technical Advisor, MFA – Member

(5) Dr. Shao-er Ong
A/D/C Associate – Member

The Committee invited senior officials of the MFA and other related ministries, and experts from neighbouring countries and international organizations to prepare papers and participate in this Seminar. There was a total number of 73 participants and 12 observers.

Twelve papers from Nepal and ten from neighbouring countries and international organizations were presented and discussed at the Seminar. Four of the five-day Seminar were spent on the deliberation of papers, while the fifth day was devoted to a field trip.

A grant from the United States Agency for International Development (USAID) enabled A/D/C to support the organizing and to publish the proceedings of this Seminar. An Editorial Committee made up of the following five members was established by A/D/C:

(1) Dr. Tan Bock Thiam
Director
Computer Centre
University of Malaya
Malaysia

(2) Dr. Brian Lockwood
A/D/C Associate
Pakistan

(3) Dr. Thomas Walker
A/D/C Associate
India

(4) Dr. Veit Burger
A/D/C Research Specialist
Nepal

(5) Dr. Shao-er Ong
A/D/C Associate
Nepal

The Committee started editing the papers immediately following the Seminar and met in New Delhi, India from 20 to 24 May. Except for one foreign paper which was delayed due to revision, the other 21 papers were edited and included in this volume of the Proceedings.

The MFA was happy that the Seminar progressed smoothly and the Proceedings were published early. Although the ideas expressed in the Seminar papers were primarily those of the authors and do not necessarily represent the views and policies of the organizations where they work, the cumulative experiences in hill agricultural development which were revealed in the course of the Proceedings of this Seminar will, undoubtedly, be very useful as a source of reference for policy formulation and programme planning especially in the case of Nepal.

Bed B. Khadka
Secretary
Ministry of Food and Agriculture
Nepal
May 1981.

Acknowledgements

This Seminar would like to give special thanks to:

(1) the foreign experts who have taken valuable time off to participate in this Seminar and for sharing their experiences in hill agricultural development which will undoubtedly be extremely useful to Nepal;

(2) the Secretariat of the Seminar, particularly Dr. T.N. Pant, Chairman of the Organizing Committee and Mr. G. B. Thapa, Assistant to the Chairman for their tireless efforts in making the Seminar a success;

(3) Dr. Tan Bock Thiam who participated in this Seminar, assisted in editing the papers and supervised the printing of the Proceedings so that its circulation can be made ahead of time;

(4) members of the Editorial Committee who worked very hard to edit all the papers carefully and speedily;

(5) the Agricultural Documentation Centre of the Agricultural Projects Services Centre for the preparation of the Bibliography on Hill Agricultural Development in Nepal;

(6) the United States International Communication Agency (USICA) for providing the cover photographs for the Proceedings; and last but not least

(7) Mrs. Rema Shakya and Mrs. Rita T. Shrestha, secretaries of the A/D/C office in Kathmandu who assisted in typing all the edited manuscripts.

Nepal's Experience in Hill Agricultural Development: A Seminar Summary

S.E. ONG

Introduction

Realizing the urgency of understanding the seriousness of the problems of hill agricultural development and of finding effective ways of solving these problems, the Ministry of Food and Agriculture of His Majesty's Government organized a seminar on Nepal's Experience in Hill Agricultural Development in Kathmandu from 30 March to 3 April 1981. Besides mobilizing her own experts to prepare papers based on their experiences in implementing hill agricultural development programmes, the Ministry in co-operation with the Agricultural Development Council invited specialists from neighbouring countries and international and bilateral organizations to share in their experiences. A total of 80 experts participated in this Seminar.

The objectives of the Seminar are:

(1) to make an indepth study of the constraints and to identify ways and means of overcoming such constraints in hill agricultural development;

(2) to investigate the problems of technology transfer and adoption in various development projects;

(3) to explore the need for institutional innovations; and

(4) to exchange experiences on hill agricultural development with neighbouring countries in South and Southeast Asia.

Twelve papers from Nepal and 9 from neighbouring countries were presented at this Seminar. The enthusiatic responses of the participants and the keen desire on the part of the Ministry to obtain an evaluation of her various hill agricultural development programmes by foreign experts made the five-day deliberations of this Seminar a great success. All the papers presented at the Seminar are published in this volume of the Proceedings.

As a student interested in hill agricultural development, I enjoyed working with the Seminar's Organizing Committee, besides participating in the discussions and getting their results published in this set of the Proceedings. This paper summarizes the main issues discussed in the 12 Nepalese papers which were presented at the Seminar.

Importance of Hill Agriculture

Nepal, situated between China in the north and India in the south has a total land area of approximately 140,800 square kilometres. The ecology of the region can generally

be divided into 3 main levels, namely, the Tarai (between 75 and 300 metres above sea level), the Hills (between 300 and 3,000 metres above sea level) and the Mountains (between 3,000 and 8,000 metres above sea level).[1] Because of snow coverage, the mountain areas are of little agricultural importance.

Out of a total land area of 14 million hectares, the Tarai occupies only 17 percent, when compared with 68 percent and 15 percent for the Hills and Mountains respectively. But the area of arable land in the Hills is extremely limited. Of the total of 2.3 million hectares of cultivated land in Nepal, only 0.6 million hectares or less than one-third of the total is found in the Hills.

In 1980, 66 percent of the total population of 14 million lived in the Hills. The average size of holding here is less than 0.5 when compared with 1.7 hectares in the Tarai. In addition, the Hills faces serious problems of soil erosion and deforestation.

Hill agriculture is limited to small valleys and terraced slopes. About three-fourths of the cultivated land is under upland terraces. Visitors are impressed by the engineering feat of the Nepalese farmers in terracing their land from the foothills to the mountain tops. Almost every inch of arable land in the Hills is intensively utilized.

Among the food crops, maize is the most important, followed by paddy, wheat and millet. In the high Hills, potato and herb predominate. On hill slopes the popular cropping pattern is maize-based, whereas in the valleys it is primarily paddy-based. Maize/millet – fallow, paddy/millet, maize/millet – wheat, paddy/potato, paddy–pulse, maize/wheat, paddy–potato and paddy–maize are the principal crop rotations in the Hills.

An integrated crop–livestock system is the rule rather than the exception in hill agriculture. Milk, ghee and live animals are not only the main sources of cash income but they also constitute an important part of the daily diet. Bullock is used for draught power and animal dung is used as manure as well as fuel.

In the above context where hill agriculture plays a vital role in the economy of the country, and where the average hill farmer with a family of 6 persons owns less than 0.5 hectare of farming land, the question that emerges is how such a farmer can achieve a decent standard of living with such meagre resources. This challenge is perhaps the main reason for the importance which hill agricultural development has assumed in the country's national development scenario in recent times.

Experience of Development

Over the centuries, Nepalese farmers have developed indigenous and unique hill farming systems. They were able to establish holdings in remote areas where conditions are extremely difficult, by selecting, testing and adopting locally suitable crop and livestock enterprizes. Soil fertility was maintained and improved with the use of farmyard manure and compost. They were also able to apply terracing techniques to prevent soil erosion, and by group action, succeeded in building indigenous irrigation systems and trekking roads. The high intensity of land use and the skillful combination of crop and livestock enterprizes have made the industrious Nepalese farmers well-known throughout the world.

Public programmes designed specially for the development of hill agriculture began only recently. The first four Five-Year Economic Development Plans (1956 – 76) adopted "Tarai first" strategies. Very little public funds were invested for the improvement

[1] The Hills can be divided into the low and high Hills. The low Hills are between 300 and 1,500 metres above sea level and the high Hills are between 1,500 and 3,000 metres above sea level.

of the quality of life of the rural people. Only in the Fifth Five-Year Economic Development Plan (1976 – 81) was emphasis placed on the development of hill agriculture in an organized manner. Hill agricultural development programmes are currently being accorded top priority in the Sixth Five-Year Development Plan (1981 – 86).

The primary emphasis in developing hill agriculture is to accelerate the rate of increase in agricultural productivity, create more gainful employment opportunities for the growing farm population, and effect a more equitable distribution of development benefits among the rural people in different regions. The major responsibility for implementing hill agricultural development programmes rests with the Ministry of Food and Agriculture.

A rugged topography, poor infrastructure facilities and extensive wilderness are the main physical constraints that hamper hill agricultural development. They are aggravated by socio-economic problems where the majority of the population live below the poverty line, and where approximately 94 percent of women and 67 percent of men are illiterate. In such a situation, the initial investment required for hill agricultural development programmes is high and the expected development benefits are low, thus making development efforts and investment risky.

Knowledge generated by trial and error during the past decade reinforced the belief among the officials of the Ministry of Food and Agriculture that given special physical and socio-economic conditions, Nepal should map out her own strategy for hill agricultural development. In doing so, close attention should be directed to the transfer and adoption of foreign technology with adequate stress laid on its proper testing and scrutiny, for without which, such technology may yield negative results.

In Nepal, variations in elevation, cloud cover and topography permit the cultivation of:

(1) paddy, maize, sugarcane, wheat and mustard in the low Hills;

(2) fruit such as the apple, pear and peach, and food crops such as wheat, barley and potato in the mid Hills; and

(3) barley, rye and herb in the high Hills.

Experimental trials carried out on government farms and on farmers' plots demonstrated that a considerable scope exists for yield improvement with the adoption of better varieties, and water management, nutrient supply and pest control measures.

According to past experience, the Hills possesses important comparative economic advantages for vegetable and fruit production which offer brighter prospects for raising employment and income. Orange grown in the Eastern and Far-Western Hills and apple in remote areas such as Mustang and Jumla are already well-known for their high quality. Radish, cauliflower, cabbage, carrot and onion seed are extensively produced in suitable hill pockets. In addition, cardamom and tea in the Eastern Hills and ginger in the Western Hills are important cash crops which can be greatly improved in both quality and yield through better management. A potential also exists for developing an export market for these crops.

Livestock is another enterprize which holds good promise for future development. A milk yield of 1,200 litres per lactation can be obtained from crossbreeding the local and Murrah buffalo when compared with an average yield of 500 litres from the local buffalo. Breeding work on the Hill goat has shown the possibility of obtaining an average milk production of 58 kilogrammes per lactation.

The lack of roads, storage, and marketing facilities are the primary constraints for increasing the commercial production of fruit, vegetable and some food crops. Poor quality and inadequate feed, low genetic potential of indigenous breeds, high incidence of diseases and the absence of suitable marketing channels for livestock products are the factors contributing to the present low livestock productivity. These constraints, however, can be overcome with the introduction of appropriate technology and proper research programmes.

Food Grain and Livestock Production Trends

The Nepalese diet which is somewhat similar to that of other South Asian countries consists of both food grain and livestock products. Their existing and future demand and supply in the Hills are discussed in 2 papers presented at the Seminar.

Food Grain

In Nepal, 85 percent of the cropped area is under cereal such as paddy, maize, wheat, millet and barley. Sugarcane, potato and oilseed are the principal cash crops. The cereal consumption pattern varies widely between the Hills and Tarai. Rice occupies first place in the Tarai while maize is the staple in the Hills. Millet and barley constitute about 11 percent of cereal consumption in the Hills but only 3 percent in the Tarai.

At present, the total per capita cereal consumption in the Hills is 156 kilogrammes as against 191 in the Tarai. The national average is estimated at 170 kilogrammes per capita.

Ministry officials estimate the 1980 hill cereal requirement as 1.86 million tonnes. This will rise to 2.12 million tonnes in 1985, 2.48 million tonnes in 1990 and 3.48 million tonnes in the year 2000.

Its total production in the Hills in 1978/79 was 1.36 million tonnes. This was 501,000 tonnes below the 1980 requirement. This deficit was balanced by a surplus from the Tarai. Traditionally, rice has been an important source of export earnings. Due to rising demand in the Hills, the exportable surplus has declined from over 200,000 tonnes in the late 1960's to less than 100,000 tonnes in the late seventies.

Officials from the Ministry did signal two warnings on food supply problems which may have serious policy implications. Firstly, the annual increase in population in the Hills between 1968 and 1979 was 2.0 percent, while the annual increase of food grain production during the same period was less than 1 percent. Secondly, the per capita demand for cereal will increase from 156 kilogrammes in 1980 to 163 kilogrammes in 1990 and to 185 kilogrammes in the year 2000. If these growth rates in food grain production were to continue, food deficit in the Hills will be in the region of 504,000 tonnes in 1985, 768,000 tonnes in 1990 and 1,500,000 tonnes in the year 2000. The Tarai can remain as a food surplus region until 1990, but there will be a deficit of 345,000 tonnes by the year 2000. Thus, if the present level of food grain production is not stepped up over the next two decades, Nepal may have to import 1.82 million tonnes to meet her domestic requirement. This will definitely cause a setback in the national economic development.

The Ministry, however, anticipates a minimum annual increase of 3.06 percent in food grain production between 1980 and 2000. In the next 20 years, paddy, maize, wheat, millet and barley production is also expected to increase by 59, 60, 84, 45 and 80 percent respectively. This target appears optimistic, and it can only be realized with the expansion of irrigation facilities, more use of purchased input such as improved seed, and inorganic fertilizer, and the implementation of remunerative pricing and marketing policies. If the

targeted rate of expansion can be met, the Ministry estimates that between 1990 and 2000, Nepal will be able to export approximately 400,000 tonnes of cereal yearly.

Livestock

Nepal's livestock population per unit of land area is one of the highest among Asian countries. The Hills has 68 percent of the cattle, 78 percent of the buffalo, 78 percent of the goat and 86 percent of the sheep population. From available statistics, it is estimated that over the past 13 years, the cattle population rose at only an annual rate of 0.17 percent, while the buffalo population increased by 0.26 percent. Factors such as the acute feed shortage, heavy parasitic infestation, late maturity, infertility, inadequate livestock development services and the migration of people from the Hills have affected the livestock economy. The high prices of goat and sheep meat in recent years have led to a greater use of buffalo meat in the regular diet, and the culling off of unwanted buffalo.

Supply projections for milk and egg reveal similar trends. Although the total milk production is estimated to rise in the next two decades, the daily availability per capita is expected to be only 84 millilitres in 1980 and 75 millilitres in 2000. The annual per capita egg availability is calculated at 12.5 for 1980 and 11.4 by the year 2000. Only 50.4 percent of the nation's meat demand can be met in 1980, and this will be reduced to 40.6 percent in the year 2000. The available milk supply can meet only 86.4 percent of the country's requirement for the year 2000. Only 14.8 percent of the egg demand was met in 1980, and this is expected to drop to 13.5 percent by 2000.

The acute shortage of feed in the Hills is a major constraint in stepping up the supply of animal protein. The Hills' demand is calculated at approximately 5.6 million tonnes of total digestible nutrient (TDN) which will expand to 6.2 million tonnes by the year 2000. At present, only 3 million tonnes of TDN, which account for 54 percent of the total requirement is available. Furthermore, this percentage is projected to decline to 43 percent by 2000. The problem is further aggravated by the fact that good quality green fodder in adequate quantities is generally available only from June to September each year. In the dry season, animals thrive on crop residue and are virtually in a semi-starved condition for a period of 7 months of the year. This malnutrition over two-thirds of the year adversely affects animal health and productivity.

Improvements in hill livestock production appear to be more complicated than those of food grain production because the former is closely linked with cultural values and religious beliefs. However, projects have been prepared which will eventually counter the adverse effects of:

(1) human population growth;

(2) excessive ruminant population;

(3) vegetation and environmental degradation;

(4) lack of feed resources; and

(5) parasitic infestation and diseases.

Desirable Changes in the Farming System

Expansion in agricultural productivity must commence at the micro-level, that is, from small family farms in the Hills. To begin with, changes in the farming system must first of all be tested in farmers' fields. Unless the farmers are able to see for themselves the benefits that can be derived from the proposed innovations, such innovations may not be acceptable by them.

The Department of Agriculture with financial assistance from the United States Agency for International Development, Nepal (USAID/Nepal) has launched an Integrated Cereals Project (ICP) in 1976 with the aim of increasing total production, improving farmers' income and creating gainful employment for surplus rural labour by:

(1) promoting multiple cropping system; and

(2) expanding crop yield.

This Project has worked directly with farmers in 6 sites of the Kingdom, 4 of which are located in the Hills, namely, Pumdi Bhumdi in the Western Region, Khandbari in the Eastern Region, Lele in the Kathmandu Valley and Chauri Jahari in the Far-Western Region. All trials are conducted on farmers' fields and involve a comparison of productivity and income between plots utilizing existing and improved technology.

The improved technology is made up of 4 major components:

(1) changing varieties of existing crops;

(2) using moderate doses of fertilizer;

(3) application of disease and pest control measures; and

(4) application of improved cultural practices.

Data collected from 3 years of trials on farmers' fields greatly strengthened the Ministry's conviction that tremendous possibilities exist for increasing crop yield with the use of such improved technology.

According to survey results, the rice yield varied from 1.6 to 1.9 tonnes per hectare under prevailing crop production practices, when compared with between 2.6 to 3.5 tonnes per hectare under improved technology. The average wheat yield under existing practices was 1.07 tonnes per hectare, but it rose to 3.21 tonnes per hectare with the adoption of advanced technology. Similarly, the average maize yield of 1.03 tonnes per hectare under traditional methods increased to 3.01 tonnes per hectare with the application of advanced technology.

The survey also showed that 51.5 percent of farm income is contributed by crops, 21.5 percent by livestock and 27.0 percent by off-farm employment. Livestock is an important component of the hill farming system since it provides cash income, animal protein, draught power and compost, and meets the social and religious needs of farmers.

To better utilize the available but limited hill land resources, the farming system should include crops, livestock, fruit, vegetable, sericulture and beekeeping. These enterprizes have complementary and supplementary relationships and they enable farmers to earn more cash income, provide additional farm work, and improve nutrition, besides helping to maintain and improve soil fertility. Fruit production in Helambu, Jumla and Mustang,

and vegetable seed production in Marpha and Rukum provide a high income to growers. However, as fruit and vegetable production gains momentum, problems such as appropriate technology, organized markets, transport facilities, storage, processing and grading surface. These problems must also be solved simultaneously.

Essentials for Development

Agricultural development cannot be brought about by the farmers themselves because of their limited resources and knowledge. Off-farm assistance is very important. To raise agricultural productivity today, the farmer depends more and more on purchased input such as irrigation water, chemical fertilizer, improved seed, insecticide, pesticide and farm machinery and tools. His surplus produce must be marketed. Price information and appropriate technology have to be obtained from the agricultural extension service. To get agriculture moving, the Ministry of Food and Agriculture therefore becomes one of the most important instruments of change, because it generates the essential elements which make hill agricultural development possible. In this Seminar, several papers deal with these essentials of the development process.

Water Use and Management

Despite abundant water resources in the Hills, only 20 to 25 percent of the cultivated land is irrigated. The Sixth Five-Year Plan hopes to bring another 25 percent of this area under irrigation. Most of the existing small irrigation schemes are constructed by diverting water from rivers, streams and springs through small rivulets for cultivation. During the monsoon season, excessive suspended sediment loads damage irrigation work, while the small rivulets have little or no water at all for irrigation during the dry winter.

Planned hill irrigation development is a complex exercise. Most diversion structures are temporary in nature and can be easily damaged or destroyed during the rainy season. Canals do not possess scape facilities for removing excess water. Due to poor maintenance, high conveyance losses and erosion frequently occur. They can also be destroyed by landslide and peak flow.

To assure better water distribution in the Hills, the Ministry suggests that both its technical and institutional aspects be carefully studied. Technically, the location of feeder canals should be well chosen, the water flow in canals should be controlled and the canal bottom and walls should be lined. Polyethylene pipes can be laid to bypass landslide, and scape structures should be built to remove excess water. In terms of institutional development, users' groups should be formed and be made responsible for the repair and maintenance of small irrigation schemes. Those which serve less than 50 hectares of farmland possess a great potential for expanding agricultural production.

Market for Farm Products

Farm production will only increase when there are markets for it at remunerative prices. Moreover, when farm income increases, farmers will need to purchase input and daily necessities. The shortage of rural markets presents a serious problem for hill agricultural development.

Most rural markets are periodic in nature. Altogether, there are 640 such markets, but less than one-third of them are located in the Hills. Among the hill markets, 76 percent are sited in the Eastern Hills. Farmers in the Western and Far-Western Hills enjoy little marketing facilities. The Sixth Plan intends to develop new rural markets with priority being placed on the Hills. Out of the 115 proposed, 80 are to be established in

the Hills. However, despite the existing and proposed new markets, their total number remains far from adequate.

Facilities such as transportation, storage, processing, information and communication, standard weights and measures, and legal infrastructure are far less developed in hill markets than elsewhere.

There are currently 680 co-operative and 33 district co-operative unions. Few are located in the Hills. In theory, these societies should focus on the provision of marketing facilities, distribution of input and credit, sale of consumer goods and marketing of agricultural produce for farmers. But in practice, they concentrate on input supply and the sale of daily necessities, and neglect the marketing of agricultural produce. Village merchants do perform some of the functions of middlemen, but the volume of the farmers' produce handled by them is rather small, and they operate primarily as moneylenders.

It is recommended that new rural markets be established in the Hills to support the development of livestock, horticultural and special crop production programmes. In this case, public investment maybe required to expand marketing facilities such as transportation, storage and processing.

Availability of Input Supplies

To promote agricultural production, farmers require input supplies such as seed, fertilizer, pesticide, insecticide, livestock feed, medicine and tools. Sufficient quantities of these inputs must be available at all focal points to meet the demands of every hill farmer.

The Agricultural Inputs Corporation (AIC) is the sole agency under the Ministry of Food and Agriculture which handles the import and distribution of agricultural input. All imports are transported by rail or road from Calcutta port to AIC godowns at border districts. The AIC then arranges for their carriage by trucks to hill district godowns, from where they are moved to remote hill areas by porters and mules. This lengthy procedure makes the entire delivery system difficult and complicated.

Due to topographical difficulties, the amount delivered to hill areas remains small. During the Fifth Five-Year Plan period, fertilizer sales totalled 210,000 tonnes, of which only 34,000 tonnes were consumed in the Hills when compared with 75,000 tonnes in the Kathmandu Valley and 101,000 tonnes in the Tarai. Other output such as improved seed, pesticide and tools were distributed in far smaller quantities in the Hills than in the Tarai during the same period. The Ministry also pointed out that the existing hill storage capacity is only 7,050 tonnes as against 5,200 tonnes in the Kathmandu Valley and 42,850 tonnes in the Tarai.

The logistics of moving input in sufficient quantities and at the proper time to remote hill districts is a great challenge to the AIC. Six thousand trucks are required to distribute fertilizer throughout the country. Their availability together with other forms of transport become a major constraint. Additionally, 180,000 porters are also needed to move input between truck-end points and the remote hills. There is often a shortage of porters during peak periods. In view of the seriousness of the constraint, greater investment on transportation facilities is urgently needed.

Improved seed appropriate for the Tarai may not be applicable for the Hills. The reasons given by hill farmers for the non-acceptance of AIC seed include poor germination, the lack of seed certification, and its failure to perform well under hill conditions. To overcome this problem, the AIC has started a seed production and input storage project for 25 hill districts. It will take a few years before the impact of this project can be felt.

Hill farmers will not purchase supplies from the AIC unless they are able to obtain credit from the Agricultural Development Bank of Nepal (ADB/N). They are, however, frequently discouraged from doing so because of the lengthy and complicated procedures involved. In the remote hill regions where no retail outlets are available, the AIC takes over distribution responsibilities. This is an added burden to the limited number of AIC staff. Warehousing, management and handling problems, including the uncertainty of shipment arrival from donor countries adversely affect the AIC's delivery schedule from the Tarai to the Hills.

The issues often debated at the policy-making level are whether the government should subsidize food or fertilizer in the Hills, and whether a uniform fertilizer subsidy should be continued. Each of these issues has its merits and demerits, and requires further in-depth research.

Production Incentives

Within the context of hill agricultural development research in Nepal, an incentive is a factor that will encourage farmers to use their resources for increasing food production. The most important incentive, as indicated by the Ministry, is economic in nature. Others include credit, irrigation, an equitable share of the harvest, psychological recognition and non-farm activities.

A remunerative price relationship between input and output is the single most influential incentive for farmers to raise their production. This relationship will behave differently in the free market situation where the forces of demand and supply determine prices, and in the government controlled market where public regulations and measures can lead to either price stability or instability. In the case of Nepal, the impact of the latter should not be overlooked, and the floor price, if any, should be fixed well before crop planting begins.

Next in importance to price incentive is the availability of agricultural credit. According to the 1968 agricultural credit survey, institutional credit supplied only 25 percent, while village moneylenders shared the remaining 75 percent of the total credit supply. There are at present 217 co-operative societies, 72 field offices of the ADB/N and 124 field offices of commercial banks catering to the credit needs of hill entrepreneurs. Ministry officials believe that adequate arrangements for easy credit by themselves cannot fully ure higher production, unless purchased input is made available both on time and in adequate quantities.

Irrigation and an equitable share of the harvest are other incentives for increasing production. Hill irrigation facilities will not only expand and stabilize yields but it will also enhance the value of land, which indirectly strengthens the farmers' credit standing. In 34 out of the 55 hill districts surveyed, the share cropping system on an equal basis where all input cost is borne by the tenant, is a common practice. However, such a system gives the share tenant the least incentive to adopt improved farming techniques, including irrigation improvement for better yield. This Seminar recommended that tenancy rights should be strengthened and the fixed rental system in all districts be enforced to guarantee that tenants receive a fair share of the harvest.

Besides economic incentives, the public recognition of successful farmers will have a complementary effect. Giving prizes to the best farmers can arouse their interest in better farming. At the same time, it is also necessary to encourage hill farmers to take up non-farm work, not only to make more productive use of their surplus labour but also to earn income from non-farming sources.

Hill Labour Migration

As much as two-thirds of Nepal's population live in the Hills. The migration of some of them to the Tarai or to neighbouring countries either temporarily or permanently will reduce the population pressure on the limited supply of land, and help accelerate the process of hill agricultural development. The Seminar recognized that hill labour migration is not a purely demographic problem. It contains economic, ecological, social and political dimensions, and is a matter of great concern to both planners and policy-makers.

Its causes include income disparity, low levels of economic development, small fragmented farms, landlessness, absence of economic and social amenities, uneven population distribution, implementation of new development and settlement programmes, natural calamities and ecological imbalances. Also important considerations are differences in human capital in terms of skill, knowledge, training and education; in economic resources such as land, capital and technology; and in social factors such as organization and leadership.

Does hill migration benefit both the Hills and the Tarai? The Seminar discussions on this subject revealed negative as well as positive aspects. The former include the promotion of economic and social integration between the two regions, reduction of population pressure in the Hills, neutralization of class and group barriers, development of the idea of one Nepal, discouraging discrimination between the *Pahari* (Hills) and *Madhishe* (Tarai) people, and the fostering of unity among them. A number of encouraging signs and trends in these directions have already been observed. However, while the population has increased in the Tarai, it has not been accompanied by a decrease in the Hills. Although its growth rate has lowered in the Hills, the absolute number of people living in this region continues to be on the rise.

The negative results of hill migration to the Tarai include:

(1) destruction of forest resources and the creation of an ecological imbalance;

(2) increasing labour supply in the Tarai which can outstrip the opportunities for its productive employment;

(3) generating tension caused by the competition for land;

(4) increasing the disparity in income distribution; and

(5) creating a growing class of landless labourers.

Migration has also drained the Hills of its active population and leadership, and affected its development potential both in terms of resources and skills. Agricultural pursuits are left unattended, cottage industries and handicrafts are depressed, and construction work in some hill areas are compelled to use imported Indian labour. This is a paradoxical situation, where migrant hill labour in the Tarai is underemployed while labour from India is imported at greater cost.

The Seminar agreed that priority should be given to hill agricultural development and allied pursuits including livestock and horticulture. It is believed that such development efforts can feed as well as employ more people who would otherwise migrate to the Tarai or abroad. Hill craft and cottage industries should be revived and promoted for employment generation, internal consumption, the tourist industry and exports in

order to strengthen the hill economy. Settlement and resettlement programmes in the Tarai should aim at the identification of surplus labour, landless farmers and those suffering from the consequences of natural calamities.

In order to decrease the rapid Hill to Tarai migration and emigration, additional investment in rural development programmes are needed. More construction work should be started in the Hills with the use of local labour resources. More hill labour should be trained in modern technology to undertake various professional occupations. Social infrastructure such as rural education, improved rural health services, water supply, sanitation, rural electrification, transportation, market centres and medical facilities should be developed. In other words, the Seminar recommended that the government develop the Hills to make it an attractive place to live and work in. Ultimately, the rate of Hill to Tarai migration can only be curtailed when the hill economy progresses.

Technological Innovations

Critical technological issues for hill agricultural development identified by the Ministry include those on compost, chemical fertilizer, seed, intensive farming methods, irrigation and drainage, terracing, fruit production, improved animal husbandry and fodder production. As new technology in these critical areas is being generated by scientists working in government experimental farms, the major thrust of the Seminar is to find ways and means of transferring this technical knowledge to local farmers.

Terracing is a traditional method of cultivation which is being carried out in the Hills. A simple technique to improve it and allow rainwater to percolate, so that good soil will not be washed away has to be devised. The cultivation of suitable, remunerative and acceptable cover crops during the rainy season should also be investigated.

Farmyard manure from livestock is available everywhere in the Hills. Improved and speedy compost practices aided by the use of bacteria culture will help farmers increase the amount of nutrient for their fields. Moreover, gobar gas which is in popular use in the warm Tarai as fuel and fertilizer (slurry) can be modified to meet the requirement of the cooler Hills. Modern seed technology should also be introduced to ensure the availability of high quality seed and plant.

Hill rainfall distribution is uneven and 75 to 80 percent of it goes to waste during the monsoon season. Technology to collect this rainwater on hilltops by constructing dams in certain catchment areas and small ponds at high levels needs to be developed. This will step up the water supply after the monsoon season.

The hill farming system such as intensive crop rotation, intercropping and livestock and crop combination has evolved over the years in Nepal. In the present context, special attention is required to improve such system through orderly techno-economic studies.

Land available for grazing in the Hills is scarce, but the possibility of using terrace slopes for raising fodder is high. Proper pasture management and fodder production will eventually step up the efficiency of livestock production as well as crop cultivation through the increased supply of manure and draught power.

Institutional Innovations

The Seminar noted that there were no major programmes and projects designed exclusively for hill agricultural development in the first four Five-Year Plans (1956 – 76). It was only from the Fifth Five-Year Plan period that agricultural development policies began to focus on the expansion of livestock in the Mountains, horticulture in the Hills and cereal and cash crops in the Tarai. Since the private sector in Nepal has not been fully developed, the government and public institutions must take the lead. Important

agencies involved in the hill agricultural development process are the ADB/N, the AIC, the co-operative societies and *Sajha* institutions, the Agricultural Projects Services Centre (APROSC) and the Department of Agriculture.

The ADB/N provides short, medium and long-term agricultural loans through its 176 offices operating throughout the country. Seventy-six of them are located in the Hills, and in 1980, they provided loans totalling Rs 68 million to farmers to purchase input and develop horticultural and livestock activities. The AIC plays a significant role in the diffusion of seed-fertilizer technology by making timely deliveries of input through its field offices in 38 hill districts. Its new project on seed multiplication and storage will further increase the input supply and facilitate the advancement of hill agriculture.

Under the new co-operative system, *Sajhas* supply loan input and consumer goods, market agricultural produce and mobilize rural savings. However, many of them in the Hills are facing financial problems as the ADB/N and AIC have been reluctant to extend financial support to them. This has weakened the link between public institutions and the people.

The APROSC was established in 1975 to reduce the heavy reliance on foreign experts in identifying, monitoring and evaluating agricultural and rural development projects. Since then, it has provided services to both the government and international aid agencies by preparing over 50 projects on integrated rural development programmes, resource conservation and utilization, agriculture, irrigation, livestock raising, extension and evaluation of agricultural development programmes.

Among government institutions, the Department of Agriculture is the key agency responsible for diffusing improved technology in the Hills through Junior Technical Assistants (JTAs) and Agricultural Assistants (AAs) at the *Panchayat* level. It has also set up Agricultural Service Centres (ASCs) in each district to provide regular in-service training to JTAs as well as to farmers. As a result, it has established a direct link with farmers including those in the remote hill areas.

Although institutions formed specially for the generation and diffusion of technical knowledge are vital for the successful implementation of hill agricultural development programmes, the Seminar noted that there appears to be more institutions which disseminate technical know-how than those which generate appropriate technology for the progress of hill agriculture. The Seminar participants emphasized the need to bridge this gap.

Accelerator of Development

A difference exists between the "essentials" and "accelerators" of agricultural development. The essentials are the key factors which maintain and improve agricultural productivity and growth. Without them, there will be little development, while the accelerators although important for rapid progress are by themselves not indispensible. For example, foreign assistance in Nepal is an accelerator but is not essential for the nation's economic development.

Hill agricultural development is given top priority in Nepal's Fifth and Sixth Five-Year Plans. The government has mobilized all essentials to get hill development programmes moving. Since Nepal has limited physical and financial resources, external assistance is an accelerator. It consists of 3 major components, namely, experts, technology and commodities. To make it an effective accelerator, the government should identify priority areas for negotiation with donor countries, instead of allowing them the privilege of choosing the projects for assistance. Based on past experience, Nepalese officials from the Ministry of Agriculture made several suggestions on the better utilization of foreign assistance.

Nepal receives assistance from about 20 countries and 18 international and regional agencies. The main ones involved in the agricultural sector are India, the United States of America, Switzerland, New Zealand, Denmark, the Federal Republic of Germany, Japan and the United Kingdom. Among the multilateral agencies, the World Bank (IBRD), the Asian Development Bank (ADB), and the International Fund for Agricultural Development (IFAD) have been major contributors.

Some important foreign-assisted hill agricultural development projects are:

(1) the horticultural and livestock development network including veterinary services for the hill and mountain regions under Indian aid;

(2) the establishment of agricultural centres for the Western Hills at Lumle and for the Eastern Hills at Pakhribas by the United Kingdom;

(3) a dairy development programme and a cheese factory in the Hills by Switzerland; and

(4) the Gandaki Agricultural Development Project by the Federal Republic of Germany.

The Sixth Plan regards the expansion of food grain production as the foremost priority in the Hills. A number of bilateral and multilateral projects are in the process of being implemented. For example, the Hill Agricultural Development Project (HADP), initiated in 1973, aims at increasing the income and productivity of hill farms. This is a joint undertaking of the Nepalese government, the United Nations Development Programme (UNDP) and the Food and Agriculture Organization of the United Nations (FAO). The maintenance and improvement of soil fertility as well as an ecological balance in the Hills are also a part of the objectives of this programme. Besides this project, 8 others are in various stages of preparation and implementation.

From now on, the government aims to further expand hill agricultural development programmes. Hence, foreign assistance will continue to play an important role. Within this context, the Seminar recognized that their future success will depend on the systematic mobilization of local resources and the better utilization of external assistance.

What's next?

Each paper has made a certain number of recommendations to improve hill agricultural development programmes. This summary will not attempt to list them, but rather try to reflect the consensus of opinion presented and discussed during the Seminar on the strategies and directions the Nepalese government should adopt to develop hill agriculture in the next two decades.

The Seminar has provided a rare opportunity for government officials to evaluate their own experiences and to think ahead on what should be done in subsequent years. Perhaps, due to their daily association with hill agricultural problems, they may either have got accustomed to them, and thereby overlook their impact, or they may only see the trees and not the forest, and, as a result, rely only on short-term solutions. When the papers incorporating indepth analysis of the problems were prepared and discussed by the Seminar's group of competent experts, their scope and diversity, together with the great opportunities that exist for overcoming them were realized.

Nothing is more crucial for the development of hill agriculture than the projected increase in food grain production at an annual rate of 3.06 percent. If the national effort fails to achieve this target, either the hill population will go hungry, or the Tarai will have to import food before the year 2000. This is a challenging task as past efforts revealed a discouraging annual growth rate of less than 1 percent. For the next two decades, therefore, the possibilities of attaining a growth rate of 3.06 percent in food grain production will constitute a formidable goal for both the government and the people of Nepal.

Livestock development in the Hills also encounters production and health problems. To overcome them, 3 measures are required, namely,

(1) a reduction of the unproductive cattle population;

(2) an improvement in breeding programmes to increase milk yield; and

(3) an increase in fodder production.

In the case of health problems, the strengthening of veterinary services to eradicate parasitic infestation will be a priority function.

The targets of food grain and livestock production can only be achieved when productive hill farming systems are established by a judicious combination of crop and livestock enterprizes to generate more employment and higher income for the hill population under the given resource endowment. Due to the special ecological conditions of the Hills, other crops with a high protein content and market value should also be introduced.

Another essential consideration for the agricultural development of the Hills is the harnessing of all available water resources for irrigation. Problems of water distribution, use and management at the farm level in hilly areas prevail but they are not insurmountable. Traditional and indigenous hill irrigation systems established by farmers centuries ago are still in operation today, indicating the feasibility of introducing further similar or improved hill irrigation schemes. It is generally acknowledged that public investment in hill water resource development for the purposes of irrigation will in normal circumstances result in a very high payoff in the long-run.

When productivity expands, farmers demand markets to sell their produce, and to purchase input and daily necessities. Unfortunately, the Hills have few regular markets. Thus, the development of agricultural marketing facilities and the improvement of rural markets become equally important priorities.

Except for compost and farmyard manure which are available within the farmers' reach, other inputs including seed, fertilizer, insecticide, pesticide, implements and tools have to be shipped either from the Tarai or abroad. The AIC is responsible for their delivery to hill farmers on time, in sufficient quantities, and of appropriate quality. As indicated by the officials of the Ministry of Food and Agriculture, the efforts made to supply hill farmers with purchased input to expand their production, will in the long-run be more meaningful and economical than the supply of emergency food relief.

The provision of farmers with production incentives of both an economic and non-economic nature is another essential element of hill agricultural development. In other words, the production cost should be lower than the gross revenue in order to yield a margin of profit to enable the hill populace to raise their standard of living. Besides, whatever achievements that are accomplished by them should be given due public recognition.

Within the Nepalese framework, besides the above 4 essentials, hill labour migration, appropriate technology and institutional innovations also play significant roles. The kind of employment to generate in the Hills to prevent migration to the Tarai and abroad, the type of technology to test and adopt for the improvement of hill agriculture, and the manner in which existing rural institutions can efficiently serve the needs of hill farmers have become issues of major concern to policy planners and makers.

This Seminar dealt at great length with each and every one of these essential elements in its attempt to give as complete a picture as possible of the issues, problems and the opportunities that surround hill agricultural development in Nepal, and the possibilities that are within reach for surmounting them. Based on past experience, the government is able to propose a number of hill projects which the country wishes to develop, but they should be lucidly identified prior to seeking assistance from specific donors. The Seminar has also indicated that without foreign assistance which acts as an accelerator, hill agriculture may not be able to progress as fast as anticipated.

One gratifying observation which can be made from this Seminar is the due consideration accorded by the Ministry of Food and Agriculture to the proposals and recommendations made, and its desire to incorporate them in its future programmes and projects on hill agriculture. It is hoped that the Proceedings of this Seminar will be used as a basic document to compare hill agricultural development at the present time and 10 or 20 years later.

I
NEPAL'S EXPERIENCE

1
Development Potentials of Nepal's Hill Agriculture

T.N. PANT and G.B. THAPA

Introduction

The Hills of Nepal occupy a prominent place in the geographical and economic setting of the country. They account for more than three-fourths of the land area but contain only one-third of the total cultivated land and nearly two-thirds of the total population. Agriculture is the mainstay of the economy and it is noted for its crop-livestock based intensive farming system and permanent settlement. It has remained self-sustaining and self-reliant for a long time in the past.

However the situation has changed in recent years. There are now more mouths to feed and virtually no additional land to bring under cultivation. This demand for new land for agriculture and also the demand for timber as building material and fuel have resulted in large-scale deforestation. At the same time, the increasing unproductive livestock population has led to excessive grazing and encroachment on forest land.

The net outcome is an ecological imbalance threatening soil erosion and landslides. Agricultural productivity has declined as more and more marginal land is brought into cultivation.

The complex problems of agricultural development in the Hills have raised two inter-related issues during the past decade. The first relates to the fact that agriculture cannot support and maintain the growing population, and that there is little scope for achieving a meaningful level of development. The second is concerned with the massive migration of people from the Hills to the Tarai, and the need for large-scale afforestation of the Hills. These issues have to be dealt with very carefully in the context of the socio-economic, cultural, and political system of Nepal.

In the last few years, planners have shown an increasing interest in the development of hill agriculture. Their interest is focused not so much on the romantic aspects of the natural scenery, as on the deteriorating ecological balance, the worsening economic situation of the people and on the potentials for development.

This paper is written with this background in mind. An attempt is made to identify first some of the major problems facing hill agriculture, followed by an assessment of the potentials for development of food crops, plantation crops and livestock.

Hill Agriculture

The Hills (including the Mountains) have approximately 0.6 million hectares under cultivation, which is less than one-third of the total cropped area (2.3 million hectares) in the country. In contrast, two-thirds of the total population live in the Hills. The population density of the Hills exceeds 1,500 persons per square kilometre of arable land or 12 persons per hectare of cultivated land [World Bank, 1979]. Eighty-two percent of the farms are less than 0.67 hectare in size. The average size of holding is less than 0.5

hectare compared with 1.7 hectare in the Tarai [World Bank, 1981].

In the Hills, agriculture is confined to valleys and terraced slopes. Of the total cultivated area of 0.6 million hectares, three-fourths are upland terraces.

Food crops are grown on a major part of the cultivated area. Table 1.1 shows the area, production and yield of principal crops in the Hills. During the period from 1967 to 1972 the yield of paddy, maize and wheat declined by 1.3, 2.0 and 3.9 percent respectively [World Bank, 1974]. The production record for food grain in the seventies was equally disappointing. Table 1.1 shows that the yield of all food crops except wheat has declined over the years. In 1970/71, 34 of the 55 hill districts were food deficit areas while as many as 47 were food deficit in 1976.

The Hills account for about 36 percent of the area under food grain and 38 percent of the total production in the country. Maize is the most important crop, followed by paddy, wheat and millet. Barley, potato and herb predominate in the higher Hills.

Paddy is grown mainly in the valleys or lowland while maize and paddy are cultivated on the hill slopes or upland. Paddy-wheat, paddy-potato and paddy-maize form the principal crop rotation in the valleys of the lower Hills, whereas maize/millet-fallow, paddy-millet, maize/millet-wheat, paddy-potato, paddy-pulse, maize/millet-oilseed are common crop cycles on the upland slopes.

Soil fertility in the Hills is maintained by the recycling of organic residue, supplemented by farmyard manure and compost. The use of chemical fertilizer is extremely low (3 kilogrammes per hectare). There is a limited potential for surface irrigation in upland terraces, and the irrigated areas are confined mainly to lower valleys. Irrigation is mainly through surface diversion of water from rivers and streams.

The livestock industry plays an important part in the rural economy and constitutes an integral part of the total farming system in the Hills. Animal products such as milk, ghee and live animals are major sources of cash income for hill farmers. Milk and milk products are an important part of the diet and a source of animal protein. Bullocks are used for draught purposes and animal dung is used as manure and in some cases as fuel.

Integrated crop-livestock production is the established characteristic of Nepalese agriculture in general and in the Hills in particular. Such integrated crop-livestock farms are the case for over 95 percent of farm holding in the hill regions.

Development Plans

Nepal's first three development plans (1956–1970) emphasized the creation of basic infrastructure and paid little attention to agricultural production programmes. In the Fourth Five-Year Plan, agriculture was given high priority and in order to reduce regional disparities, the government introduced the concept of corridor development to integrate the Hills and the Tarai. This strategy of agro-climatic specialization emphasized the promotion of livestock in the Mountains, horticulture in the Hills, and food grain in the Tarai. These are the long-term objectives, while in the short-run, there is an urgent need in the Hills to achieve a higher degree of self-sufficiency in food grain production. Thus, the Sixth Plan emphasizes food grain production in the Hills.

The strategy of the first four plans had far-reaching consequences for the Hills where per capita production has declined. Table 1.2 shows the food balance projections for the Hills until 1989/90. An average family in the Hills currently produces food for only about 226 days of the year. If population and food production follow similar growth rates as in the past, food produced by the average hill farm family will cover only approximately 197 days of normal yearly subsistence needs in 1989/90. This will cause the majority of people to suffer from malnutrition. Such a situation has been substantiated

TABLE 1.1
AREA AND PRODUCTION OF MAJOR FOOD CROPS IN THE HILLS, 1979/71 – 1979/80

Year	Paddy			Maize			Wheat			Millet			Barley			Potato		
	Area (ha)	Prod. (tonnes)	Yield (tonnes/ha)	Area (ha)	Prod. (tonnes)	Yield (tonnes/ha)	Area (ha)	Prod. (tonnes)	Yield (tonnes/ha)	Area (ha)	Prod. (tonnes)	Yield (tonnes/ha)	Area (ha)	Prod. (tonnes)	Yield (tonnes/ha)	Area (ha)	Prod. (tonnes)	Yield (tonnes/ha)
1970/71	196,928	501,475	2.55	305,420	602,775	1.97	111,200	111,734	1.00	92,795	112,019	1.21	19,296	19,801	1.03	36,820	201,099	5.46
1971/72	201,505	481,012	2.39	299,321	533,329	1.79	112,133	123,692	1.10	95,545	113,209	1.18	19,357	19,709	1.02	37,725	204,415	5.42
1972/73	197,088	479,070	2.43	308,546	575,659	1.87	110,986	121,597	1.10	102,104	116,414	1.14	19,266	19,612	1.02	37,918	200,825	5.29
1973/74	215,325	526,861	2.45	317,486	589,416	1.86	128,285	122,134	0.95	102,329	123,751	1.21	19,699	20,052	1.02	39,196	210,728	5.38
1974/75	215,853	524,124	2.43	317,089	603,403	1.90	116,842	119,636	1.02	105,541	124,308	1.18	19,754	20,141	1.02	40,350	209,686	5.19
1975/76	221,040	555,111	2.51	314,120	567,590	1.81	105,553	124,778	1.18	105,570	130,090	1.23	20,391	20,227	0.99	41,599	234,243	5.63
1976/77	225,278	560,085	2.49	315,649	584,219	1.85	114,803	125,538	1.09	104,384	122,667	1.18	20,379	17,374	0.85	42,110	203,768	4.84
1977/78	230,160	529,590	2.30	314,560	521,330	1.66	124,240	146,740	1.18	102,210	111,930	1.10	19,500	18,160	0.93	41,760	217,830	5.22
1978/79	230,680	516,770	2.24	323,400	523,560	1.62	128,820	155,303	1.20	103,970	115,540	1.11	19,210	16,810	0.88	42,210	236,950	5.61
1979/80	228,620	460,710	2.02	311,060	414,960	1.33	129,534	145,192	1.12	103,450	101,930	0.99	19,150	17,120	0.89	42,700	232,560	5.45

Source: Nepal [1977].
World Bank [1981].

by a recent survey on nutrition which revealed that 54.2 percent of the rural population in the Hills suffered from moderate to chronic stuntedness due to undernourishment [World Bank, 1979]. Food deficit in the Hills accelerated the migration to the Tarai and thereby reduced this region's exportable surplus of food grain.

The absence of roads makes it cost-prohibitive to shift grain on a large-scale from the surplus areas of the Tarai to the Hills. Moreover, farmers will continue to grow food crops to feed themselves rather than grow horticultural crops which have a long gestation period.

Development Potentials

No significant potential exists for expanding the area under cultivation in the Hills. On the contrary, some marginal areas have to be reverted to forest and grazing land to control soil erosion. Therefore, higher agricultural production must be achieved through improved yield and higher cropping intensity.

Ecological conditions vary widely in the Hills due to variations in elevation, cloud cover, and topography. The prevalence of numerous micro-climates permits the cultivation of a variety of crops. The valleys in the lower Hills are suitable for tropical species such as paddy, maize, sugarcane, and mustard. Warm temperate fruit such as the apple, pear and peach, and food crops such as wheat, barley and potato do well in the mid-hill region, while the Mountains or higher Hills are suitable for the cultivation of cool temperate species such as barley, rye and herb.

There are a number of valleys in the Hills which possess a great potential for agricultural production. The important ones are the Kathmandu, Pokhara, Dang and Surkhet valleys. Here, the possibilities of developing irrigation facilities are high. Tropical and warm temperate crops can be successfully cultivated in these valleys, and two crops can normally be grown in a year under rainfed conditions.

Irrigation

Irrigation water is a prerequisite for both higher crop yield and higher cropping intensity. Table 1.2 shows that an area of 110,000 hectares was under irrigation in 1979. This figure corresponds to 18 percent of the total cultivated area and 36 percent of the total irrigable land in the Hills. Although there is no significant potential for increasing the irrigated area in the Hills, it is evident that the effective area under irrigation can be expanded by increasing the efficiency of existing facilities and by extending the irrigation period so as to enhance cropping intensity.

Food crops

Experimental trials carried out on government farms and on farmer's fields have demonstrated that there is considerable scope for the improvement of crop yield through better varieties, water management, nutrient supply and pest control. For example, cropping system research has shown that various combinations of improved farming practices which are adapted to the farmers' present cropping pattern have resulted in significantly higher yield and income (Table 1.4). In the case of potato for example, the adoption of simple, improved agronomic techniques, clean seed, and improved varieties has nearly trebled yield from 4.5 to 12 tonnes per hectare in Rasuwa-Nuwakot.

The potential for raising the average yield of millet and pulses is limited as improved varieties are not available; however, some improvement is possible through the selection of local germplasm and better agronomic practices.

TABLE 1.2
FOOD BALANCE PROJECTIONS FOR THE NEPAL HILLS
1976/77 – 1989/90

Year	Population* ('000)	Total gross production+ ('000 tonnes)	Consumable production‡ Total ('000 tonnes)	Consumable production‡ Per capita (kg)
1976/77	8,071	1,612	1,107	137
1977/78	8,224	1,622	1,113	135
1978/79	8,382	1,631	1,119	133
1979/80	8,544	1,641	1,126	132
1980/81	8,707	1,651	1,133	130
1981/82	8,886	1,661	1,140	128
1982/83	9,069	1,671	1,147	126
1983/84	9,255	1,681	1,154	125
1984/85	9,433	1,691	1,161	123
1985/86	9,638	1,701	1,168	121
1986/87	9,850	1,711	1,175	119
1987/88	10,070	1,722	1,182	117
1988/89	10,299	1,732	1,189	115
1989/90	10,535	1,742	1,196	114

Notes: *Based on the National Planning Commission, Nepal Population Projections 1971–86. Estimates extrapolated to 1989/90. Annual migration of 0.5 percent of the hill population to the Tarai is assumed. This is equivalent to approximately 40,000 in 1967/77.

+Includes cereal and potato. Growth extrapolated at an average growth rate from 1966/67 to 1976/77 for total cereal.

‡Net production is computed assuming seed requirements of 2 percent, a waste of 10 percent of total production, and a conversion factor of 0.78 to express it in edible form.

Horticulture

Because of diverse ecological conditions, the Hills possesses important comparative advantages for the production of fruit and vegetable. The production of low-weight, high-value fruit, spice, herb and vegetable seed offers attractive opportunities for raising employment and income.

The orange and apple are both commercially important crops of the Hills. The former is grown in the Eastern and the Far-Western Hills. Here and in the Pokhara Valley, diseases have adversely affected the production of high quality citrus. There has been some success in growing excellent apple in such remote areas as Mustang, Helambu, Jumla and Rasuwa. The guava, pear, peach and plum trees are also cultivated.

The expansion of horticulture in the Hills is limited by the lack of roads, storage, and marketing facilities. Bearing these constraints in mind, commercial fruit-growing should be located in accessible areas, particularly along roads.

TABLE 1.3
EXISTING AND PROPOSED AREA UNDER IRRIGATION IN THE HILLS

Item	Permanent (perennial)	Supplementary (monsoon) ('000 ha)	Total
Existing (1979)	11.0	99.0	110.0
Under construction	0.8	1.7	2.5
Proposed for the Sixth Five-Year Plan	1.1	2.2	3.3
Total (by the end of the Sixth Plan)	12.9	102.9	115.8

Because of its varied ecological range, the Hills are ideally suited for the production of a variety of winter and summer vegetable and seed. Past efforts have demonstrated that high quality vegetable seed such as those of the radish, cauliflower, cabbage, carrot and onion can be produced in suitable hill pockets. Since vegetable seed production is very labour-intensive and does not require much land, it offers a great potential for raising the income and employment of small farmers.

Despite this agro-climatic advantage, there is a lack of improved technology to raise productivity, and hence returns to vegetable cultivation are low. The absence of systematic, organized and effective extension services for vegetable production, improper methods of handling produce, scarcity of marketing facilities, and the failure to make production input such as improved varieties of seed available on time are some other important problems confronting vegetable cultivation.

In spite of the potential for fruit and vegetable production, development programmes have suffered from weaknesses in research and technology delivery and transfer. There is a need for a comprehensive research and seed multiplication programme.

TABLE 1.4
AVERAGE AND EXPERIMENTAL YIELD OF PRINCIPAL FOOD CROPS IN THE HILLS*

Crop	Eastern Hills			Central Hills			Western Hills			Far-Western Hills		
	Average yield	Experimental yield	% increase	Average yield	Experimental yield	% increase	Average yield	Experimental yield	% increase	Average yield	Experimental yield	% increase
Paddy	2.19	3.90	78	2.74	4.10	50	2.42	3.40	40	2.30	2.80	22
Maize	1.79	4.70	163	1.93	5.30	175	1.85	3.70	100	1.76	–	–
Wheat	1.05	1.80	71	1.91	2.80	135	1.00	2.54	154	0.84	4.84	471
Barley	0.87	–	–	0.87	3.02	247	0.88	1.00	14	0.89	3.50	293

Notes: *Average yield refers to the average yield for hill areas in 1977 in tonnes per hectare.
Experimental yield was taken from yield provided during 1977 to 1979 at the following experimental stations:

Eastern Hills	–	Khandbari, Sankhuwasabha
Central Hills	–	Lele, Lalitpur
Western Hills	–	Pumdi Bhumdi, Kaski
Far-Western Hills	–	Chauri Jahari, Rukum.

Sources: Nepal [1977].
Nepal [1979].

Spices, particularly ginger and cardamom, are important cash crops in some hill areas. Cardamom is important in the Eastern Hills but its export potential is limited because of its low quality. Ginger is an important cash crop mainly in the Western Hills where it may be feasible to increase the production and export of less-fibrous, lighter-coloured varieties. The cultivation of medicinal herb particularly *belladonna* and *derris* is important in a few hill areas.

The Eastern Hills, especially in the Ilam district, is suitable for high quality tea production, but most of the existing plantations produce low quality tea and the yield is low. There is a significant potential to increase both quality and yield through better management [World Bank, 1974].

Livestock

Cattle, buffalo and goat are the main livestock in the Hills, while sheep, yak and chauri are kept in the Mountains. The horse, bullock, sheep and mule are used for transportation and draught. The livestock population density in rural Nepal is among the highest in developing countries. An average rural household maintains 3.8 cattle, 1.6 buffalo and 2.7 goat/sheep [World Bank, 1972].

The ADB [1979] has identified the following factors as contributing to low livestock productivity.

(1) poor quality and insufficient quantity of feed;

(2) low genetic potential of the indigenous breeds for milk and meat production;

(3) high incidence of diseases; and

(4) lack of suitable marketing channels for livestock products in most areas.

Feed deficit during the dry season has been estimated in the order of 30 – 40 percent [Mauch and Schwank, 1979]. This deficit is due to the overpopulation of animals and the absence of fodder cultivation. Animal diseases and internal parasites reduce the productivity of livestock and cause high mortality. Legal and religious prohibition of the slaughter of cattle and female ruminants result in large numbers of unproductive animals. It is estimated that the ratio of productive to non-productive cattle is about 1 to 9 [ADB, 1979].

Increasing the availability of feed and fodder is vital for livestock production since feed supply is the single most important constraint to animal husbandry in Nepal. The production of fodder on marginal land unsuitable for crop production, the improvement of pasture through the introduction of improved fodder grasses and quick-growing legume, the better utilization of pasture land through planned and controlled grazing, the storage of seasonal surplus in the form of hay, and the propagation of fodder trees offer tremendous potential for the expansion of fodder supplies. A potential also exists for feeding tuber crops to livestock. For the lower Hills, *setaria* and *napier* grass hold good promise.

In other respects, improvements in local cattle and buffalo genetic stock present significant possibilities for stepping up livestock production. A milk yield of 1,200 litres per lactation can be obtained from the improved local crossbred Murrah buffalo [World Bank, 1980]. The breeding of local cattle with 50 percent crossbred bulls such as the Brown Swiss has proved beneficial in some areas of the Eastern Hills [Menzi and Mauch, 1980].

The progeny of the Hill goat crossed with the Jamunapari goat has shown an improved performance. Breeding programmes confirmed the high fertility and prolificacy of the Hill goat which is capable of an average milk production of 58 kilogrammes per lactation [World Bank, 1980].

In the higher Hills, the processing of locally-produced wool is an important source of income.

Recommendations

The above section highlights some of the potentials for the advancement of agricultural production. However, the real potentials are in fact much greater than those indicated by the limited success of past development efforts. For example, the yield of the most productive and profitable sets of practices conducted in the cropping trials of research sites is still quite low. Whenever the grain crop with the best treatment records less than six tonnes, explanations for failure to reach higher levels should be offered [Wortman, 1981].

In order to harness the development potential inherent in Nepal's hill agriculture, it is imperative to develop and diffuse whenever feasible appropriate and productive technology, to develop small-scale irrigation facilities, to deliver production input to farmers and to develop an organized market mechanism for farm produce.

The development and dissemination of yield–increasing agricultural technology are often regarded as the key mechanism to boosting agricultural output. The successful utilization of such technology depends on a strong programme of adaptive research and a comprehensive extension programme designed to diffuse this technology which must, to begin with, be appropriate and suitable for adoption by the farmer. Research into what constitutes appropriate technology is, therefore, of vital importance. Agricultural research must be problem-oriented and research results must be tested under farmers' conditions. One of the main problems in attempting to establish superior technology for the Nepalese hills lies in their physical variability. The performance of high-yielding varieties and cultural practices must be related to the specific environmental conditions favouring them.

Besides, farming in the Hills is compost-based and research is needed to improve the techniques of producing good quality compost and on the use of organic manure. This is all the more important in view of rising fertilizer prices, supply uncertainties, and difficulties in transporting fertilizer to the Hills. However, fertilizer will continue to play a vital role simply because compost and farmyard manure alone will not be sufficient to generate optimal recommendations for inorganic fertilizer and compost utilization. Since leguminous crops play a significant role in maintaining soil fertility, it is also important to develop better varieties and improve their agronomic practices.

At the farm level, crops should be considered in conjunction with livestock since the typical Nepalese farm is a mixed crop-livestock enterprize. Any effort to raise the productivity of one component should give due regard to the interrelationships governing the whole farming way of life. Imbalances in a subsystem will affect the entire farming economy which in turn, has an impact on farm income. The new technology, although superior in a partial context, may not fit into the farmers' complex farming system. For example, a new crop variety developed by a single commodity approach may be high-yielding but it may not meet their need for joint products. Hence, it is crucial that the new technology when developed should be appropriate in the context of the whole farming system.

REFERENCES

ADB. 1979. *Appraisal of the Livestock Development Project in Nepal.* Manila: Asian Development Bank.

Mauch, S.P. and O. Schwank, 1979. *Estimating the Impacts of IHDP Programme Components.* Lalitpur: Integrated Hill Development Project.

Menzi, M. and Mauch, S. 1980. *Proposals of IHDP Livestock Policy: Report of a Special Field Mission.* Lalitpur: Integrated Hill Development Project.

Nepal. 1977. *Agricultural Statistics of Nepal.* Kathmandu: Department of Food and Agricultural Marketing Services.

Nepal. 1979. *The Short-Term Cropping System Potential of Five Sites of Nepal and its Relevance to Similar Environments.* Kathmandu: Department of Agriculture.

World Bank, 1972. *Nepal Agricultural Sector Survey.* Washington D.C.

World Bank, 1974. *Nepal Agricultural Sector Survey* Vol . 1. Washington D.C.

World Bank, 1979. *Nepal Development Performance and Prospects.* Washington, D.C.

World Bank, 1980. *Report of the Nepal Hill Food Production Project Preparation Mission.* Vol. I. Washington D.C.

World Bank, 1981. *Staff Appraisal Report of the Hill Food Production Project.* Washington D.C.

Wortman, S. 1981. *Accelerating Nepal's Agricultural Progress. A Report for the Secretary of Agriculture.* Kathmandu: His Majesty's Government of Nepal.

2
Demand and Production of Food Grains in the Hills

B.B. KHADKA and J.C. GAUTAM

Introduction

Agriculture in Nepal is the most important sector in terms of income and employment generation. About 65 percent of the total Gross Domestic Product (GDP) is contributed by this sector, while over 94 percent of the total labour force is employed in agriculture. Agriculture accounts for about 80 percent of export earnings. About 85 percent of the cropped area is under cereal, the most important of which are paddy, maize, wheat, millet and barley. Traditionally, rice has been an important source of export earnings, but the exportable surplus has declined from over 200,000 tonnes in the late sixties to less than 100,000 tonnes in normal production years of the late seventies. Jute, sugarcane, tobacco, oilseeds, and potato are the principal cash crops, of which jute is the major export commodity.

Farming in Nepal is still based largely on traditional technology. In 1979/80 the use of chemical fertilizer was about 7 kilogrammes of plant nutrients per hectare of cropped area. Only about 10 percent of the total cultivated area is irrigated. The average size of the operational holding is less than 1 hectare.

Agricultural production pattern is very much conditioned by geographical and climatic factors. Because of its inherent advantages, the Tarai produces about 60 percent of the GDP and accounts for 80 percent of exports. The Tarai is a food surplus area while the Hills is deficit in food.

This paper examines the current situation with regard to the consumption and production of food grain in Nepal. If present trends continue, severe food deficits are predicted for the Hills by the year 2000. A normative analysis shows that even under optimistic assumptions, the Hills will remain a food deficit region. Implications for food pricing and marketing policies are discussed in the last section.

Consumption of Food Crops

Comprehensive regional studies on rural food consumption are not available. Two household consumption studies were carried out in the late sixties, but they covered only one *Panchayat* each in the Hills [Nepal, 1968]. In 1973/74, a consumption survey was conducted in 19 districts but results from this study have not yet been released. The Trade Flow Survey [Nepal, 1971] provides district-level information on the balance of trade of cereal grain.

An attempt was made to update estimates of per capita consumption of different food crops in Nepal. On the basis of previous studies and on the availability of food crops in the country, their estimated consumption pattern for the base period 1979/80 is given in Table 2.1.

TABLE 2.1
PER CAPITA CONSUMPTION OF MAJOR FOOD CROPS (IN EDIBLE FORM) BY ECOLOGICAL REGION, 1979/80

Region	Rice	Maize	Wheat	Millet	Barley	Total cereal	Pulses	Oil	Potato	Total food crops
	(kg per capita)									
Hills	48.48	69.39	16.43	14.07	3.24	151.61	2.70	1.70	20.08	174.92
Tarai	124.95	36.79	17.12	3.39	1.53	183.78	2.28	1.73	10.19	197.98
Nepal	78.32	56.67	16.70	9.90	2.57	164.16	2.61	1.79	16.22	184.78

The per capita consumption of total cereal in the Hills is 17.5 percent less than that estimated for the Tarai. The per capita consumption of potato in the Hills is almost double that of the Tarai. The consumption of pulse is marginally more, but the per capita consumption of all food crops is 11.65 percent lower in the Hills than in the Tarai.

This could be attributed to lower levels of income and production in the Hills. A survey report of the National Planning Commission [Nepal, 1978] estimates the per capita income of rural areas in the Hills and the Tarai at Rs 857 and Rs 1,005 respectively. Similarly, a comparison of per capita production of cereal in 1978/79 reveals production levels of 433 kilogrammes for the Tarai and 161 kilogrammes for the Hills.

Consumption pattern of cereal varies widely between the Tarai and the Hills (Table 2.1). Among cereal, rice occupies first place in the Tarai, while maize is the staple in the Hills. Maize and rice together contribute to more than three-fourths of the total quantity of cereal consumed in both regions. Millet and barley constitute about 11 percent of cereal consumption in the Hills but only 3 percent in the Tarai. There is little difference in the consumption level of wheat.

Projected Demand for Cereal

Income elasticities for cereal were calculated from food consumption survey data for 12 blocks representing 3 ecological zones and the 4 administrative regions.[1,2] The projected per capita consumption levels of total cereal are given in Table 2.2.

[1]For planning and development purposes, the Kingdom of Nepal is divided into four administrative regions. However, very recently the Far-Western Region has been divided into two regions making a total of five regions). Each administrative region extends from South to North and has different ecological regions, that is, Tarai, Hills and Mountains. Results of this survey have not been published.

[2]Income elasticities reflect the percentage change in the quantity demanded given a percentage change in income. They were estimated indirectly by the use of expenditure elasticities. Because the household survey did not contain income data, income elasticities were derived by multiplying the expenditure elasticity by an estimate of the elasticity of total expenditure. This latter was taken from a publication entitled "Employment, Income Distribution, and Consumption Patterns in Nepal" issued by the National Planning Commission [Nepal, 1978]. A double logarithmic functional form was used to estimate the commodity expenditure elasticities.

TABLE 2.2
ESTIMATED PER CAPITA DEMAND FOR CEREAL (IN EDIBLE FORM)

Region	Rice	Maize	Wheat	Millet	Barley	Total cereal
			(kg/capita/year)			
			Year 1985			
Hills	52.12	68.92	17.90	13.70	3.08	155.72
Tarai	130.54	37.37	18.04	3.25	1.48	190.68
Nepal *	83.33	56.36	17.96	9.54	2.44	169.63
			Year 1990			
Hills	58.58	68.14	20.30	13.10	2.86	162.98
Tarai	142.55	38.04	19.99	3.00	1.35	204.93
Nepal *	91.35	56.39	20.18	9.16	2.27	179.35
			Year 2000			
Hills	77.41	66.13	26.86	11.73	2.49	184.62
Tarai	178.96	40.30	25.54	2.46	1.08	248.34
Nepal *	117.03	56.05	26.34	8.12	1.94	209.48

Notes: *Per capita figures for Nepal are weighted by population.

Projections are based on the following formula:

$$Q_t = Q_0 \left(1 + \frac{Y_t - Y_0}{Y_0} I\right) \quad \text{where,}$$

Q_t = projected per capita quantity demanded in year t;

Q_0 = per capita consumption in the base year;

Y_t = projected per capita income in year t;

Y_0 = per capita income in the base year;

I = estimated income elasticity of demand.

FAO projections were used to estimate changes in per capita income to 2000 [FAO, 1979]. Population projections were taken from the Central Bureau of Statistics until 1986 [Nepal, 1974]. Separate projections were made to 2000. The per capita projected demand was multiplied by predicted population to arrive at a total demand by region and by year.

The most striking feature of projected demand for cereal is that the per capita consumption of wheat, rice and total food grain will increase in both the Hills and the Tarai. Demand is expected to increase by 22 percent in the Hills and 35 percent in the

Tarai. Demand for rice in the Hills is expected to increase from about 48 kilogrammes in 1980 to 77 kilogrammes in 2000, while wheat is estimated to increase from 16 to 27 kilogrammes. The per capita demand for millet and barley is expected to decrease in the Hills and Tarai while the demand for maize will remain virtually unchanged.

The future requirement for total cereal has been projected from the per capita demand estimates and is reported in Table 2.3[3].

TABLE 2.3
ESTIMATED GROSS REQUIREMENT OF TOTAL CEREAL, 1980 – 2000

Region	1980	1985	1990	2000
	('000 tonnes/year)			
Hills	1,857	2,124	2,477	3,477
Tarai	1,748	2,063	2,340	3,350
Nepal	3,605	4,187	4,817	6,827

Nepal will need 90 percent more food grain by the year 2000 to meet estimated demand. Among the cereal, the increments in total demand for wheat are highest in the Hills at 149 percent, followed by rice (122 percent) and maize (47 percent). The total demand for millet and barley is estimated to increase by 33 and 24 percent respectively. Their annual increases will be nominal compared with those of wheat, rice and maize.

Production of Cereal

Of the total area under cereal in the Hills, maize ranks first followed by paddy and wheat. Maize and millet are generally grown on terraced slopes, while paddy is planted in the river basins and valleys. In 1978/79, the total harvested area of cereal was 2,226,600 hectares, of which 36 percent was in the Hills (Table 2.4).

TABLE 2.4
PROPORTION OF AREA UNDER CEREAL BY REGION, 1978/79

Region	Paddy	Maize	Wheat	Millet	Barley	Total cereal
Hills	18	71	36	84	83	36
Tarai	82	29	64	16	17	64

Source: Nepal [1979].

[3]Gross grain requirements include consumption, intermediate demand, and storage and milling losses. Gradual reductions on storage and milling losses have been assumed due to potential improvements in postharvest technology.

The proportion of harvested area of cereal to total cultivated area for the Hills and the Tarai in 1979/80 was 80 and 97 percent respectively. Maize commands the highest proportion of total harvested cereal area followed by paddy and wheat in the Hills, while paddy is predominant in the Tarai (Table 2.5).

TABLE 2.5
PROPORTION OF AREA UNDER CEREAL WITHIN THE HILLS, TARAI AND NEPAL, 1978/79

Region	Paddy	Maize	Wheat	Millet	Barley	Total cereal
Hills	28	40	16	13	3	100
Tarai	72	9	17	1	1	100
Nepal	57	20	16	6	1	100

Source: Nepal [1979].

TABLE 2.6
PRODUCTION OF CEREAL IN THE HILLS, 1967/68 – 1978/79

Year	Paddy	Maize	Wheat	Millet	Barley	Total cereal
	('000 tonnes)					
1967/68	448.5	540.8	122.7	97.7	17.7	1,227.4
1968/69	463.3	552.9	135.3	105.9	18.5	1,275.9
1969/70	476.4	574.3	145.3	107.5	19.1	1,322.9
1970/71	502.1	602.6	111.7	112.2	19.6	1,348.2
1971/72	492.4	533.4	123.7	112.2	19.7	1,281.4
1972/73	482.0	585.3	120.2	117.4	19.6	1,324.5
1973/74	526.9	591.4	122.1	123.8	19.9	1,384.1
1974/75	524.1	594.4	119.6	124.0	19.9	1,382.0
1975/76	558.0	567.5	125.5	124.5	20.2	1,395.7
1976/77	560.1	583.2	125.6	122.7	17.4	1,409.0
1977/78	529.6	521.4	145.8	111.9	17.6	1,326.3
1978/79	536.3	533.1	155.0	115.5	16.7	1,356.6

Sources: Nepal [1972, 1977].
Nepal [1979].

Table 2.6 gives the time series data on cereal production in the Hills from 1967/68 to 1978/79. 1979/80 was not a normal year throughout the country, since paddy, maize and millet suffered severely from drought. Therefore, 1978/79 was selected for comparison with 1967/68 as the base cropping year.

There has been no sustained trend of increasing production in the Hills (Table 2.6). The annual increase in total cereal has been less than 1 percent (0.95) from 1967/68 to 1978/79.

In contrast, wheat production in the Tarai has increased at an annual rate of 20 percent which is due to increases in both area and yield (Tables 2.8 and 2.9). The performance of other crops has not been as good. Production of all cereal in the Tarai has increased by 1.46 percent annually. For the country as a whole, the increase in cereal production has been 1.27 percent (Table 2.8).

TABLE 2.7
PRODUCTION OF CEREAL IN THE TARAI, 1967/68 – 1978/79

Year	Paddy	Maize	Wheat	Millet	Barley	Total cereal
	('000 tonnes)					
1967/68	1,670.9	204.8	82.2	15.7	4.9	1,978.5
1968/69	1,714.9	211.8	97.4	15.5	4.9	2,044.5
1969/70	1,764.9	220.6	119.4	16.8	5.3	2,127.0
1970/71	1,802.7	230.7	81.6	17.3	5.6	2,137.9
1971/72	1,851.4	225.3	99.5	17.3	5.8	2,199.3
1972/73	1,528.4	236.8	192.3	17.0	5.2	1,979.7
1973/74	1,889.2	222.2	186.3	18.1	5.6	2,321.9
1974/75	1,928.1	232.3	211.2	17.9	5.7	2,395.2
1975/76	2,046.7	180.3	261.5	18.1	4.4	2,511.0
1976/77	1,826.2	214.1	236.3	15.4	3.2	2,295.2
1977/78	1,752.8	219.1	265.5	17.6	4.3	2,259.3
1978/79	1,803.0	209.5	260.2	17.6	6.0	2,296.3

Sources: Nepal [1972, 1977].
Nepal [1979].

TABLE 2.8
ANNUAL GROWTH RATE OF CEREAL PRODUCTION IN THE HILLS, TARAI AND NEPAL, 1967/68 – 1978/79

Region	Paddy	Maize	Wheat	Millet	Barley	Total cereal
			(%)			
Hills	1.78	– 0.13	2.27	1.66	– 0.51	0.95
Tarai	0.72	0.21	19.66	1.10	2.04	1.46
Nepal	0.94	– 0.04	9.33	1.57	0.04	1.27

In the Hills, the growth rate in cereal production has been less than the growth rate in area (Table 2.9) which suggests that average yield has been declining. This observation applies particularly to maize production in the Hills.

TABLE 2.9
ANNUAL GROWTH RATE OF AREA UNDER DIFFERENT CEREAL, 1967/68 – 1978/79*

Region	Paddy	Maize	Wheat	Millet	Barley	Total cereal
			(%)			
Hills	2.12	1.25	2.92	2.15	0.72	1.88
Tarai	0.61	0.01	12.74	0.71	– 0.13	1.49
Nepal	0.85	0.93	7.76	1.90	0.47	1.66

Note: *Some of the apparent increase in area under crops in the Hills, however, is due to a difference of recording. The cadestral survey has generally shown more area than used to be previously assumed.

The growth rate in production has not kept pace with population growth. Per capita production has declined gradually from 1967/68 to 1978/79 (Table 2.10).

The per capita cereal production in the Hills increased until the early seventies, after which it declined. Its percentage decline (14 percent) is greater in the Tarai than in the Hills (9 percent). This decrease is aggravating the food deficit situation in the Hills, while the reduction in the Tarai is eroding its exportable surplus position.

Projection Trend of Cereal Production

The projection reported in Table 2.11[4] represents the levels of production that may be

[4]For the purposes of trend analysis, the production data were separately fitted for the Mountains, Hills, and Tarai.

achieved if the past trend, present efforts, and current resource-use are continued. Projections for the next 20 years are based on linear equations.

Provided that present trends continue, the increase in cereal production in the next twenty-year period for the Hills, Tarai, and Nepal will be 12, 27 and 21 percent respectively by the year 2000. Maize output is projected to decline both in the Hills and Tarai by 22 percent and 32 percent respectively. With the exception of barley and maize, production of other cereal is projected to increase. The growth rate for cereal lags behind the assumed population growth rate of 2.3 percent to 2.5 percent per annum.

The balance between projected demand and production of cereal in edible form is documented in Table 2.12. The Hills are chronically deficit in cereal and in 1980, this deficit is in the order of 349,000 tonnes of cereal in edible form. By the year 2000, this deficit will reach 1,517,000 tonnes, which is an increase of about 335 percent. Even the Tarai, often called the granary of Nepal, is threatened as a surplus producing region.

TABLE 2.10
PER CAPITA PRODUCTION OF TOTAL CEREAL, 1967/68 – 1978/79

Year	Hills	Tarai	Nepal
		(kg/capita)	
1967/68	177	504	295
1968/69	181	504	299
1969/70	186	506	305
1970/71	187	492	302
1971/72	174	497	295
1972/73	175	439	274
1973/74	179	505	301
1974/75	175	511	300
1975/76	174	520	304
1976/77	173	461	282
1977/78	160	440	267
1978/79	161	433	266

Sources: Nepal [1972, 1977].
Nepal [1979].

TABLE 2.11
PRESENT AND PROJECTED CEREAL PRODUCTION USING LINEAR TREND, 1980 – 2000

Region	1980	1985	1990	2000
	('000 tonnes)			
Hills				
Paddy	567	612	656	746
Maize	519	490	461	404
Wheat	142	163	183	224
Millet	119	123	127	135
Barley	18	17	17	16
Total cereal	1,365	1,405	1,444	1,525
Tarai				
Paddy	1,900	1,983	2,066	2,231
Maize	192	177	159	131
Wheat	296	391	485	673
Millet	18	18	19	20
Barley	5	5	5	5
Total cereal	2,411	2,574	2,734	3,060
Nepal				
Paddy	2,467	2,595	2,722	2,977
Maize	711	667	620	535
Wheat	438	554	668	897
Millet	137	141	146	155
Barley	23	22	22	21
Total cereal	3,776	3,978	4,178	4,585

TABLE 2.12
BALANCE BETWEEN PROJECTED DEMAND AND NET PRODUCTION OF CEREAL USING LINEAR TREND, 1980 – 2000

Region	1980	1985	1990	2000
	('000 tonnes in edible form)			
Hills	–349	–504	–768	–1,517
Tarai	+389	+316	+206	– 345
Nepal	+ 40	–188	–562	–1,862

A Normative Scenario for Cereal Production

With a view towards sustaining the present food surplus position of Nepal and arresting the emerging gaps between requirements and production of cereal, a study team is currently preparing a perspective twenty-year plan based on production potential in the Hills and Tarai.

The plans envisaged increased cereal production by improving crop productivity and by expanding the area under irrigation. The greater use of improved seed and inorganic fertilizer constitutes other elements of the strategy for boosting production. Potential production is calculated using the following assumptions:

(1) By the year 2000 cereal yield will increase by 43 percent. In the Hills, augmented irrigation is expected to increase paddy yield and facilities for supplying irrigation to about 150,000 additional hectares is proposed.

(2) The proportion of area planted with improved seed for barley, millet, maize, paddy and wheat in the Hills will rise to 26, 51, 65, 70 and 100 percent of the cultivated area.

(3) In the Hills the use of chemical fertilizer will go up by approximately 44,000 tonnes of nutrient and the bulk of this amount will be applied primarily to irrigated areas.

(4) The land use intensity will be increased. Maize as a spring crop in the additional irrigated area will be extended to 57,000 and 37,000 hectares in the Hills and Tarai respectively. The area under barley will increase to about 6,700 hectares. The plan does not forsee any increase in the area for millet.

Under these assumptions, the total cereal production will increase by 3.06 percent annually in the Hills, compared with 4.93 percent for the country during the period from 1980 to 2000. Planned production levels of cereal in the Hills are given in Table 2.13.

The production of paddy, maize, wheat, millet and barley is envisaged to increase by 59, 60, 84, 45 and 80 percent respectively. Provided that the proposed production levels are achieved, the food grain deficit in the Hills will decline, while there will be a larger surplus in the Tarai (Table 2.14).

The hill production potential to meet additional cereal requirement is limited. Therefore the transport of food grain to the Hills will have to continue.

TABLE 2.13
PRESENT AND PLANNED PRODUCTION FOR CEREAL IN THE HILLS, 1980 – 2000

Crop	1980	2000	Annual increase
	('000 tonnes)		(%)
Paddy	546	868	3.95
Maize	551	880	2.98
Wheat	153	282	4.19
Millet	102	147	2.24
Barley	17	31	3.99
Total	1,369	2,208	3.06

TABLE 2.14
BALANCE BETWEEN PROJECTED DEMAND AND PLANNED PRODUCTION LEVELS OF TOTAL CEREAL (IN EDIBLE FORM)

Region and projection	1980	1985	1990	2000
	('000 tonnes)			
Hills				
Projected demand	1,295	1,471	1,756	2,545
Planned production	960	1,132	1,327	1,681
Surplus (+) or deficit (–)	–335	–339	–429	–864
Tarai				
Projected demand	1,005	1,190	1,412	2,191
Planned production	1,373	1,840	2,309	3,472
Surplus (+) or deficit (–)	+368	+650	+897	+1,281
Nepal				
Projected demand	2,300	2,661	3,168	4,736
Planned production	2,333	2,972	3,636	5,153
Surplus (+) or deficit (–)	+33	+311	+468	+417

Pricing and Marketing Policies

The government presently provides a subsidy on the transport of both food grain and fertilizer. The subsidy on the former is aimed at maintaining price stability and to cushion off food deficit in the Hills. The Nepal Food Corporation (NFC) operates a subsidy programme on food grain transportation in almost all the hill districts. The transport subsidy costs about Rs 40 million annually and is administered by the NFC. In view of the ever increasing deficit in the Hills, this subsidy if continued in its present form will commit the exchequer to finance substantially increasing amounts every year.

The opportunity cost of such a subsidy can be questioned. At the same time, it can also be asked whether the artificially depressed prices of food grain in hill markets are due to government subsidies which have discouraged investment in food production in the Hills. If the answer is in the affirmative the basic purpose of development may be defeated. But there is no clear evidence to indicate that the decline of productivity in the Hills is due to the government's subsidy programme. The quantity handled by the NFC is less than 10 percent of the total deficit in the hill area, and about 45 percent of the amount purchased is distributed in the Kathmandu Valley, where productivity is most impressive.

The growth objectives of pricing policies, whether for the Tarai or the Hills, should not be blunted. Prices guide proper resource allocation, balance income distribution by transferring income from non-agricultural to the agricultural sector, and encourage capital formation and investment. Thus it maybe proper to gradually reduce or withdraw subsidies on food, at least from those areas of the Hills which have a comparatively better potential. Encouragements given to the private sector to transport food grain in the Hills may help the government phase out or decrease this subsidy.

Presently, the NFC handles around 40,000 tonnes of cereal in edible form. If about 10 percent of the estimated deficit in the Hills is to be supplied by the government, then around 80,000 to 90,000 tonnes of cereal will have to be procured annually. This will mean the need to more than double the present capacity of the NFC. Of the NFC's existing total 36,400 tonnes storage capacity, about 51 percent is located in the Hills, and 49 percent in the Tarai where most of the food grain is procured. The strain will be greater in the future because all the remote districts will be food deficit areas. The construction of procurement centres in suitable places of the Hills may encourage the development of viable markets.

Nevertheless, it should be borne in mind that food problems are sensitive both from political and social points of view. In the remote hill areas of the country, direct government involvement maybe needed for both political and social reasons. At the same time, the government is often faced with inherently contradicting interests of providing higher prices to the farmers while at the same time maintaining the supply of food grain at lower prices to consumers. There are limits of the extent to which both objectives can be achieved simultaneously. This, however, should not rule out the possibility of increasing marketing efficiency in which both producers and consumers can benefit.

Prices on fertilizer are equalized throughout Nepal by means of a uniform pricing policy. In 1978/79, the total amount of subsidy involved was over Rs 440,000 and the quantity of fertilizer distributed was around 46,000 tonnes. Thus, the subsidy on a tonne of fertilizer is about Rs 96. Although the index of fertilizer consumption at the end of the Fifth Five-Year Plan has gone up to 150 compared to the beginning year of the plan, there has been little change in terms of nutrients used per unit of cropped area.

Consumption of most of the fertilizer is concentrated in the Central Hills which include the Kathmandu Valley (Table 2.15). While the index for the rest of the Hills

has reached 199 by 1978/80, the total quantity consumed in that year was a mere 8% of the fertilizer used in the country. The Tarai used 51 percent, and the Central Hills 41 percent.

TABLE 2.15
QUANTITIES AND INDICES OF FERTILIZER DURING THE FIFTH FIVE-YEAR PLAN PERIOD

Region	1975/76		1976/77		1977/78		1978/79		1979/80	
	Q	I	Q	I	Q	I	Q	I	Q	I
Central Hills	5,328	100	6,251	117	6,897	129	7,303	137	7,677	144
Rest of the Hills	739	100	1,172	159	1,255	170	1,109	150	1,471	199
Tarai	6,315	100	7,914	124	7,981	126	15,552	240	9,438	149
Nepal	12,384	100	15,337	124	16,133	130	23,964	194	18,586	150

Notes: Q = quantity in tonnes.
I = index, base year is 1975/76.

Source: AISC [1981].

Another pricing policy that the government has pursued is the fixing of the minimum support prices for paddy and wheat. If properly carried out, this policy will provide a mechanism for influencing resource allocation by producers and for regulating marketable surplus. Small farmers who do not have much production for the market may not benefit from such a scheme. A policy that will encourage investment in the farms and at the same time guarantee a minimum level of income may be optimal. A price support policy must be flexible enough to respond to a dynamic situation. For parity, any price policy adopted has also to consider border prices in the neighbouring countries.

Conclusion

The Hills contain 77 percent of the total land area of 14.2 million hectares but only 9 percent of it is under cultivation. The possibility of further expansion in area under cultivation is negligible. The consumption requirement of food grain in the Hills will rise by 87 percent in the next two decades. Its production has however, remained relatively constant over the past decade. The realization of potential crop yield by the use of presently available technology is limited by the failure to adopt complete technological packages. This poses a problem on the ability of the Hills to provide for its own supply of food grain.

Nevertheless, there is considerable scope for increasing the production of food grain in the Hills. This will, however, require a greater emphasis on the development of technological packages specially tailored for hill conditions. A balanced approach is needed

to meet the long-term objectives of developing both horticulture and livestock enterprizes. Policies dealing with prices and food grain distribution should be designed to ensure that they support programmes aimed at increasing its production.

REFERENCES

AISC. 1981. *"Quantities of Fertilizer Used in the Fifth Five-Year Plan Period"*. Kathmandu: Agricultural Inputs Supply Corporation (Unpublished).

FAO. 1979. *Agriculture Towards 2000, Mimeograph on Nepal.* Rome: Food and Agriculture Organization of the United Nations.

Nepal. 1968. *Report on Food Consumption Survey of Batulechour Gram* Panchayat. Kathmandu: Ministry of Agriculture.

Nepal. 1971. *Report on Trade Flow Survey of Agricultural Commodities, Particularly Cereal Grain in Nepal.* Kathmandu: Food and Agricultural Marketing Services Department.

Nepal. 1972, 1977. *Agricultural Statistics of Nepal.* Kathmandu: Food and Agricultural Marketing Services Department.

Nepal. 1974. *Population Projections for Nepal, 1971 – 1986.* Kathmandu: Central Bureau of Statistics.

Nepal. 1977. *Analysis of the Population Statistics of Nepal.* Kathmandu: Central Bureau of Statistics.

Nepal. 1978. *Employment, Income Distribution and Consumption Patterns in Nepal.* Kathmandu: National Planning Commission (Summary Report Vol. IV).

Nepal. 1979. *Handbook of Agricultural Statistics of Nepal.* Kathmandu: Food and Agricultural Marketing Services Department.

3
Trends and Projections of Livestock Production in the Hills

H.B. RAJBHANDARY and S.G. SHAH

Introduction

The limited transport and communication infrastructure in Nepal's rugged and mountainous terrain has contributed towards the evolvement of a complex farming system, where agriculture, livestock, forest resources and rangeland are intertwined. Population pressures have forced the hill people to cultivate marginal rangeland. Livestock raising is a fundamental component of the farming system. It provides draught power to till the land and to transport agricultural goods besides manuring field crops and nourishing the farmer. It also constitutes an additional source of income for the farm household. Yet in reality, the importance of such livestock is neither appreciated nor recognized. The shortage of feed resources has stunted and starved them. Rampant parisitic infestation depressed their productivity and has given rise to the animal's unattractive appearance. Tree cutting and overgrazing are laying bare the mountain forest and rapidly changing the ecosystem.

In the Hills, livestock rearing is considered to be the second major economic activity and it contributes to about 27 percent of household income. The size of the livestock unit is positively related to the cultivated land holding per family. Forest, crop and livestock activities are very closely interconnected and are interdependent on each other.

The lower mid-Hills situated between 500 and 1,800 metres above sea level are characterized by multiethnic settlements where the farmers are more dependent on crop cultivation. Cultivated areas are located primarily on foothill terraces where irrigated portions are devoted mainly to paddy and wheat, and the nonirrigated ones to maize and millet. General animal husbandry practices remain as stall feeding of crop residue supplemented by leaf fodder and grass/weed collected from the the nearby forest, and grazing in the communal open and barren grazing land or in the depleted scrub/forest land.

The upper mid-Hills on an elevation of 1,800 to 2,500 metres are inhabited characteristically by monoethnic settlements of primarily the Magar, Tamang, Gurung, Sunwar, Rai, Limbu and Sherpas. The mountain slopes here are steeper and the cultivated land is mainly rainfed. Immediately after the first shower of rains in the summer, farms around the settlements are cultivated and most of the animals are driven out to the pasture at a higher altitude. They remain there for the entire summer, grazing from place to place on the mountain ranges which are typically transhumane in nature. When the summer crops are harvested, the animals return to the settlement to feed on crop residue and to manure the field.

The climate of the Mountains is cooler, but here it is less fertile and production is less efficient, because it takes longer for the crops grown in this region to mature. The farmers' main source of income is derived from livestock production. A few fertile

patches either at the foothills or by the riverside are intensively cultivated, leaving little scope for greater production to supplement their income. Individual households maintain livestock in herds of 15 to 30 cattle and over 200 to 300 sheep and goat. These animals live on the mountain ranges for most of the time in a transhumane fashion as in the medieval ages. Twice a year, they are herded to settlements —– once for barley sowing and the other for harvesting. Otherwise, they are on the move all the time.

The primary objectives of this paper are:

(1) to analyze the trends and projections of livestock production in the hill areas of Nepal;

(2) to evaluate the relationship between the supply and demand for animal produce;

(3) to identify the constraints to increasing livestock production in the Hills; and

(4) to recommend policies that can lead to an increase in the productivity of this sector of the Nepale' s hill economy.

Livestock Population

Nepal's total livestock population in 1979/80 consisted of 5.98 million cattle, 2.60 million buffalo, 3.65 million goat, 0.56 million sheep, 0.36 million pig, and 8.21 million poultry. This places her among those countries with the highest livestock population per unit of land area.

The Hills and Mountains contain 68 percent of the cattle, 78 percent of the buffalo, 78 percent of the goat and 86 percent of the sheep population. The ruminant species are mostly concentrated in the Hills which possesses 53, 58, 62 and 65 percent of the nation's cattle, sheep, goat and buffalo population respectively (Table 3.1).

The present cattle population consists of 37 percent adult males, 33 percent adult females and 30 percent young stock. The high proportion of adult males is probably due to the need for draught animals in field operations. Large numbers of farm animals are maintained for manuring the fields and providing fuel from dung. About 20 percent of the value of livestock produce for 1976/77 and 1977/78 was from manure, fuel and draught power.

It is illegal to slaughter female livestock in general and cattle in particular, but this prohibition does not apply to the male buffalo. As a consequence, the population of the adult male buffalo is only 6 percent compared with 53 percent adult female and 41 percent young stock. The herd composition of sheep, goat, pig and poultry is similar to that of the buffalo, since male animals are extensively slaughtered for meat.

Data from the Department of Food and Agricultural Marketing Service and the Central Bureau of Statistics were used to estimate livestock population trends over the past 13 years (Table 3.2). The main trends are:

(1) cattle population increased at a very low rate of 0.17 percent per annum;

(2) buffalo population declined by 1.3 percent per annum; and

(3) sheep and goat population increased by 0.26 percent per annum.

An acute shortage of feed, heavy parasitic infestation, late maturity, infertility, inadequate livestock development services and the migration of people from the Hills have affected the growth in livestock population. In recent years, the high prices of goat and sheep meat have led to an increase in the use of buffalo meat in the regular diet and the culling off of unwanted buffalo.

TABLE 3.1
LIVESTOCK POPULATION OF THE HILLS AND MOUNTAINS BY ECOLOGICAL REGION, 1979/80

Ecological region	Cattle	Buffalo	Sheep	Goat	Pig	Poultry
			('000 heads)			
Eastern						
Mountains	237.3	61.1	43.9	164.7	35.3	235.3
Hills	553.2	164.7	79.7	494.8	101.8	1,048.9
Total	790.5	225.8	123.6	659.5	137.1	1,284.2
Central						
Mountains	208.2	101.2	31.1	169.0	8.0	300.1
Hills	719.5	351.1	41.3	628.2	34.0	2,736.1
Total	927.7	452.3	72.4	797.2	42.0	3,036.2
Western						
Mountains	24.8	–	5.2	28.2	–	11.9
Hills	860.0	677.2	138.1	692.6	31.5	1,348.5
Total	884.8	677.2	143.3	720.8	31.5	1,360.4
Far-Western						
Mountains	426.4	194.4	77.6	208.0	–	87.9
Hills	1,020.3	503.0	64.2	455.2	13.0	1,360.4
Total	1,446.7	697.4	141.8	663.2	13.0	657.3
Total for Mountains	897.7	356.5	157.9	570.0	43.3	635.3
Total for Hills	3,152.9	1,690.0	323.2	2,270.8	180.4	5,703.0
Total for Mountains and Hills	4,409.6	2,052.5	481.1	2,840.8	223.7	6,338.3

Sources: Nepal [1980].
APROSC [1979].

TABLE 3.2
LIVESTOCK POPULATION FOR THE HILLS AND MOUNTAINS, PRESENT AND PROJECTED

Livestock	1966/67	1979/80	1984/85	1989/90	1994/95	1999/2000
	('000 heads)					
Cattle	3,965	4,050	4,151	4,255	4,363	4,472
Buffalo	2,487	2,053	2,104	2,194	2,250	2,306
Sheep	3,212*	481	493	505	518	521
Goat		2,841	2,955	3,073	3,198	3,328
Pig	-+	224	230	236	243	248
Poultry	-+	6,338	6,845	7,393	7,984	8,580

Notes: *Refers to sheep and goat.
+Data not available.

Livestock Products

Demand

An attempt has been made to project the minimum requirement for meat, milk and egg up to the year 2000. The United States National Research Council (USNRC) recommends that 1 gram of protein should be consumed daily per kilogramme of body weight and that 50 percent of this protein should be animal protein. Since the average body weight of the Nepalese is 45 kilogrammes, 22.5 grams of animal protein are required, per person per day. The Food and Agriculture Organization of the United Nations (FAO) states that a diet with only 50 percent of the required animal protein can be considered satisfactory. Based on these assumptions and recommendations, 11.25 grams of animal protein are used for our projections.

Assuming that the animal protein contents of meat, milk and egg are 22, 35 and 15 percent, the per capita annual requirements for these food items are calculated at 8.0 46.9 and 84.0 kilogrammes respectively. The projected demand, based on minimum requirement and population trends is shown in Table 3.3.

TABLE 3.3
MEAT, MILK AND EGG REQUIREMENT

Item	1970	1980	1985	1990	1995	2000
Meat ('000 tonnes)	56.4	68.2	75.2	83.0	91.7	101.2
Milk ('000 tonnes)	331.5	400.8	442.2	488.1	538.8	594.8
Egg (million)	596.3	720.9	795.5	878.0	969.1	1,069.8

Milk Production and Projections

Estimates of two levels of production — high and low are presented in Table 3.4 for the next twenty years. The high level production estimates are based on 40 percent of the adult cows and 55 percent of adult buffalo cows being in lactation, whereas the low estimates are based on 30 and 50 percent respectively; 32.7 percent of the cattle population and 53.3 percent of the buffalo population are estimated to be adult females. Annual milk production is assumed at 165 and 450 litres per cow and buffalo cow respectively.

The total milk production of the Hills and Mountains in 1980 is estimated at 346,000 tonnes at the high level and 312,000 tonnes at the low level; 25 percent of this milk is from cattle while the rest is from buffalo. Approximately 111 and 100 millilitres of milk are available per person per day at high and low levels respectively. In the year 2000, the total milk production is projected at 378,000 and 348,000 tonnes at the high and low levels respectively. The milk available per person per day will fall to 84 and 75 millilitres at these two levels.

Meat Production and Projections

As a basis for estimating meat production, the off-take rates of the buffalo, sheep/goat, pig and poultry are assumed to be 10, 30, 50 and 75 percent respectively. The average carcass weight of 100, 10, 25, and 0.5 kilogrammes are used in the projections.

TABLE 3.4
ESTIMATED MILK PRODUCTION

Milk	High level					Low level				
	1980	1985	1990	1995	2000	1980	1985	1990	1995	2000
Cattle milk (tonnes)	87	90	92	94	97	77	78	80	83	84
Buffalo milk (tonnes)	259	265	276	284	291	235	241	252	258	264
Milk per person per day (ml)	111	103	97	90	84	110	102	96	81	75

Source: UNDP/FAO [1975].

It is estimated that meat production in 1980 in the Hills and Mountains was 35,800 tonnes of which 82 percent came from the former and 18 per cent from the latter (Table 3.5).

Given the trend in livestock numbers, meat production is expected to increase by 1,000 tonnes in the Mountains and by 4,300 tonnes in the Hills by the year 2,000. However, the quantity of total meat available for consumption per person per day would decline from the present level of 11.0 to 8.9 grams. Buffalo contributes to about 57 percent of the projected meat production (Table 3.6). The estimated increase in production is the result of livestock population growth, while productivity per animal is assumed to remain constant.

TABLE 3.5
MEAT PRODUCTION BY ECOLOGICAL ZONE

Ecological zone	1980	1985	1990	1995	2000
	('000 tonnes)				
Mountains	6.5	6.8	7.1	7.3	7.5
Hills	29.3	30.2	31.4	32.7	33.6
Total	35.8	37.0	38.0	40.0	44.1
Meat per person per day (gm)	11	11	10	10	9

Sources: UNDP/FAO [1975].
World Bank [1979].

TABLE 3.6
MEAT PRODUCTION BY TYPE OF LIVESTOCK

Livestock	1980	1985	1990	1995	2000
Buffalo	20.5	21.0	21.9	22.5	23.0
Goat	8.5	8.9	9.2	9.6	10.0
Sheep	1.5	1.5	1.5	1.6	1.6
Pig	2.8	2.9	3.0	3.1	3.1
Poultry	2.5	2.7	3.0	3.2	3.4
Total	35.8	37.0	38.6	40.0	41.1

Sources: Nepal [1980].
Nepal [1980a].
World Bank [1979].

Egg Production

Laying hens are estimated to be 40 percent of the poultry population and on an average produce around 42 eggs per bird per year. Trends in egg production are presented in Table 3.7.

TABLE 3.7
EGG PRODUCTION

Egg	1980	1985	1990	1995	2000
Total production (million)	106.5	115.0	124.2	134.1	144.2
Eggs per person per year	12.5	12.2	12.0	11.9	11.4

Availability of Livestock Products

The present availability of meat, milk and eggs is only 50.4, 86.4 and 14.8 percent of the assumed minimum requirement and it indicates a downward trend (Table 3.8).

TABLE 3.8
RELATIVE AVAILABILITY OF LIVESTOCK PRODUCTS

Livestock production	1970	1980	1990	2000
		(% requirement)		
Meat	51.0	50.0	46.5	40.6
Milk	102.2	86.4	75.5	65.4
Egg	*	14.8	14.2	13.5

Note: *Data not available.

The projected decline in relative availability per capita stems from the following factors:

(1) a human population growth rate of 2.2 percent in the Hills and Mountains;
(2) a cattle population growth rate of only 0.17 percent over the past 13 years;
(3) a declining buffalo population;
(4) deterioration in feed sources such as open grazing land, steppe land and forest;
(5) rampant parasitic infestation such as liver fluke; and

(6) ineffective government efforts to promote livestock development and to provide veterinary services.

The infrastructure established for livestock production over the last three decades, and the proposed programme from 1980 to 1985 are summarized in Table 3.9. The technology developed for livestock production is still in its infancy, and the projects carried out are too low in intensity, too small in coverage and too inadequate in magnitude to address to the needs of the Hills and Mountains.

TABLE 3.9
INFRASTRUCTURE FOR LIVESTOCK PRODUCTION

Item	Up to 1960	1960–1975	1975–1980	1980–1985
Animal health				
Number of veterinary hospital	1	21	21	75
Number of veterinary dispensary	3	15	16	16
Number of veterinary checkpost	–	2	2	4
Vaccine production laboratory	–	1	1	1
Disease investigation laboratory		1	1	1
Livestock farm				
Mixed farm	2	3	3	3
Poultry farm	1	1	1	4
Sheep farm	1	2	3	4
Goat farm	–	–	1	2
Pasture unit	–	2	2	2
Yak farm	–	1	2	2
Calf rearing unit	–	–	–	3
Artificial insemination centre	–	1	1	1
Artificial insemination subcentre	–	11	31	50
Intensive livestock extension centre	–	–	17	22
Manpower				
High level	13	74	117	341
Middle level	38	260	324	2,160

Feed Resources

Feed Requirement

There is an acute shortage of livestock feed in the Hills. The feed from crop residue, fodder trees, forest and rangeland is inadequate, and its quality so poor that it cannot meet the nutritional requirement of the livestock population [World Bank, 1979].

Constant dietary deficiencies have far more adverse effects on production than all the animal diseases put together.

The feed requirement for ruminant livestock in the Hills is estimated at 5.6 million tonnes of total digestible nutrient (TDN), and it will increase to 6.2 million tonnes by the year 2000 (Table 3.10).

TABLE 3.10
FEED REQUIREMENT IN TOTAL DIGESTIBLE NUTRIENT FOR RUMINANT LIVESTOCK*

Livestock	1966/67	1980	1985	1990	2000
			('000 tonnes)		
Cattle	2,974	3,042	3,119	3,198	3,361
Buffalo	2,611	1,949	1,998	2,049	2,154
Sheep	88	91	93	95	100
Goat	495	520	541	563	610
Total	6,168	5,602	,751	5,905	6,225

Notes: *TDN requirement for 1979/80 is calculated on the basis of liveweight and performance. The projections for the rest of the years are based on population growth.

Total TDN requirement per livestock unit is 751,950, 188 and 183 kilogrammes per head for cattle, buffalo, sheep and goat respectively.

The feed requirement for large ruminants is eight times greater than those for small ones and constitutes 89 percent of the total. For unproductive cattle it is much more than for the entire buffalo, goat and sheep populations combined. The TDN requirement for animals in the Hills is about four times that of the Mountains (Table 3.11).

Feed Availability

At present 3 million tonnes of TDN are available; this corresponds to only 54 percent of the requirement for adequate nutrition. Furthermore, this percentage is projected to decline to 43 percent by the year 2000 (Table 3.12).

Green fodder of adequate quality is generally available in sufficient quantity from June to September each year. In the dry season, animals are fed submaintenance rations and are virtually in a semi-starved condition for a period of seven months. Thus malnutrition over two-thirds of the year miserably reduces the animals' condition and adversely affects production.

TABLE 3.11
TOTAL DIGESTIBLE NUTRIENT REQUIREMENT FOR THE HILLS AND MOUNTAINS, 1980

Livestock	TDN requirement		
	Mountains	Hills	Total
	('000 tonnes)		
Cattle	673	2,369	3,042
Buffalo	339	1,610	1,949
Sheep	30	61	91
Goat	104	416	520
Total	1,146	4,456	5,602
%	20	80	100

TABLE 3.12
FEED AVAILABILITY IN TOTAL DIGESTIBLE NUTRIENT FOR RUMINANTS

Availability	Years				
	1970	1980	1985	1990	2000
	('000 tonnes)				
Feed requirement for adequate nutrition	6,168	5,602	5,751	5,905	6,225
Feed available	3,308	3,014	2,918	2,876	2,660
Availability as percent of requirement	53.6	53.8	50.7	48.7	42.7

Sources of Feed

At present, the rangeland supplies 34 percent of the total feed. This is followed in importance by cropland, forest and wasteland, but forage availability is projected to decline from all sources other than cropland (Table 3.13).

Cropland

Crops provide residue and byproducts such as stubble, grass and weed from maize, millet, rice and winter field crops, and from terrace risers and bunds. Fodder trees found around homesteads and weed on fallow land also furnish digestible nutrient. At present, cropland contributes 28 percent of the total feed.

It will remain as the main source of feed unless intensive pasture development programmes are implemented in the Hills and Mountains. By the year 2000, cropland is

expected to provide one and a half times more feed than the entire combined forest and open grazing land.

The cultivation of fodder crops in the Hills and Mountains is still an unknown practice. Large ruminants are dependent mainly on crop residue while small ones are left to graze. Paddy straw and maize stalk are the main crop residue available (Table 3.14).

TABLE 3.13
SOURCES AND QUALITY OF LIVESTOCK FEED

Feed	Years				
	1970	1980	1985	1990	2000
Total TDN ('000 tonnes)	3,306	3,014	2,918	2,876	2,660
Percentage from:					
Cropland	27	28	31	33	39
Rangeland	35	34	33	30	28
Forest	22	23	21	20	17
Wasteland	16	15	15	16	16

TABLE 3.14
COMPOSITION OF CROP RESIDUE IN TOTAL DIGESTIBLE NUTRIENT SUPPLIED

Crop residue	% TDN
Paddy straw and bran	42.3
Maize stalk and cob	33.6
Wheat straw and bran	10.6
Millet straw	9.9
Others	3.6

Only about 30 percent of the wheat straw is utilized, the rest is either left in the fields after harvest or used for roofing. The introduction of chaffing practices could increase its utilization for feed. Most of the millet straw is fed to dry animals just after harvest, but its utilization is low because the leafy portion is small and the stem is woody. Maize stalks are fed green from July through September every year and dried during the winter.

Up to 24 percent of cultivated land in the Hills and Mountains is estimated to consist of terrace risers and bunds, and this area provides a significant amount of green fodder [Shah, 1979; Shah, 1980]. There is a potential for increasing forage production by using terrace risers and bunds for grass and legume production. Forage cultivation is an unknown practice.

Fodder trees are the only source of green matter during the dry period from October to June. Postharvest grazing is common, but grazing in lowland areas (paddy fields) causes parasitic infestation, especially liver fluke.

Forest

Forests are subjected to heavy grazing pressure at all elevations. They provide leaf fodder, grass and weed which are cut and carried. At present, they contribute to 23 percent of total feed but this is declining over time as the forest land decreases in area and productivity. About 50 percent of the forest area is grazed throughout the whole year. The lack of feed resources in the Hills and Mountains has left farmers no alternative but to extensively utilize such land for grazing.

Even a slight increase in livestock population will adversely affect forest resources. Forest land itself is fast disappearing in the Hills and the ecology has changed from full forest canopy to scattered trees. Its fodder productivity is comparatively low. The regeneration of useful plants and fodder trees is negligible, and weeds are replacing them. The present carrying capacity of livestock units per hectare is only 0.31 in hill forest, but the current stocking rate is nine times more than this level. The carrying capacity is estimated to decline by approximately 1.25 percent per year [Shah 1979].

Rangeland

Rangeland constitutes about 15 percent of the land area in the Hills and Mountains and provides 34 percent of the total feed. It consists of Alpine meadow, steppe, and open grazing land in the Hills (Table 3.15).

TABLE 3.15
RANGELAND PRODUCTIVITY IN 1980

Rangeland*	% of area	Livestock units ('000)	Area ('000 ha)	TDN (tonnes/ha)	Carrying capacity of livestock units (/ha)	Present stocking rate of livestock units (/ha)
Alpine meadows	57	1,059.4	994.2	1.54	1.42	0.64
Steppe	10		183.8	0.06	.01	0.19
Open grazing	33	4,117.8	582.7	.58	0.54	7.07

Note: *In the Hills and Mountains of Nepal, livestock is not confined to grazing land, hence data on stocking rates overestimate the density of livestock population. Moreover, the feed requirement has not been adjusted for the small size of the indigenous livestock.

Alpine meadows. Situated between 3,600 to 5,400 metres above the tree line in the high Himalayan range, they make up about 57 percent of the total rangeland. The vegetation and pasture are of two main types — dwarf shrubland of *Juniper* rhododendron and

berberis with low productivity and little grazing value, and steppe with short tussock grass and shrub, with *festuce* and *agropyron* as the predominant grass species of high grazing value [Van Swindern, 1978]. This native grassland is the main grazing area for the sheep, goat, yak and chauri (cross between yak and cattle). This pasture has short growing seasons and is generally grazed from June to October. The carrying capacity is estimated at 1.42 livestock units per hectare.

About 80 percent of the sheep, 40 percent of the goat, and 23 percent of the cattle population of the Mountains graze in Alpine meadow for 4–5 months of the year. These areas seem to be undergrazed and only about 45 percent of the highly productive pasture is being utilized. However, in some areas, pasture has been overgrazed and desirable grasses are gradually replaced by nonedible weed. Rotational grazing and partial reseeding at lower elevations could substantially increase the carrying capacity.

Steppe. This constitutes about 10 percent of the total rangeland and is found in the Dolpa-Mustang region of the Trans-Himalayan zone where rainfall drops to 200 millimetres, and spiny dwarf shrub dominates the vegetation. Continuous dry winds and high solar radiation with very little or no cloud interception increase the evaporation rate and result in very little moisture being made available for plants. Consequently, the ground cover vegetation is very poor.

The carrying capacity is estimated at 0.06 livestock unit per hectare, but the actual stocking rate is over three times the carrying capacity. The *Pashmina* goat is the main grazing animal.

Open grazing land. This makes up about 33 percent of the total rangeland area. It is scattered in patches over large areas from the subtropical to the cool temperate zone. Much of the open grazing land is the product of an ecosystem brought about by human activities. Excessive forest grazing, clearing area for cultivation, burning and tree-felling for fuel and timber have converted scattered forest or scrubland into open grazing land. The grasses are of tropical origin and legume species are absent. The carrying capacity is estimated at 0.54 livestock unit per hectare, but the present stocking rate is about 13 times more than this. The tremendous pressure of grazing animals gives little chance for regrowth and regeneration. Palatable species have given way to nonedible weed such as *eupatorium* and *rumex*. The burning of open grazing land has become a common practice and has reduced the chances for the natural reseeding of desired species. The growth pattern is seasonal and is only productive from May to October. Grazing land is usually converted into terraces. If the present trends are not reversed, the carrying capacity of rangeland will decline to a level of 0.42 livestock unit per hectare by the end of this century.

The improvement of such grassland will not be effective unless both the land use pattern and land tenure system are changed. Viable and functional institutions for the management of forest and pastureland existed in the past, but they disintegrated with nationalization of common property resources. Grassland and wasteland improvement could be based on a system that integrates forest and pasture management, but there is a lack of technology in this field at the present time.

Productivity

The productivity of livestock in the Hills and Mountains is in continuous decline as demonstrated by the pronounced downward trend in such production parameters as prolongation of the first breeding age, long calving and lambing intervals, and low fertility rates.

The entire ruminant livestock population consists of indigenous breeds which have adapted to low levels of nutrition. Their production possibilities have not been fully

explored. Shah [1980] reported a large variation in production parameters such as milk yield and calving interval in indigenous cattle and buffalo in the Phewatal area; the milk production of the buffalo averages 460 litres, with a range from 128 to 785 litres per lactation of 275 days. At the Pokhara Livestock Farm in the Hills, improved feeding and management have increased its milk production from an average of 485 to 671 litres per lactation of 300 days [Shah, 1975]. Rajbhandary *et al.* [1973] reported an average milk production of 510 litres per lactation of 277 days for local cows under improved feeding and management at the Khumaltar Farm. These results indicate the potential of indigenous breeds.

Given the present level of productivity and land use pattern, the Hills and Mountains of Nepal could efficiently maintain 2.78 million livestock units. Therefore, the current 5.2 million units are posing an excessive burden on the land, and this will increase to 5.8 million by the end of the century (Table 3.16).

The increasing livestock population will either destroy the natural resources in its search for food or destroy itself through declining productivity and degeneration, or it will continue to adapt to the prevailing deteriorated environment in such a way that any livestock improvement programme will have little long-lasting effect. Obviously, the livestock population, and especially the number of cattle have to be drastically reduced.

TABLE 3.16
FEED RESOURCES AND SUSTAINABLE LIVESTOCK POPULATION

Item	1980	1990	2000
Percent feed available to meet the assumed requirement	53.8	48.7	42.7
Total livestock units, present and projected ('000)	5,177	5,498	5,845
Number of livestock units that the land could carry ('000)	2,785	2,678	2,496
Excess burden of livestock units ('000)	2,392	2,820	3,349

Recommendations

The declining trend in the livestock production of Nepal's hill and mountain regions is due to:

(1) diminishing feed resources;

(2) poor health measures;

(3) low productive capacity of indigenous stock;

(4) a livestock development programme of nominal magnitude and coverage, with only vague ideas about directions, objectives and priorities, and with insufficient innovations and techniques;

(5) poorly developed delivery systems for available technology; and

(6) an inappropriate land use pattern.

Livestock production problems differ in type and magnitude between ecological zones, and there is a strong need for separate livestock production technologies for each zone. Livestock development institutions should be given the resources that will enable them to generate appropriate technology. The priority areas for livestock development should be determined.

The upper Hills are a high priority zone for the development of cattle, goat and sheep enterprizes, while yak, chauri and sheep development should be focused on the Mountains. In the lower Hills emphasis should be given to the buffalo, cattle, poultry, goat and pig.

To have any positive impact on the hill economy, any proposed livestock project must be of such magnitude and coverage that it will counter the adverse effects of (i) human population growth, (2) excessive ruminant population, (3) vegetative and environmental degradation and deficit feed resources, and (4) parasitic infestation and disease.

The first phase of a livestock production programme for Nepal's Hills and Mountains must assign importance to (1) development of resources, (2) animal population planning to relieve the burden of 2.2 million livestock units, (3) mass control of animal parasites, and (4) delivery systems for appropriate technology. The second phase must be one of technology generation and extension. In the upper Hills, livestock production should be integrated with resource conservation programmes, and in the lower Hills with crop production programmes.

The following measures should be adopted to improve feed resources:

(1) management of Alpine and steppe rangeland;

(2) conversion of open grazing land and wasteland into productive grassland in the Hills and Mountains accompanied by community pasture development;

(3) integrated forest and pasture development;

(4) introduction of leguminous forage crops; and

(5) efficient utilization of crop residue.

REFERENCES

APROSC. 1979. *Mahakali Rural Integrated Development Project Draft Feasibility Report.* Kathmandu: Agricultural Project Services Centre.

Nepal. 1980. Unpublished reports. Kathmandu: Central Bureau of Statistics.

Nepal. 1980a. *Agricultural Bulletin.* Kathmandu: Department of Food and Agricultural Marketing Services.

Rajbhandary, *et al.* 1973. "Milk Production in Local and Crossbred Cows". *National Livestock Seminar -- Kathmandu, 1973.*

Shah, S.G. 1975. "Livestock Development Farm Report" *Regional Agricultural Seminar -- Pokhara, 1975.*

Shah, S. G. 1979. *Range Management and Pasture Production: A Survey and Programme Paper.* Kathmandu: Resource Conservation and Utilization Project.

Shah, S. G. 1980. *Animal Husbandry and Feed Resource System in the Phewatal Watershed.* Kathmandu: United Nations Development Programme.

UNDP/FAO. 1975. *Livestock Development Survey.* Kathmandu: United Nations Development Programme.

Van Swindern, H. 1978. *Terminal Report of the Pasture and Fodder Technical Report.* Kathmandu: United Nations Development Programme.

World Bank. 1979. *Nepal Agriculture Sector Review.* Washington, D. C.

4
Potential Impact of Desirable Changes in Relation to Productivity and Income in Hill Farming Systems

P.N. RANA and S.B. MATHEMA

Introduction

In Nepal, food cultivation and livestock raising have been the two main interrelated activities in hill farms for many generations. Due to the wide climatic variations in the Hills, farmers also grow many types of fruits and vegetables. They operate their farms with numerous other enterprizes which are suited to a particular location, district or region. The farming system changes both within and across physical environments depending on the resources available to the farmer and the needs of his family. These are again subjected to agro-climatic requirements, economic feasibility and social acceptability.

The cropping systems programme which is a part of the activities of the Integrated Cereals Project (ICP) was started in early 1977 with the aim of increasing total food production and improving farmers' income by:

(1) multiple cropping; and

(2) increasing crop yield.

This programme is devoting its efforts primarily on developing an understanding of hill farming systems as practised by farmers at these sites. It is felt that a knowledge of the farmers' existing practices and the reasons behind their adoption will help in the identification of practical and acceptable means of improving hill farming and thereby expanding agricultural production and farmers' income.

From 1977 to 1980 (except in Ratnanagar, where the programme commenced in 1980), the programme has worked directly with farmers in six sites, namely:

(1) Pumdi Bhumdi in the Western Region;

(2) Khandbari in the Eastern Region;

(3) Lele in the Kathmandu Valley;

(4) Chauri Jahari in the Far-Western Region;

(5) Langari, Dhobini, Suckchaina and Lipani Birta in the Tarai; and

(6) Ratnanagar in the Inner Tarai.

It is important to note that all except Langari, Dhobini, Suckchaina, Lipani Birta and Ratnanagar are in the Hills. These sites are selected as representative of the agro-climatic zones of Nepal and the results obtained in this study can be extrapolated to similar areas.

Research is also carried out to:

(1) identify improvements in the farmers' existing cropping systems which will result in higher yield;

(2) determine if this increase in yield will result in substantial gains in income, given current input cost and the prevailing price of farm products; and

(3) create employment opportunities for surplus labour.

In this research programme, efforts are made to obtain the farmer's direct involvement. He becomes a collaborator and helps to select variables for testing and participates in the evaluation of his own and his neighbours' trials. His judgement is utilized in determining the acceptance of the new technology and the package of cultural practices.

The data and information described in this paper are collected from various sources including the results from other development projects conducted earlier. Most of it however, is derived from farm surveys carried out under the cropping systems research programme. The number of farmers interviewed and samples collected in these surveys are shown in Appendix 4.1. A description of the 5 sites involved in this study is shown in Appendix 4.2. The information on horticulture, sericulture, beekeeping, livestock and soil conservation is based on secondary data collected from various sources.

The main objectives of this paper are to:

(1) describe the general situation existing in the hill cropping systems sites used in this study;

(2) show the potential increase in yield which can be achieved by improved cultural practices and cropping patterns;

(3) compare income under farmers' existing technology with income under improved technology;

(4) demonstrate the desirable changes in productivity and income with the production programme using improved technology;

(5) show the benefits from improved horticulture, animal husbandry, sericulture and beekeeping practices; and

(6) show the constraints that have been identified against achieving higher yield.

Desirable Changes in Productivity

Productivity is measured by expressing output as a ratio to the amount of input required to produce it, or by expressing the change in output as a ratio to the change in the amount of input used. It can be land or labour productivity. Land productivity is the output per unit of cropped area and is measured as follows:

$$P_L = \frac{\Sigma_j \Sigma_i q_{ij}}{\Sigma_j L_j}, \text{ where}$$

P_L = land productivity,

q_{ij} = output of the *i*th crop grown by the *j*th farmer.

L_j = the size of the net cultivated land of the *j*th farmer.

Similarly, labour productivity is the output per unit of labour used.

Results from cropping systems trials show a very high potential for increasing production. Yield increase can be achieved by changing some of the components such as variety and/or practices in the cropping pattern. Table 4.1 shows the crop yield under the farmers' own practices and by using improved technology in four hill cropping systems sites.

In studying existing and alternative cropping patterns, all available improved varieties of rice, wheat, maize, millet, lentil, soybean and chickpea have been evaluated. Pest control and agronomic practices, mainly planting method, seed rate and fertilization have also been tested in farmers' fields. Emphasis has been given to evaluate the effect of improved agronomic techniques at different levels in such a way as to identify those techniques which would demand a low cash investment. The agronomic and economic evaluation of the results obtained at the different cropping systems sites indicate that some of the agronomic practices tested in the farmers' fields are economically and technically viable and are attractive to local farmers.

When the yield data of the two different situations for all the sites are compared, it is apparent that there is a tremendous increase in yield using the improved technology. The yield data of farmers' own practices are based on the cropping systems survey and crop cutting test, whereas those using improved technology are based on the crop cutting test of agronomic trials. In the maize-millet-wheat pattern in Pumdi Bhumdi, there is more than a 300 percent increase in maize and wheat yield. The varieties used are *khumal yellow* and *RR 21* respectively. The local millet variety is used in both cases. Similarly, in the rice-wheat-maize pattern, there is a significant increase in the rice, wheat and maize yield. A doubling of rice yield is achieved when compared with existing practices. The variety used is *Taichung 176*. A similar trend is observed at other sites. These results indicate that substantial yield increases can be achieved by changing the variety grown, applying moderate doses of fertilizer and improved practices in both land types with different cropping patterns.

Table 4.2 indicates that the rice yield varies from 1.6 to 1.9 tonnes per hectare under existing farm situations. With improved technology, the yield ranges from 2.6 to 3.5 tonnes per hectare. Rice production can be increased by 64,83,123 and 78 percent in Pumdi, Bhumdi, Lele, Chauri Jahari and Khandbari respectively. These potential increases are calculated on the basis of the total cultivated area available in the *Panchayats* and the potential crop yield at each site. With this increase, farmers will realize considerable economic benefit from their production provided reasonable prices for their products prevail. Similar trends are observed for other crops such as wheat, maize, millet and lentil. The average yield of wheat under the farmers' existing situation is 1.07 tonnes per hectare which can be increased to 3.21 tonnes per hectare with improved methods. Wheat production can be raised using the new technology in the Pumdi Bhumdi, Lele, Chauri

TABLE 4.1
CROP YIELD OF PREDOMINANT CROPPING PATTERNS UNDER FARMERS' AND IMPROVED TECHNOLOGY, 1980

Land type	Combinations of cropping patterns	Pumdi Bhumdi		Lele		Chauri Janari		Khandbari	
		F	I	F	I	F*	I	F	I
Upland	Maize	1,191	3,700	1,141	4,000	0	0	786	4,200
	Millet** (R)	1,358	1,358	0	0	0	0	700	700
	Wheat	765	2,500	0	0	0	0	0	0
	Soybean (M)	0	0	12	470	0	0	0	0
	Mustard	0	0	185	410	0	0	0	0
Total		3,314	7,558	1,452	4,880	0	0	1,486	4,900
Lowland	Rice	1,782	2,900	1,801	3,300	1,568	4,000	1,967	3,300
	Wheat	532	2,000	1,114	2,800	1,245	4,800	1,290	3,000
	Maize	839	2,000	0	0	0	0	0	0
Total		3,153	6,900	2,915	6,100	2,813	8,800	3,257	6,300

Notes: *Data based on tentative crop yield from cropping systems survey.

**Millet in this paper refers to finger millet.

R = Relay crop.

M = Mixed with main crop.

F = Farmers' own technology. Data based on cropping systems survey, 1977/78.

I = Improved technology. Data based on cropping systems trial results.

TABLE 4.2
POTENTIAL INCREASE IN CROP PRODUCTION, 1980

Crops	Cropping systems sites	Total cultivated area (ha)	Existing production (1977/78) Yield (tonnes/ha)	Existing production (1977/78) Production (tonnes)	Potential production (1979) Yield (tonnes/ha)	Potential production (1979) Production (tonnes)	Expected increase in production (tonnes)	Percentage increase in production
Rice	Pumdi Bhumdi	640	1.58	1,012	2.60	1,664	652	64
	Lele	205	1.80	369	3.30	677	308	83
	Chauri Jahari	508	1.57	797	3.50	1,778	981	123
	Khandbari	375	1.86	697	3.30	1,238	541	78
Wheat	Pumdi Bhumdi	420	0.65	273	2.25	945	672	246
	Lele	198	1.11	221	2.80	554	333	151
	Chauri Jahari	510	1.25	635	4.80	2,448	1,813	286
	Khandbari	25	1.29	32	3.00	75	43	134
Maize	Pumdi Bhumdi	140	1.19	167	2.85	399	232	139
	Lele	484	1.14	552	4.00	1,936	1,384	251
	Chauri Jahari	388	1.00	388	1.00	388	0	0
	Khandbari	404	0.79	318	4.20	1,697	1,379	434
Millet	Pumdi Bhumdi	140	1.36	190	1.36	190	0	0
	Lele	0	0	0	0	0	0	0
	Chauri Jahari	0	0	0	0	0	0	0
	Khandbari	202	0.70	141	0.70	141	0	0
Lentil	Pumdi Bhumdi	360	0	0	2.95*	1,062	1,062	0
	Lele	0	0	0	0	0	0	0
	Chauri Jahari	14	1.70	24	2.52	35	11	46
	Khandbari	0	0	0	0	0	0	0

Note: *Introduced crop in Pumdi Bhumdi is rice/lentil.

Source: Nepal [1978].

Jahari and Khandbari *Panchayats* by 246,151, 286 and 134 percent respectively. Similarly, the average yield of maize under the farmers' existing situation is 1.03 tonnes per hectare, but it can be raised to 3.01 tonnes per hectare with improved methods.

Main Sources of Household Income

Farmers derive their income from three main sources:

(1) crop production;

(2) livestock; and

(3) off-farm employment.

Based on cropping systems and livestock survey, the data are analyzed to determine the average gross income per farm per year. Table 4.3 indicates that the average gross value of crop production is higher than the average benefit from livestock and the average income from off-farm employment in all sites except Lele. An average farmer in Khandbari with an average farm size of 1.1 hectares, has the highest gross income from crop production, that is, Rs 5,008 per annum, and also the highest gross income per farm per year, that is, Rs 8,249. In Pumdi Bhumdi, the average farmer receives more income from livestock and off-farm employment when compared with other sites. Off-farm employment which generally occurs throughout the year includes jobs in government offices as clerks or peons, teaching, army service, ironmongery, carpentry, road construction, brick-making and portering.

The average gross value of crop production per farm is directly related to farm size, that is, the larger the farm size the more the income from crop production. The average income from off-farm employment is not related to farm size. Livestock provides a significant contribution to household income even in very small farms. The survey results indicate that crops contribute to 47, 61, 40 and 58 percent of gross income in Pumdi Bhumdi, Khandbari, Lele and Chauri Jahari respectively.

Five main reasons are given by farmers for owning livestock. These are:

(1) cash income;

(2) food for household consumption;

(3) draught power;

(4) compost; and

(5) festivals and other occasions.

They are interested in keeping additional livestock on their farms for the following reasons:

(1) to have more cash income;

(2) to obtain animal products;

TABLE 4.3
AVERAGE INCOME PER FARM BY SOURCE, 1979

Cropping systems sites	Farm size (ha)	Gross value of crop production	Benefit from live-stock	Income from off-farm employment	Gross income per farm	Contribution from crops	Percentage Contribution from livestock	Contribution from off-farm employment
		(Rs)						
Pumdi Bhumdi	0.87	3,387	1,776	2,131	7,294	47	24	29
Khandbari	1.1	5,008	1,701	1,540	8,249	61	20	19
Lele	0.54	1,704	695	1,800	4,199	41	17	43
Chauri Jahari	0.65	3,419	1,391	1,075	5,885	58	24	18
Average	0.79	3,380	1,390	1,637	6,407	52	22	26

Source: Nepal [1979].

(3) to provide commodities for household consumption; and

(4) for draught power and compost.

On an average, a farmer with 0.79 hectare of land has a gross income of Rs 6,407 per year; 51.5 percent of this gross income is derived from crops; 21.5 percent from livestock and 27 percent from off-farm employment.

This indicates that livestock and off-farm employment are also contributing significantly to the farmer's household income, especially cash income. Thus, emphasis should be given to improving the whole farm rather than concentrating on a single component of the system.

Potential Increases in Farmers' Income

Numerous cropping patterns exist at each site due to the variability of agro-climatic conditions, land type and farmer's preferences. If a farmer adopts improved technology, there is scope for varying the cropping pattern or land type or both. Based on the predominant cropping pattern for each site, farm plans are developed for each recommended cropping pattern. Returns from farmers' existing technology[1] are compared with the improved method. A large increase in income can be achieved by following the predominant cropping patterns with improved technology[2] (Table 4.4).

Maize/millet-wheat is the most common cropping pattern in upland areas in Pumdi Bhumdi. The gross return and gross margin for this pattern under farmers' existing technology are Rs 3,792 and Rs 1,322 per hectare respectively, compared to Rs 12,031 and Rs 8,048 with improved technology. This is an increase in gross return and gross margin of 217 percent and 509 percent respectively. Millet is excluded from the computations due to the nonavailability of reliable data. Only the local varieties of maize and wheat are replaced by improved varieties. A similar return is observed with the rice-wheat-maize and rice lentil cropping patterns at Pumdi Bhumdi. This indicates that there is tremendous scope in the Pumdi Bhumdi *Panchayat* to increase agricultural productivity and farmers' income.

Three major cropping patterns are predominant in the Khandbari *Panchayat*. They are:

(1) rice-fallow;

(2) rice-wheat; and

(3) maize/millet.

Gross return and gross margin are calculated for both situations for each pattern. Their increase due to improved technology is 78 and 94 percent respectively for the rice-fallow pattern. It is 100 and 130 percent respectively for the rice-wheat pattern. The maize/millet pattern gives an increase of 196 percent gross return due to the adoption of improved methods. Such potential increases also exist in Lele and Chauri Jahari.

[1]Farmers' existing technology -- the term is used for traditional agriculture where the operations, activities and input are based only on farmers' experience gained over time.

[2]Improved technology -- the term is used for modern agriculture, where the knowledge and input generated by research are utilized.

TABLE 4.4
POTENTIAL INCREASE IN GROSS RETURN AND GROSS MARGIN*, 1979

Predominant cropping patterns	Farmers' existing technology		Improved technology		Percentage increase	
	Gross return	Gross margin	Gross return	Gross margin	Gross return	Gross margin
	(Rs/ha/year)					
Pumdi Bhumdi						
Maize/millet-wheat	3,792^{+}	1,322^{+}	12,031^{+}	8,048^{+}	217	509
Rice-wheat-maize	6,689	2,459	12,968	7,169	94	192
Rice/lentil	3,130$^{\neq}$	1,733	14,234	n.a.	355	n.a.
Khandbari						
Rice-fallow	4,457	3,230	7,920	6,257	78	94
Rice-wheat	7,527	4,882	15,060	11,206	100	130
Maize/millet	3,042	– 369^{+}	9,018	4,756^{+}	196	–
Lele						
Maize+soybean–mustard	3,304	– 151"	10,647	4,664"	222	–
Rice-wheat	4,823	603	9,975	4,533	107	652
Chauri Jahari						
Rice+maize–lentil	3,340$^{\neq}$	1,266$^{\neq\neq}$	5,964$^{\neq\neq}$	3,275$^{\neq\neq}$	79	159
Rice-wheat	8,474	1,266**	17,055	4,766**	101	276
Rice+maize–chickpea	9,746	1,266^{++}	15,862	3,275^{++}	63	159

Notes: *Gross return is the total return, while gross margin is the total return less variable cost.

$^{+}$Millet excluded.

$^{\neq}$Lentil excluded in farmers' existing technology.

n.a. Not available.

"Soybean excluded.

$^{\neq\neq}$Maize and lentil excluded.

**Wheat excluded.

$^{++}$Maize and chickpea excluded.

In all sites, the use of improved technology adapted to the farmers' existing combination of crops has resulted in a remarkable expansion of yield. The gross margin ranges from Rs 3,275 to Rs 11,206 per hectare per year. These data are the average figures from trials conducted over a two-year period in small farms managed by the farmers themselves with support and technical supervision from the cropping systems staff.

Arising from results obtained over 3 years, the cropping systems programme is able to recommend a few cropping patterns based on improved technology for each specific location. However, these patterns are not new to the farmer. They are generally existing ones but modified with some improvements. The production programmes based on cropping systems research are being developed with the purpose of improving the existing agricultural subsistence system. Cropping patterns with better technology can be applied on a wider scale at different but similar locations so as to increase agricultural productivity and the farmers' income. To make this effective, the dissemination of on-farm research results to farmers through better informed extension personnel appears to be the key answer.

Yield Constraints

The major constraint to increasing crop yield is the lack of plant nutrient. Farmers classify 56 percent of their parcels as experiencing a shortage of plant nutrient. Chauri Jahari farmers, for example, face greater problems of nutrient deficiency than those from other sites, that is, 79 percent of the parcels are classified as having serious nutrient deficiencies. Lele, Pumdi Bhumdi and Khandbari face similar but less severe constraints (Table 4.5).

Another serious constraint is the lack of irrigation water. Forty-two percent of the parcels lack water to step up production. Sixty percent of the parcels surveyed from Chauri Jahari also lack water. The same problem exists in Pumdi Bhumdi, Lele and Khandbari. Insect and pest attacks are also common to farmers at all the sites. On an average, 35 percent of the parcels are confronted with insect and pest infestation.

Before the introduction of the pilot production programmes, a farm survey was conducted to access farmers' reaction to the recommended technology. The survey results indicate that they were in favour of it, but they mentioned that the main constraint encountered is the absence of knowledge of such technology and of the benefits that can be derived from its usage.

A number of organizational setbacks also surface in the production programme such as co-ordination among extension agencies, the Agricultural Development Bank, Agricultural Inputs Corporation (AIC) and the Department of Food and Agricultural Marketing Services.

Horticulture

Horticultural enterprizes can be more profitable than cereal crops in the Hills. Fruit trees such as the apple, pear and mandarin are reported to produce 25 tonnes per hectare per year. The national average for fruit production is about 6 tonnes per hectare per year. A study in Helambu (a hill station in Eastern Nepal) indicates that after the ninth year fruit trees gave double the economic return per hectare when compared to the potato-radish-barley cropping pattern [Manandhar and Vreeland, 1976]. There is some evidence to suggest that farmers in Helambu are switching over to fruit cultivation because it gives higher return, demands less labour, and helps to prevent soil erosion on steep mountain terraces.

TABLE 4
MAIN CONSTRAINTS FOR INCREASING YIELD,* 1977/78

Cropping systems sites	Lack of water	Lack of plant nutrient	Problem of insect and/or pest	Lack of labour and/or bullock	Problem with cattle grazing	Lack of money	Problem of too much water/flood	Due to high wind and bad weather	Shade and cold water	Miscellaneous*
Pumdi Bhumdi	41	53	35	11	0	0	4	0	0	12
Lele	33	55	19	7	0	11	0	0	6	32
Chauri Jahari	60	79	21	2	1	5	0	0	0	2
Khandbari	32	35	66+	5	8	0	0	3	0	3
Average≠	42	56	35	6	2	4	1	1	2	12

Notes: *Includes the lack of improved seed and hail.

+Includes the problem of wild animals.

≠Since farmers generally reported more than one constraint, the total percentages in a row may exceed one hundred.

Source: Nepal [1978].

Due to the diverse agro-climatic conditions prevailing in the Hills, there is tremendous scope for vegetable growing. But hill farmers are not well acquainted with this technology, and especially with vegetables which can only be grown in the highlands. Potato is the major food crop of the high Hills and 20 percent of the hill population depends on it as a staple. In terms of production of protein per hectare, it outranks all other grain crops. In some of the cropping systems sites, it is included as an important vegetable crop. An improved variety called *Kufri Joti* was introduced in the maize/millet-potato pattern in the upland areas of Pumdi Bhumdi.

Apple Cultivation in the Hills

Apple is considered as one of the most profitable fruit crop. It can be grown in various hill districts of Nepal and it performs well at a height of 1,820 to 2,730 metres above sea level in regions where there is low rainfall. Despite the vast potential area available for apple cultivation, it is currently being grown on a commercial scale only in Solukhumbu, Helambu (Sindhu Palchowk District), Jumla and Mustang, and Rasuwa districts. The total number of trees in these districts is 51,000, 35,000, 20,944 and 3,863 respectively. It is estimated that 25 percent of them are in production.

The cost of establishing a hectare of apple orchard is estimated at Rs 17,700. After year 6, it will cost less than Rs 3,000 per year. Income from it will only commence after year 5, but by year 9 it will be possible to recoup the money invested. After year 10, the income will exceed Rs 25,000 per year.

When compared with other crops, apple cultivation after the tenth year gives 18, 3, 3 and 2 times more return than barley, wheat, radish and potato respectively. Additionally, crops such as the potato, radish and the pea can be intercropped with apple trees during the early years. A suitable climate, significant profit and the high demand for apple saplings have attracted hill farmers to apple growing. However, with production increase every year, transportation to markets becomes more and more difficult.

The Fruit Development Division is now trying to promote the planting of walnut and other light but more profitable fruits in the Hills. However, farmers continue to demand for more apple saplings.

Vegetable Seed Production

After the establishment of the Vegetable Development Division in 1972, potential areas for vegetable seed production were identified. They included the Marpha area of the Mustang district, the Rukum district, the Dadhikot area of the Bhaktapur district and Dhankuta district. All of them are situated in the Hills. The first farmer-level vegetable seed production programme was started in the Marpha area in 1975. In the Rukum district, the programme began in 1979.

Vegetable seed production in farmers field is a very important project for the country and it is also profitable for farmers. They gain more from it than from the cultivation of traditional crops. The most profitable seeds to produce are those of the cauliflower, cabbage, radish and onion. They receive facilities such as short training and technical supervision from government farms. Farmers are known to be able to obtain a very high net return of Rs 24,000 per hectare from producing onion, radish, cauliflower and cabbage seed.

Major Constraints for Horticultural Development

Horticultural development in Nepal has not made significant progress because of the lack of a good transportation network, a guaranteed market, technical knowledge and

storage facilities. Adequate technology for future follow-up programmes is also absent, and the majority of fruit trees are either having low productivity or are dying.

The following are some of the major constraints of horticultural development:

(1) absence of appropriate technology that will support the horticultural enterprize;

(2) absence of an organized market and grading facilities;

(3) poor transportation facilities;

(4) absence of storage and processing facilities;

(5) natural hazards such as hails and storms in certain regions;

(6) lack of a sound research and development base; and

(7) lack of good vegetable and potato seed.

Sericulture and Beekeeping

The mid-Hills of Nepal are suited to sericulture. Mulberry plants can be grown even on steep slopes as their deep roots aid in soil conservation. Widespread mulberry cultivation for sericulture will also help to solve the firewood crisis in the Hills since regular pruning of the trees is essential prior to feeding the leaves to the silkworm. One hectare of mulberry cultivation for sericulture produces a net income of Rs 7,000 to Rs 12,000 per year. Some experimental and production work is being undertaken by the sericulture farm at Khopasi, near Kathmandu Valley.

In addition to sericulture, beekeeping can be introduced as an income-generating activity in the Hills. Farmers are at present practising the traditional method of beekeeping. They need assistance to adopt modern technology in this field which will enable them to increase their income.

Livestock

The majority of livestock in the Hills are of local breed and are poor yielders. The most common animals are cattle, sheep and goat. The buffalo is kept for milk purposes only, as it is not suited for draught on the slopy and rugged mountainous terrain. Most hill farmers rear some cows, bullocks and buffaloes. During the day, they graze on the slopes of pasture and forest land. Animal feed is supplemented by straw and leaves, especially during the winter months when its scarcity is acute.

Feed stuff supplied by pasture, forest and wasteland grazing, and by crop residue and fodder trees is usually in short supply. Natural grazing grounds exist in the Hills and alpine areas but the sward conditions are poor. They are often overrun by weed and brush or suffer from serious soil erosion due to overstocking and overgrazing.

Pasture and fodder development work has been initiated at Khumaltar, Jiri, Pokhara and Lumle, and fresh weight yields of 70 tonnes per hectare have been achieved with the use of improved methods of cultivation. However, controlled grazing is essential for pasture and fodder development. Without it, any improved species which are being introduced would perish.

Animal manure is one of the most important livestock by-products in the Hills. A socio-economic survey conducted by Conlin and Falk [1979] revealed that raising the amount of manure applied to crops gives a greater return than increasing the amount of labour spent on their cultivation. Its expansion however is limited by the number of domestic animals a farmer can keep because of the short supply of fodder in the Hills. Besides, manure production per animal is determined by the feed intake. The Pakhribas Agricultural Centre proved that the increased production of farmyard manure is possible with stall feeding and the collection of all the manure produced. Moreover, its quality could be improved with storage in covered stone-lined pits.

Soil Conservation

Hill farming is practised on terraced slopes and river valleys. Fields on the northern slopes tend to have richer soil and retain moisture for a longer period than those on the southern slopes which are more susceptible to erosion and rapid drying. Soil erosion is a serious problem in the Hills of Nepal. Virtually all arable land in the Hills is currently being used. Reclamation of virgin lands after deforestation is still in progress. Soil erosion occurs in most parts of the Hills during the monsoon season. Soil conservation should be implemented to prevent it. On a long-term basis, it should receive top priority as it is the most important factor governing hill agriculture in Nepal. Fodder tree planting, reforestation and orchard development will lower the erosion rate. However, minimum or zero tillage, contour farming, proper terracing, better management of irrigation water, mixed cropping and relay cropping should receive higher priority in hill cropping systems.

Recommendations

In order to improve the economic conditions of hill farmers, planners and policy-makers should take the following recommendations into consideration:

(1) A knowledge of existing farming practices will be a stepping stone to the identification of feasible and acceptable means of improving the hill farming systems.

(2) Substantial increases in yield can be achieved by replacing crop varieties, applying moderate doses of chemical fertilizer and by adopting improved practices. Agricultural input such as improved seed, chemical fertilizer, insecticide, pesticide, credit and extension services should be made available on time, at proper locations, and in sufficient quantities to ensure the adoption of improved technology.

(3) Production programmes with improved technology should be encouraged and implemented in hill areas with agricultural potential. They should be started in areas where the recommended technology is both feasible and accepted by farmers.

(4) Dissemination of results of on-farm research through farmer visits to cropping systems sites, and during meetings with farmers and extension personnel are crucial factors to be taken into consideration. Besides, there should be co-ordination among extension agencies, the Agricultural Development Bank, the AIC and the Marketing Department.

(5) An assured market is a prerequisite for any agricultural enterprize. No matter how good the production programme, farmers will not show any interest in it unless they can dispose of their excess produce. They are unlikely to produce

more unless there are substantial benefits by way of increased food supplies, increased income or both. Farmers should get reasonable returns from the sale of their farm produce for them to benefit from their surpluses, and thereby improve their economic status. In short, there must be a definite pricing policy with guaranteed markets for the additional farm produce.

(6) Requirements for human labour and power for crop intensification by multiple cropping will increase, but the seasonal surplus labour of the Hills should be diverted to off-farm activities. This is possible with the establishment of some small-scale agro-based industries such as fruit canning, vegetable drying and hide tanning.

(7) Due to the lack of transportation and communication facilities the input delivery system is ineffective. The related agencies should actively attempt to improve it.

(8) Irrigation is important for increasing agricultural production. Production programmes should concentrate on those hill areas which are served by irrigation facilities, especially during the winter and dry seasons.

(9) Horticulture is an important component of hill farming. Research should be conducted on mixed-cropping of horticulture with other crops.

(10) An integrated package of practices from planting to harvesting and marketing developed on similar lines as those for the major cereal grains is also needed for major fruits and vegetables which have been identified for cultivation in the Hills.

(11) Emphasis should be placed on the increased production of non-perishable and non-bulky produce, the provision of marketing facilities, and storage and fruit preservation units. Sericulture and beekeeping should be extensively promoted as supplementary enterprizes for hill farmers.

(12) A vegetable seed production programme is appropriate for the Hills and it should be well-organized and expanded for the future.

(13) Increase in livestock products is dependent primarily on the enhancement of feed and fodder supply. Large-scale planting and proper maintenance of fodder trees and good pasture management are needed. Stall feeding should be encouraged while free grazing should be controlled.

Farmyard manure is required in larger quantities to increase the production of agronomic and horticultural crops but its supply is dependent on the greater production of fodder in hill areas.

(14) In the long-term, soil conservation remains the most important consideration. Every production and development programme should accord it the highest possible priority. Any activity which is detrimental to soil conservation should not be implemented.

(15) A farming system approach should be stressed, that is, emphasis should be placed on the development of all the major components of a farming system such as crop, livestock, horticulture and off-farm employment. Focus on only one component will cause imbalances.

Conclusion

Results of cropping systems trials reveal that a very high potential exists for increasing crop production. This potential expansion in the yield of major crops can be achieved by the use of improved technology, that is, by altering the varieties of existing crops, adopting recommended fertilizer levels, disease and insect control, and improved cultural practices.

With expansion in crop yield, farmers will derive economic benefits from their production, provided they obtain a reasonable price for their produce. They obtain their income from various sources, the main ones being from crop production, livestock, horticulture, army pension and off-farm employment. The average gross value of crop production is higher than the average benefit from livestock and off-farm employment in all sites except Lele. Out of the total gross income, 51.5 percent is contributed by crops, 21.5 percent by livestock and 27 percent by off-farm employment.

Based on these results, the cropping systems programme recommended varying cropping patterns in various locations. The technology can be implemented on a larger-scale when multilocation tests at different environments have been completed. Pilot production programmes based on cropping systems research are being developed for the purpose of improving the existing agricultural subsistence system.

Despite these promising results, there are a number of major technical and socio-economic constraints faced by farmers which may slow down the adoption of improved technology. A major technical constraint is the lack of plant nutrient followed by a lack of water, and insect and pest damage. Other constraints include the lack of labour and power during peak periods, lack of money, problems associated with cattle grazing, and climatic problems connected with flood, high wind, bad weather, shade, low temperatures, cold water and hail. Survey results indicate that the main socio-economic constraint is the farmers' lack of knowledge of the recommended technology and of the benefits that can be derived from using it. In addition, there is the organizational problem relating to co-ordination among the various agencies concerned.

A tremendous scope exists in Nepal for growing various kinds of fruits and vegetables due to the availability of diverse agro-climatic conditions. On the whole, fruit cultivation gives higher economic return per hectare than food crops. But not many farmers in the country are undertaking it as a commercial enterprize because of the high cost, the long gestation period and the risk involved.

In the case of vegetable cultivation, potential hill areas for vegetable seed production have been identified. Farmers in these areas are receiving more profit from it than from the cultivation of traditional crops. They are able to obtain a net return of about Rs 24,000 per hectare from vegetable seed production alone.

Some of the major constraints to horticultural development are the absence of appropriate technology and organized market, poor transportation facilities, absence of storage and processing facilities and natural hazards in certain areas.

Most hill farmers rear animals such as the cow, buffalo and bullock. They are prepared to raise more livestock on their farms but are hampered by the limited supply of feedstuff from pasture, forest, wasteland grazing, crop residue and fodder trees. To overcome this, pasture and fodder development work has been initiated in a few locations. Improvement in the quality of manure is another important aspect to be considered.

Appendix 4.1

Number of Farms Surveyed and Crop Cutting Samples

Cropping systems hill sites	Cropping systems survey 1977/78	Livestock survey 1979	Crop cutting sample taken in 1979				
			Rice	Wheat	Maize	Millet	Mustard
Pumdi Bhumdi	82	82	70	34	69	18	4
Lele	74	71	50	39	59	0	11
Khandbari	86	86	85	10	52	0	0
Chauri Jahari	74	74	77	*	0	0	0
Total	316	313	282	83	180	18	15

Note: * Not available.

Appendix 4.2

General Situation of the Sites

Pumdi Bhumdi

Pumdi Bhumdi *Panchayat* lies in the mid-Hills of Western Nepal. The site is located about 8 kilometres west of Pokhara, on the Pokhara-Bhairahwa road. The *Panchayat* lies in the north and south sides of a hill which varies in height from 750 to 1,270 metres above sea level. The average rainfall is about 4,000 millimetres per year. Hail damage is a serious problem for farmers in this area. It generally occurs from February to March and from September to November.

The total population of the *Panchayat* is 5,610. It is estimated that 1,047 families are settled in an area of 25 square kilometres. An average household size of 5 to 6 members subsists on 0.87 hectare of cultivated land. The average family labour available for farming is 3 members.

Maize mixed-cropped with bean followed by a relay crop of millet and a winter crop of wheat, mustard or barley is the predominant cropping pattern in the fertile upland. Survey results show that on the whole, 51 percent of the upland area is devoted to triple cropping, 43 percent to double cropping and only 2 percent to monocropping. In contrast, 55 percent of the lowland area is devoted to a monocrop of rice, 24 percent to maize-rice-winter crop (mainly wheat with some barley and mustard) and 18 percent to rice followed by wheat. The land utilization index (LUI)[1] and the multiple cropping index (MCI)[2] are 56 and 168 percent respectively.

[1] LUI is the number of days the land is utilized expressed as a percentage for the year.

[2] MCI is the sum of cropped areas in a year, divided by the total cultivated area and multiplied by 100. Mixed crops are regarded as one crop and relay crops are regarded as two.

An average family owns 7 heads of livestock composed of 1.70 buffaloes, 0.61 bullock, 0.13 cow, 0.79 calf, 1.63 sheep and goats, 2.35 poultry and 0.04 pig [Table 4.2.1]. A significant characteristic is the high percentage of farmers who do not own bullock. This is an indication of the power constraint faced by them.

Khandbari

The Khandbari *Panchayat* lies in the mid-Hills of the Eastern Region. It is situated in the north and south sides of a hill which varies in height from 462 to 1,077 metres above sea level. The average rainfall is about 1,200 millimetres a year.

The total cultivated area in Khandbari *Panchayat* is approximately 834 hectares, and the total population is 4,300. The family size is 5 to 6 in number, and an average of 1.1 hectares of land is cultivated per household. The average family labour available for farming is 2 to 3 members.

In the uplands, the predominant cropping patterns are maize relayed with millet (maize/millet), maize-mustard, and maize-fallow. About 50 percent of the millet is relay cropped with maize. Most of the lowlands are devoted to a monocrop of rice and left to fallow for 8 months of the year. A very small percentage of the land, where irrigation is available, is double cropped with rice and followed by wheat or potato. The LUI and MCI in this area are 48 and 130 percent respectively.

There are nearly 12 heads of livestock per household comprising 0.45 buffalo, 1.45 bullocks, 1.0 cow, 1.15 calves, 2.36 goats, 4.90 poultry and 0.36 pig. In this site, the number of poultry and goats is higher than for other animals, while the bullock population is lower.

Lele

The Lele *Panchayat* is situated in the Lalitpur district within the Kathmandu Valley. It is 15 kilometres south of the Khumaltar Agricultural Research Station. The altitude of this site varies from 1,300 to 1,700 metres above sea level. The average annual rainfall of the valley is about 2,025 millimetres. Eighty-six percent of the total rainfall occurs from June to October. Hailstorms occur occasionally from March to May each year.

The total population in the *Panchayat* is 5,130, and its cultivated area is approximately 700 hectares. Fifty percent of the land holdings is less than 0.50 hectare. A household size of 5 to 6 members live on an average of 0.54 hectare of cultivated land. The average family labour available for farming is 3 members.

In the uplands, the most common cropping pattern is maize mixed-cropped with soybean followed by a relay crop of millet. Another common pattern is maize mixed-cropped with soybean or other bean followed by a winter crop such as mustard or wheat.

The irrigated lowland is used mainly for double cropping, that is, rice followed by wheat. Potato is planted in a small area (to be used for rice nurseries) during the winter. The common cropping pattern in the rainfed and partially irrigated lowland is local rice followed by improved wheat varieties. Black gram is also grown on the bunds of rice fields. The LUI and MCI are 70 and 160 percent respectively.

As for livestock number, an average size family owns 6 heads of livestock.

Chauri Jahari

The Chauri Jahari *Panchayat* lies in the Far-Western hill region of Nepal. It is generally a plain area with an altitude of 700 metres above sea level and is surrounded by hills. It can be reached by trekking 4 to 6 days from the closest motorable road or by aeroplane. The average rainfall is 1,100 millimetres, with the peak period occuring in the

TABLE 4.2.1
EXISTING FARM HOUSEHOLD RESOURCES OF FOUR CROPPING SYSTEMS HILL SITES, 1979

Particulars	Cropping system sites			
	Pumdi Bhumdi	Khandbari	Lele	Chauri Jahari
Average family size	5.7	6.0	5.7	6.03
Average number of farm labourers	3.1	2.8	3.2	3.96
Average number of parcels	6.76	4.55	4.4	15
Average size of cultivated area (ha)	0.87	1.1	0.54	0.65
LUI (%)	56	48	70	62
MCI (%)	168	139	160	178
Average livestock owned				
Buffalo	1.7	0.4	0.28	0.63
Cow	0.1	1.0	0.89	0.96
Bullock	0.6	1.4	0.49	2.03
Calf	0.8	1.2	0.54	1.00
Sheep and goat	1.6	2.4	0.97	0.55
Poultry	2.4	4.09	2.66	2.34
Pig	0.04	0.36	0.01	0

Source: Nepal [1979].

month of July. On an average, the months of June, July and August receive more than 200 millimetres of rain. The rest of the year receives very little rainfall, and this could seriously restrict crop production when irrigation is not available. The government has completed an irrigation project which could potentially fully irrigate the flat upland area of the *Panchayat.*

However, irrigation control for the area with its predominantly light textured soil remains poor.

The total population of Chauri Jahari is 4,500. Surplus food is grown in the *Panchayat* and supplied to nearby hill districts which are generally deficit areas.

On an average, a household size of 6 members subsist on 0.65 hectare of cultivated land. The average family labour available for farming is 4 members.

In the uplands, the predominant cropping pattern is rice+maize–wheat, while other patterns are rice+maize–lentils and rice+maize–chickpea. In the lowlands, it is rice followed by wheat. The LUI and MCI are 62 and 178 percent respectively.

As for livestock number, an average family owns 6 to 7 heads of various types of livestock such as buffalo, cow, bullock, sheep and goat.

REFERENCES

Conlin, S. and Falk, S. 1979. *A Study of the Socio-Economy of the Kosi Hill Area : Guidelines for Planning an Integrated Rural Development Programme.* Vol. 1. KHARDEP Subliton: Land Resources Development Centre (Report No. 3).

Manandhar, D.N. and Vreeland, C.C. 1976. *Temperate Fruit Production in Helambu.* Kathmandu Department of Agriculture.

Nepal. 1978. *Production Programme in the Hills : A Proposal.* Kathmandu: Division of Agronomy, Department of Agriculture (Unpublished).

Nepal, 1979. *Cropping System and Livestock Survey.* Kathmandu : Division of Agronomy, Department of Agriculture (Unpublished).

5
Irrigation Water Management and Use at the Farm Level in the Hills

P.P. GORKHALY and M.M. SHRESTHA

Introduction

The government places special emphasis on the development of hill irrigation in Nepal. Despite abundant water resources, only 20 to 25 percent of the hill area in the country is irrigated. The objective of the nation's Sixth Plan is to bring an additional 25 percent of the cultivated area under irrigation. The increasing demand for food in the Hills can be met in part by improved cultivation through irrigation.

Water is thus recognized as one of the basic natural resources available for the economic development of Nepal. The average annual rainfall is 1,250 millimetres and it occurs mainly during the period from June to September when the Southeast Monsoon prevails. The distribution of precipitation is uneven and varies from year to year. Agro-ecological conditions such as temperature, rainfall, wind, light duration, light intensity, soil and slopes also vary over time and space.

Due to the shortage of arable land, the hill people are forced to cultivate steep and unstable slopes. This causes yield to be low, and soil erosion is a serious problem. Farming methods are largely traditional and fertility is maintained by the use of farmyard manure and compost. Some of the hill areas are presently irrigated from locally constructed schemes which divert water from rivers, streams, and springs. These diversion structures are not permanent and are generally damaged or destroyed during the flood season. In most cases, little or no water control is practised. Canals do not possess scape facilities for removing excess water. They are also poorly maintained and this results in high conveyance losses and erosion. However, provided water can be controlled and properly managed, it will stimulate and sustain the widespread adoption of improved production technology.

There is an urgent need to expand the irrigated regions of the Hills because the availability of water is a crucial factor for increasing the agricultural productivity of these areas. This paper describes some of the technical and socio-economic problems encountered in the existing irrigation schemes located in the Hills of Nepal. Larger investment to step up the water supply and ensure its better and more efficient distribution to the fields is required to overcome some of the prevailing technical problems connected with hill irrigation. It is recommended that a water utilization organization be formed in each hill district to provide technical and financial assistance for the implementation of small-scale hill irrigation projects.

Problems Encountered in Hill Irrigation

Although there is ample river runoff for planned irrigation development, its implementation poses a complex problem. Most of the existing small irrigation schemes are

constructed to provide water for cultivation only during the monsoon season. These schemes are fed by small rivulets which, during the dry winter, have little or no water, and in the monsoon season carry suspended sediment loads which damage irrigation works.

The major improvements required in the Hills are as follows:

(1) conversion of existing seasonally irrigated land to perennially irrigated land;

(2) conversion of rainfed land to perennially irrigated land;

(3) upgrading of existing seasonally irrigated land by the construction of improved irrigation structures; and

(4) upgrading of existing rainfed land to seasonally irrigated land.

In many places, farmers construct weirs of stones, logs and bushes to divert water into irrigation canals. The weir constructions provide sufficient water during the wet period but are not well suited to meet the irrigation needs of the dry season. In many small tributaries and streams, the dry season flow at higher elevations is subsurface, and it cannot be tapped without special structures. Water flow in most streams is limited during the latter part of the dry season, that is, from February to May, and this severely hampers the area which can be developed for irrigated winter or early paddy cropping.

Diversion structures built by farmers are frequently destroyed by floods during the monsoon period. This damage must be immediately repaired to prevent any lengthy interruption of paddy irrigation. However, workers engaged in such repair work in the rainy season are also needed to plant paddy.

Springs provide irrigation for some upper hill terraces and are also used for domestic water supplies. However, they tend to dry out in early winter, and this is a major constraint for developing and improving hill terrace irrigation.

Canal Damage From Landslides and Peak Flows

During heavy monsoon rains, almost all the rivers and streams in the Hills carry substantial material loads such as stones and logs. Damage by floods due to undermining and cutting of the river banks which support canals is one of the most common problems encountered by irrigation engineers. During every monsoon, canals are frequently disrupted by slides and gullies. Their formation is caused by the following:

(1) Poor construction of canals which when built on overly steep slopes disturb the critical balance and cause slides.

(2) Seepage from canals which is often a primary cause of slope instability.

(3) Uncontrolled feeding of water into canals causes overflow which washes the fertile earth away and contributes to gulley formation. During monsoon periods some of the sediment enters the canal and eventually silts it. This means that re-excavation work must be performed to prevent further damage. In hill irrigation, canals also serve as catchment drains during the wet season and this poses a problem. Any rainfall running down the hills will either flow into existing drains or directly into the canal itself. The amount of this runoff may be very large when the canal is up to 5 kilometres or more in

length. Such large flows break through at weak points of the canal banks and account for extensive erosion.

(4) Uncontrolled water release by farmers who cut open canal walls to irrigate their fields brings about similar damaging effects as seepage and canal overflow. In most hill irrigation schemes, the area to be irrigated is normally some distance away from the intake, and it is difficult to obtain a full-time supervisor to check the intake flow periodically. As far as possible, farmers should be discouraged from breaking canal banks and instead be persuaded to use formal outlet structures.

Water Distribution in the Fields

Water distribution system by canals is designed for the monsoon period when the fields are flooded and water flows from higher to lower terraces. However this distribution system is not adapted to the dry season. It results in heavy water losses and does not allow for proper distribution to the lower terraces. An example is the Chauri Jahari Irrigation Project in Rukum district, which suffers from serious technical deficiencies. Water released through the 14 outlets is utilized by farmers to irrigate their fields, but because of the lack of tertiary and field canals, farmers are compelled to irrigate their plots by the "field to field" method. Unclear water rights also aggravate this problem.

Lift Irrigation

It is not possible for simple gravitation irrigation schemes to provide sufficient water for wide fertile terraces which are located adjacent to deep river canyons or for those which are situated on high plateaus. Lift irrigation is required to develop such areas. The high operating costs involved in lift irrigation mean that the following criteria must be met for it to be economically feasible:

(1) good distribution of the water which is pumped up to irrigate the high fertile terraces; and

(2) intensive cultivation of the irrigated land.

The problem of fuel supply and the lack of regular maintenance facilities make the long-term success of these projects doubtful.

Technical Solutions

Canal Feeding

It is important that the location of the site for the intake structure be well chosen to prevent floating debris or large stones from rolling down with the flood water. At the same time, measures should be undertaken to ensure that the intake structure is free of sand and gravel. The design of the canal intake should also be made resistant to monsoon floods and be able to make maximum use of the low water level during the dry season.

Control of Water Flow in Canals

The velocity and quantity of water must be controlled at the canal inlet to prevent overflow which causes deep erosion of the canal bed. The construction of gates allows

the regulation of water flow by the farmers themselves. The river bank below the spillway should be protected to prevent future spills. Excessive water from the intake can sometimes be diverted into a natural drainage canal downstream.

Lining of Canal Bottom and Wall

Canal lining can be accomplished either by laying hume pipes or by lining the canal wall and bottom with cement or masonry work. If the soil is coarse and full of gravel, losses through seepage may be reduced by means of a permanent form of lining. If the canal erodes an area of irrigated terrace or its banks intercept the water table, dry stone pitching on the upper bank slope will be essential to prevent the bank from collapsing. Canal lining with the use of bricks is an expensive task. Hence stone pitching or slate lining is preferable.

Crossing Landslides

If possible, landslides should be prevented. High density polyethylene pipes can be laid to bypass landslide zones. In zones characterized by widespread landslides which cannot be stabilized, a suspended pipeline maybe considered as a solution. In stable zones hume-pipes can be readily used. Seepage when unchecked will greatly contribute to slope instability and landslides. Therefore any seepage appearing above the canal alignment should be collected in a cut-off ditch and discharged into a convenient drain or stream.

In cases where the drainage inflow has to be kept separate from the canal, it is usually made to pass below it by means of a culvert. But where the drainage inflow has to be kept separate from the drainage flow, the nature of the site will determine the most suitable kind of structure to build. One of the following can be considered:

(1) a syphon which is a canal laid under the drainage system;

(2) an aquaduct which is a canal laid over the drainage system; or

(3) a super passage which is a canal laid under the drainage system and built within a flume structure.

Scape Structure

A scape structure should be provided to protect the canal from excess flow due to runoff. It functions as a safety valve. Scape facilities to remove excess water are the most important features lacking in systems built by farmers.

Institutions for Hill Irrigation

The Department of Irrigation, Hydrology and Meteorology of the Ministry of Water and Power Resources is concentrating its efforts on the implementation, operation and maintenance of medium (50 to 100 hectares) and large (over 100 hectares) irrigation projects throughout the country, and has excluded those below 50 hectares. The government realizes that to divert water from sizable rivers for irrigation purposes involves high cost, time and adequate manpower besides large quantities of imported material. Hence, its choice to develop medium and large irrigation schemes.

Irrigation in the mountainous terrain, however, is dominated by small-scale indigenous systems which normally cover command areas well below 50 hectares. There is a great potential for improving these traditional systems. The damage brought about by each

monsoon season requires tremendous efforts to maintain these systems and keep the area under constant irrigation. In order to help restore damaged schemes and to implement new ones an institution or organization well-versed in farm irrigation work is required. The Farm Irrigation and Water Utilization Division (FIWUD) of the Department of Agriculture, Ministry of Food and Agriculture can be strengthened to execute this task. With the implementation of these farm irrigation schemes, more farming projects can be implemented and more areas cultivated. The involvement of farmers at the construction phase of such schemes will greatly assist them in understanding and managing their own projects in the future.

These farm irrigation projects should also be involved in the reconstruction of damaged projects and the construction of small ones in the Hills. Their implementation should be guided by the following principles:

(1) Projects should be initiated at the farmers' request made either to the FIWUD, the district agricultural development office or through the *Panchayat.*

(2) Farmers' involvement is essential for project implementation which is usually carried out by the FIWUD in close co-operation with farmers.

(3) A water users' group should be formed for each project. All repair and maintenance work will have to be done by this group.

(4) The FIWUD will provide the technical assistance and financial support.

(5) Any capital arising from government contribution, agricultural development bank loans, and from the water users' group will be deposited in the bank, and the account will be operated jointly by a representative of FIWUD and the water users' group.

Recommendations

The following recommendations are appropriate:

(1) A farm irrigation and water utilization organization should be established in each hill district to render technical and financial assistance in the implementation of small-scale hill irrigation projects.

(2) Follow-up programmes should be carried out to ensure their successful operation.

(3) Production programmes should be carried out simultaneously with these irrigation projects.

6
Development of Agricultural Marketing and the Improvements of Rural Markets in Hill Areas

I.R. MISRA and M.R. SATYAL

Introduction

In general, the Nepalese economy can be divided into two distinct sectors -- the Hills and the Tarai. Both are primarily agricultural in character. The Tarai is more fertile, grows most of the nation's food and cash crops and it also accounts for most of the agricultural surplus. The Hills on the other hand, although comprising nearly two-thirds of the country's total area and population, is a food deficit region. The average hill farmer has to worry about feeding his family and he cannot afford to take price risks in the marketing of horticultural or dairy products. For this reason, farmers are hesitant to alter their cropping pattern in favour of commodities where they have a comparative advantage in production.

The development of agricultural marketing is essential for accelerating economic development in a country like Nepal where 94 percent of the population is directly engaged in agriculture. In Nepal, the existing marketing practices and facilities lack integration and are underdeveloped and disorganized. The lack of marketing infrastructure such as transportation, storage, communication system, grading and standardization, packing practices, and marketing laws and regulations have aggravated the farmer's marketing problems. In view of such public inadequacies, the development of rural markets has received attention and some progress is being made.

Farmers are often left without an adequate market outlet for the farm output which the government through its various agricultural development programmes has encouraged them to produce. This is due to the absence of co-ordination between the agencies involved in such programmes. An example is seen in apple growing in the remote areas of Jumla and Mustang where farmers were encouraged to grow apples, but they subsequently found no market for their produce. There are similar problems in many other hill areas.

Agricultural marketing activities are being carried out by several agencies, both private and public, with little co-ordination. The majority of farmers are small landowners with a low volume of transaction. Co-operative marketing could be a solution to this problem, but in Nepal this approach has generally been unsuccessful. This paper traces the development of rural markets in Nepal's hill areas and recommends some major improvements in the number, distribution and operation of these markets. The development of relevant infrastructure particularly the transportation system should proceed jointly with these improvements.

Problems of Agricultural Marketing

Efforts made to establish and encourage a sound and workable marketing system in the rural areas have frequently been jeopardized by the lack of a proper transportation

system. Because of the terrain and the absence of adequate and cheap means of transportation and communication, a "national market" in the true sense of the word has not been developed yet. The lack of access to market causes the local supply and demand conditions to determine the price level of commodities.

Transportation. A transportation network is the most important infrastructure for the development of a national marketing system. Although the government has given due importance in its development plans for the establishment of an efficient transportation system, the difficult terrain and rugged topography of the country have presented a formidable challenge to the progress of this important service.

Storage. Nepal does not have adequate storage facilities at various stages of marketing. Due to this, storage losses are estimated to be at least 15 percent of total production.

Processing. Although there are a large number of mills in the country, the majority of them are very old. For example, many rice mills have a huller type machine which has a recovery rate of only 60 percent as compared with the new sheller type machine which can give a recovery rate of up to 72 percent. Besides, older hullers generally produce poor quality rice with a high percentage of broken grain.

Information and communications. An inadequate information and communication system hinders the development of marketing in Nepal. Only important market centres are served by wireless sets. Mass communication media such as Radio Nepal and local newspapers carry practically no market information at all, while such information for the hill region is still at a primitive stage of development.

Unified weights and measures. Although the government has introduced standard weights and measures in 1968, and prohibited the use of local volumetric measurements, these traditional methods persist in the Hills. Grading and standardization are practically non-existent.

Market centres. In many of the hill areas, the only established market centre is located in the district headquarters. For farmers residing in remote areas such markets are inaccessible, and the co-operative marketing system has not reached them.

Legal infrastructure. No national laws exist for the operation and management of markets, collection of fees, grading and standardization.

Co-ordination. Input distribution, credit supply, co-operative marketing, storage improvements, price reporting and improvements of local market centres are handled by different agencies with little or no co-ordination. Frequently, these agencies are not aware of the activities of others in the same area.

Marketing of Agricultural Input

The government is making a concerted effort to step up the use of improved inputs. Chemical fertilizer was introduced to Nepal in the early 1950s. Its use in the initial stages was limited to vegetable and paddy crops in the Kathmandu Valley. The type of fertilizer applied was primarily nitrogenous fertilizer in the form of ammonium sulphate. After a slow start, annual consumption increased from 2,096 tonnes in 1965/66 to 45,592 tonnes in 1978/79, or at an annual growth rate of 26.7 percent.

The Agricultural Inputs Corporation (AIC) was established in 1966 as the sole agency involved in the procurement and distribution of chemical fertilizer, improved seed and insecticide. Imports are financed either by foreign aid or from the AIC's own resources. The AIC also purchases improved seed from various agricultural research centres and selected farmers, and supplements stocks with occasional imports from India. It has appointed numerous dealers in various parts of the country for wholesaling and retailing.

Institutional dealers. District Co-operative Unions, which function as wholesalers, obtain their supplies from AIC godowns. Retail distribution is carried out mainly by *Sajhas* (co-operative societies). A small quantity is sold through private channels. With the expansion of *Sajhas*, the role of private traders in the fertilizer distribution system is gradually diminishing. At present there are 950 *Sajhas* involved in this activity and they share among them 96 percent of total sales [ESCAP, 1980]. In some remote areas, where neither *Sajhas* nor private traders operate, the AIC itself is involved in retail distribution. The AIC's direct supply to the farmers represents only 2 percent of total fertilizer sales.

Private traders. There are altogether 51 registered private traders dealing with the marketing of fertilizer but only 25 are actively engaged in this business. Their market share is only 2 percent.

The easy accessibility of farmers to input, and its timely supply are the two most important aspects of its marketing. Due to the difficult terrain and lack of other infrastructure, its distribution to hill farmers is tenuous. Farmers are therefore reluctant to increase, for example, fertilizer use even when the subsidy is as high as 25 percent, for the simple reason that they cannot depend on receiving supplies at a time when they need them.

Marketing of Agricultural Products

Most rural markets are periodic in nature; some are bi-weekly, or weekly, a few are fortnightly, and very few are monthly. There are also markets which operate only on special occasions such as during the *holi mela* and fairs.

Periodic markets. In every district there is at least one local market centre at the district headquarters. This kind of market, however, cannot serve the entire rural population. Periodic markets exist in several districts, but the majority are located in the eastern part of the country and are concentrated primarily in the Tarai. Thus there is a strong regional imbalance in the location of periodic markets (Table 6.1). Altogether there are 640 periodic markets in Nepal — 6 daily, 262 bi-weekly, 280 weekly, 44 bi-monthly, 5 monthly and 43 for religious occasions. Almost all the agricultural commodities which are produced locally are available in these markets in addition to consumer goods and daily necessities such as sugar, salt, cooking oil, kerosene, and cigarettes, and simple agricultural tools and implements such as the *kuto, kodali* and sickle. But chemical fertilizer and improved seed are not sold in these markets.

Co-operative Marketing. The co-operative movement began in 1956 with the establishment of a Co-operative Department. The Co-operative Act of 1959 led to the spread of co-operatives to various parts of the country. However, they have not been very effective and the recent emphasis is on qualitative improvement rather than quantitative growth. In line with this trend, a co-operative revitalization programme has been carried out in 28 agricultural development districts. In 1971/72 the Agricultural Development Bank,

Nepal (ADB/N) took over the management of these co-operative societies. The objective of the Bank was to transform these organizations into effective village-level institutions through which credit supply and marketing facilities could be channelled to farmers. They remained under ADB/N management until 1978, when they were transferred back to the Co-operative Department.

TABLE 6.1
PERIODIC MARKETS IN NEPAL, 1981

Development region	Ecological region			Total
	Mountains	Hills	Tarai	
Eastern	52	77	234	363
Central	11	21	149	181
Western	–	4	77	81
Far-Western	–	2	11	13
Seti-Mahakali	2	–	–	2
Total	65	104	471	640

At present there are 680 co-operative societies and 33 district co-operative unions. They are located in all the Tarai districts and in a few hill districts (Table 6.2). In theory, these societies are involved in the provision of marketing facilities, distribution of input and credit, the sale of consumer goods and marketing of agricultural produce for farmers, but in practice they concentrate on input supply and on the sale of daily necessities. Thus the marketing of agricultural produce is neglected. Table 6.3 shows the kind of activities which co-operative societies in 37 hill districts are engaged in.

Village Merchants. Village merchants and moneylenders are important marketing agents for the rural people. They provide loans to farmers in times of need and with the simplest possible procedure, even though these loans may carry a high interest charge. It is very difficult to assess what percentage of the farmers' produce is being handled by these merchants, but they are certainly the main credit suppliers.

Exports from the Hills

Nepal exports tea, large cardamom, ginger (dry and fresh), and niger seed which are produced in the Hills (Table 6.4). While Nepal has been a traditional exporter of unprocessed ghee to India, its export in the unprocessed form has been banned recently. In 1978/79, 3.5 million tonnes of processed ghee were exported to Dubai. The Western and Far-Western Hills are the main ghee producing areas. However, as important as these commodities may be for a particular area, their export to overseas countries (excluding exports to India) contributed to only 3 percent of foreign exchange earnings.

TABLE 6.2
NUMBER OF CO-OPERATIVE SOCIETIES (INCLUDING *SAJHAS*), 1981

Development region	Co-operative society	District co-operative union	Total
Eastern	160	8	168
Mountains	7	-	7
Hills	46	3	49
Tarai	107	5	112
Central	263	13	276
Mountains	17	–	17
Hills	86	6	92
Tarai	160	7	167
Western	139	6	145
Mountains	3	3	6
Hills	73	–	73
Tarai	63	3	66
Far-Western	74	4	78
Mountains	4	–	4
Hills	37	2	39
Tarai	33	2	35
Seti-Mahakali	44	2	46
Mountains	4	–	4
Hills	12	–	12
Tarai	28	2	30
Total	680	33	713

TABLE 6.3
ACTIVITIES OF CO-OPERATIVE SOCIETIES IN 37 HILL DISTRICTS, 1975/76 – 1979/80

Item	Year				
	1975/76	1976/77	1977/78	1978/79	1979/80
Number of societies	88	84	115	150	150
Total membership	29,647	22,513	32,564	97,475	137,531
Loan received from ADB/N (Rs '000)	12,049	13,659	20,125	15,357	11,074
Loan distributed to members (Rs '000)					
Cash	2,131	2,329	3,899	3,364	2,531
Kind	2,996	3,135	5,379	4,472	4,344
Sale of agricultural input (Rs '000)	14,343	9,321	16,682	16,383	17,608
Sale of daily necessity (Rs '000).	7,850	11,680	17,334	8,179	17,658
Marketing of agricultural produce (Rs '000)	735	89	2,159	1,667	1,415

Recommendations

The government intends during the Sixth Plan to develop new rural markets and at the same time to improve the conditions of existing ones. The proposed market development plan shows that it is giving priority to the Hills. Out of the 115 proposed markets, 14 are to be established in the Mountains and 68 in the Hills. Although the government has accorded due emphasis to market development in the Hills, the proposed number is far from adequate. Table 6.4 shows that even with these additional markets the number of persons served by each will not be significantly reduced.

New ones should be established in the Hills and Mountains to improve geographical and regional marketing services. Priority should be given to districts where few or none operate. At least 100 new markets are recommended, in addition to those proposed in the Sixth Plan, and they should be established in the Western, Far-Western and Seti-Mahakali development regions. The rural markets in these regions serve the largest number of people (Table 6.5).

Rural markets are needed to support the development of livestock, horticultural, and special crop production programmes. Public investment may be required to build local market facilities. The cost of establishing a typical periodic market in the Hills, and Mountains with minimum physical facilities ranges from Rs 22,500 to 35,000. Because the government is not in a position to bear all the expenses, external assistance will be required.

Institutional marketing arrangements such as management, market information and regulations are perhaps more important than physical facilities. A periodic market committee made up of representatives from the district *Panchayat*, local administrators, farmers, traders, and co-operative officers should be formed. This committee should have a separate identity and be provided with the personnel to supervise and manage the market. It should also act as a policy formulation body to improve market conditions. Its main responsibilities should be to:

(1) formulate rules and regulations;

(2) supervise market operations;

(3) allocate sites for different commodity groups;

(4) distribute funds for further development;

(5) maintain sanitary conditions; and

(6) improve physical facilities.

Nominal market fees and taxes should be charged by this committee. It is suggested that they be made uniform throughout the region, with the Department of Food and Agricultural Marketing Services having the authority to fix fees and taxes. The committee should also try to maintain a standard system of weights and measures in accordance with government policy. A fixed percentage of the income from such markets should be spent on the maintenance and improvement of physical facilities.

TABLE 6.4
EXPORT OF HILL AGRICULTURAL PRODUCE

Item	Quantity (tonnes)		Value (million Rs)*	
	1978/79	1979/80	1978/79	1979/80
Large cardamom	540.1	392.0	22.23	16.45
Dry ginger	97.8	136.0	2.52	1.53
Niger seed	82.8	78.0	0.89	0.76
Fresh ginger	9.8	–	0.08	–
Ghee	3.5	–	0.14	–
Tea	12.9	9.9	0.65	0.54
Total	746.9	615.9	26.51	19.28

Source: Nepal [1980].
Note: *In June 1981, US $1.00 = Nepalese Rs 12.00.

TABLE 6.5
PROJECTED RURAL MARKET DEVELOPMENT BY GEOGRAPHIC AND ECOLOGICAL REGIONS

Region	1981 Population ('000)	1981 Market	1981 Person/ market	1985 Population ('000)	1985 Market	1985 Person/ market
Geographic						
Eastern	3,402	363	9,372	3,726	387	9,628
Central	4,849	181	26,790	5,310	196	27,092
Western	3,003	81	37,074	3,285	94	34,947
Far-Western	1,883	13	144,846	2,062	47	43,872
Seti-Mahakali	1,193	2	59,650	1,309	31	42,226
Ecological						
Mountains	1,311	65	20,169	1,436	77	18,647
Hills	7,427	104	71,413	8,135	172	47,297
Tarai	5,592	471	11,873	6,121	506	12,097
Total	14,330	640	22,390	15,692	755	20,784

Co-operative societies should also provide credit facilities to a large number of farmers, with their major responsibility being the linking of credit with marketing. For this purpose, storage facilities should be built in rural market centres to enable farmers to secure higher prices for their produce.

The timely supply of input such as chemical fertilizer, seed and implements is of vital importance to farmers. As all chemical fertilizer has to be imported, there are often delays in obtaining supplies. It is suggested that the AIC keep a buffer stock of at least 10,000 tonnes of chemical fertilizer in various strategic locations.

The main activities of the co-operative societies and *Sajhas* centre around the supply of agricultural input, credit, daily necessities and the marketing of agricultural produce. These activities are more relevant to the functions of the Ministry of Food and Agriculture than that of the Ministry of Land Reform. At present the Co-operative Department is under the latter. It is strongly recommended that the co-operatives and *Sajhas* be placed under the Ministry of Food and Agriculture in order to better co-ordinate the supply of input and credit with the marketing of agricultural produce.

Priority should be given to the development of the transportation system which is the weakest link in Nepal's marketing system. In the Hills, rope-ways may be a viable alternative to feeder roads. It is recommended that the feasibility of building a mid-hill east-west highway be explored. Meanwhile, a few rope-way connections to serve production centres should be established.

REFERENCES

FSCAP, 1980. *Agro-Chemical Fertilizers and Agro-Pesticides News in Brief: Country Report, Nepal.* Bangkok: Economic Commission for Asia and the Pacific, Vol. 3, No. 3

Nepal. 1980. Unpublished Data. Kathmandu: Trade Promotion Centre.

7
Delivery of Agricultural Input to Hill Farmers: Issues and Problems

R.B. SINGH and G.R. SHRESTHA

Introduction

The Sixth Plan seeks to raise the present national fertilizer consumption level of 11 kilogrammes per hectare to 28 kilogrammes per hectare [NPC, 1981]. In the Hills, the current consumption level is 7 kilogrammes compared with 9 in the Tarai and 100 in the Kathmandu Valley. It is envisaged that by the end of the Plan period, fertilizer consumption will have risen to 15 kilogrammes per hectare in the Hills, 22 in the Tarai and 135 in the Kathmandu Valley. The use of other inputs such as seed, pesticide, agricultural tools and equipment are estimated to increase by 250 percent (Table 7.1).

Delivery of Agricultural Input to Hill Farmers

The Agricultural Inputs Corporation (AIC) is the sole agency handling the importation and distribution of fertilizer, improved seed, pesticide, and small farm tools and equipment. AIC has a dealer network of about 1,400 outlets of which about 300 are in the Hills.

More than 90 percent of the outlets are district co-operative unions and village level co-operatives. Private dealers are appointed only in areas where no such co-operatives exist. In most of the remote hill areas the AIC is also involved in the retail trade. The distribution channels and commission for the AIC are shown in Appendix 7.1

AIC distributes agricultural input through its 60 branch offices. They consist of 4 regional offices, 4 main branch offices, 11 branches, 20 sub-branches and 21 sales depots. The Corporation utilizes 68 warehouses with a total capacity of 55,100 tonnes. In the Hills, AIC has 39 offices, including 2 regional offices, 8 branch offices and 29 sub-branches which utilize 17 warehouses with a total capacity of 7,050 tonnes (Table 7.2).

All fertilizer is imported, either commercially or as foreign aid and is transported by rail or road from Calcutta to AIC godowns in border districts. AIC then arranges for transportation by trucks to those hill district godowns which are accessible by road. From here the input is moved to remote hill areas by porters and mules.

Past Performance

During the Fifth Five-Year Plan Period (1975/76 – 1979/80), fertilizer sales amounted to 210,000 tonnes (of which 84,000 tonnes are nutrients). Of this total, 34,000 tonnes were consumed in the Hills and Mountains as compared to 75,000 in the Kathmandu Valley, and 101,000 in the Tarai (Table 7.3).

Out of the entire amount available during the Plan period, 129,628 tonnes were received as foreign aid, 44,000 tonnes were procured from international markets, and 61,000 tonnes were from carry over stocks. Similarly, during this period, 3,300 tonnes

of improved seed (paddy, wheat and maize) were utilized in the Hills and 8,736 in the Tarai (Table 7.4). The share of wheat seed supplied by the AIC is more than 80 percent. Improved seed was collected from farmers' seed multiplication fields and from government agricultural farms.

During the Plan period, Rs 2,116,000 worth of pesticide was sold in the Hills as compared with Rs 5,650,000 in the Tarai. Similarly, Rs 3,242,000 and Rs 10,919,000 worth of agricultural tools and farm equipment were made available to the hill and Tarai farmers respectively (Table 7.4).

TABLE 7.1
DEMAND PROJECTIONS FOR AGRICULTURAL INPUT DURING THE SIXTH FIVE-YEAR PLAN

Agricultural input	1980/81	1981/82	1982/83	1983/84	1984/85	Total
Fertilizer nutrient (tonnes)						
Nitrogen	18,504	22,022	26,128	28,748	33,890	129,292
Phosphorus	7,008	8,044	9,256	10,996	12,798	48,103
Potassium	6,000	6,600	7,500	8,410	9,498	38,008
Total	31,512	36,666	42,884	48,154	56,186	215,403
Seed (tonnes)						
Paddy	400	450	525	625	750	2,750
Wheat	3,100	3,500	4,000	4,600	5,400	20,600
Maize	300	375	450	550	700	2,375
Total	3,800	4,325	4,975	5,775	6,850	25,725
Tools and pesticide (million Rs)						
Pesticide	12	15	22	28	30	107
Pump sets	10	15	25	30	40	120
Agricultural tools	24	32	43	47	55	201
Total	46	62	90	105	125	428

Source: Nepal [1980].

TABLE 7.2
STORAGE CAPACITY OF THE AGRICULTURAL INPUTS CORPORATION

Region	Existing capacity (1980)	Proposed or under construction (1980–1985)
	(tonnes)	
Eastern	9,750	1,050
Tarai	9,000	500
Hills	750	550
Central	28,900	2,300
Tarai	22,800	–
Hills	900	1,300
Kathmandu Valley	5,200	1,000
Western	10,700	4,950
Tarai	7,050	2,500
Hills	3,650	2,450
Far-Western	5,750	1,150
Tarai	4,000	500
Hills	1,750	650
Total for Nepal	55,100	9,450
Tarai	42,850	3,500
Hills	7,050	4,950
Kathmandu Valley	5,200	1,000

Source: AIC [1981].

TABLE 7.3
SALE OF CHEMICAL FERTILIZER DURING FIFTH PLAN PERIOD BY GEOGRAPHICAL AND ECOLOGICAL REGION

Region	1975/76	1976/77	1977/78	1978/79	1979/80	Total
	('000 tonnes)					
Geographical						
Eastern	3.47	3.92	4.76	5.11	5.33	22.59
Central	22.10	26.12	31.49	31.71	35.08	146.50
Western	4.67	5.54	6.90	6.90	7.67	31.68
Far-Western	0.68	1.17	1.40	1.13	1.59	5.97
Seti-Mahakali	0.38	0.84	0.74	0.75	0.62	3.33
Ecological						
Mountains	0.31	0.50	1.15	1.07	1.72	4.75
Hills (excluding Kathmandu Valley)	3.85	4.67	6.32	6.58	7.88	29.25
Kathmandu Valley	12.04	14.92	15.75	15.86	16.50	74.57
Tarai	15.10	18.05	22.07	22.09	24.19	101.50
Total quantity	31.30	37.59	45.29	45.60	50.29	210.07
Total nutrient	12.27	14.89	17.47	18.54	20.96	84.13

Source: AIC [1981].

TABLE 7.4
SALE OF SEED, PESTICIDE AND AGRICULTURAL TOOLS DURING FIFTH FIVE-YEAR PLAN PERIOD, 1975/76 – 1979/80

Year/region	Seed (tonnes)	Pesticide (Rs '000)	Agricultural tools and equipment (Rs '000)
1975/76			
Hills	673	253	865
Tarai	1,347	616	3,858
1976/77			
Hills	536	365	580
Tarai	1,710	957	2,641
1977/78			
Hills	738	539	721
Tarai	1,808	1,489	2,134
1978/79			
Hills	575	519	584
Tarai	1,768	1,472	981
1979/80			
Hills	809	440	492
Tarai	2,103	1,116	1,306
Total for Plan period			
Hills	3,331	2,116	3,242
Tarai	8,736	5,650	10,920

Source: AIC [1981].

Distribution Problems

Despite the provision of credit, irrigation and agricultural input to hill farmers, the growth of agricultural production has remained very slow. Some of the major reasons for this are cited below:

(1) *Transportation of input.* The logistics of moving input to remote areas is a challenge to the AIC. It is estimated that the AIC distributes annually a total of 6,000 truck loads of fertilizer, of which 4,500 truck loads must be distributed throughout the country within a time period of 60–75 days, to ensure that at least 50 percent of the total quantity of the winter crop requirement reaches the farmers before the onset of the monsoon. The availability of trucks and other forms of transportation is a major constraint to the AIC. It is calculated that at present there are only 7,000 private and public vehicles available for transport on the north-south and east-west roads.

(2) *Secondary transport.* A major factor affecting agricultural input distribution in the Hills is the transportation problem between the truck-end points and the remote hill districts. More than 10,000 tonnes of agricultural input have to be transported by porters or mules. Every year about 180,000 porters working a total of 720,000 man-days are engaged in carrying such input [AIC, 1978]. However, the transportation period coincides with the period of peak farm labour demand and there is often a shortage of porters. The average cost per tonne of secondary transportation from the AIC hill district godowns to the village level outlet is Rs 200 per tonne and therefore, farmers have to pay an additional 20 paise per kilogramme.

(3) *Improved seed.* Maize is the major crop in the Hills followed by paddy, wheat, millet and potato. Seed appropriate for the Tarai may not be appropriate for the Hills. The present supply of improved seed to the Hills is very nominal and hill farmers generally have not accepted AIC seed. Reasons for non-acceptance include poor germination, the lack of seed certification, and the failure of the seed to perform well under farm conditions. Farmers sow one thing and come up with another, especially in the case of vegetable seed. In co-operation with the United States Agency for International Development (USAID), the AIC has started a seed production and input storage project that is aimed at covering 25 hill districts. A seed multiplication programme will also be organized in suitable hill areas in an attempt to encourage the participation of local farmers. Each location is expected to produce 50 to 200 tonnes of seed which will be locally processed, tested, stored and distributed to farmers. They will be involved in every stage of seed multiplication, that is, from processing and testing to distribution. This project will be closely co-ordinated with other services such as extension and credit.

(4) *Extension and credit.* An expanded and organized extension service is needed to advise farmers on the proper use of input. Most of them are reluctant to approach the Agricultural Development Bank for credit primarily because of

[1] 100 paise = 1 Rs. In June 1981, US $1.00 = Nepalese Rs 12.00.

the lengthy and complicated procedures connected with borrowing, and the difficulties of establishing collateral for loans.

(5) *Food subsidy.* Food security is one of the major components of the government's food policy. More than 40,000 tonnes of food grain are moved to deficit areas annually. Food supplies under foreign grants are distributed under the "food for work" programme. Those procured from the Tarai are moved to the Hills and sold at 30 percent less than the procurement cost. Every year more than Rs 25 million are spent to subsidize the transportation of food grain. This programme has had a disincentive effect on hill production. When farmers receive food free or at a much cheaper price than its cost of production, they tend to be less interested in increasing their farm output through the greater use of input.

(6) *Retail outlet.* In hill areas, agricultural input is retailed by the AIC itself since other retail outlets such as the co-operatives or private dealers are not common. Hill co-operative societies should be organized and made responsible for providing facilities to farmers to exchange or barter their produce for agricultural input. Arrangements should be made to hand over the bartered produce to the Nepal Food Corporation. This policy will not only encourage farmers to increase their output but also save transportation cost.

(7) *Other problems.* There are warehousing, management and handling problems that call for careful and systematic measures to overcome them. The procedural delays in the commitment and disbursement of fertilizer from donor countries together with the uncertainty of arrival dates of shipments have adversely affected AIC's delivery schedule to the Hills. To avoid total dependency on foreign sources, it is appropriate to seriously consider and examine the prospects of constructing mini-fertilizer plants with Nepal's water resources.

Policy Issues

Food or Fertilizer for the Hills?

It is argued that agricultural input such as fertilizer is costly as well as difficult to supply on time in the Hills. Therefore, it should be allocated to the Tarai where productivity is higher. Moreover, agricultural input which is moved to the Hills despite high cost and difficulty is not always utilized. It is often left in AIC godowns due to the lack of technical knowledge, credit, transporation and irrigation. Instead of input, food should be moved from the Tarai to the Hills.

The counter argument is that agricultural input such as fertilizer and improved seed are the only substitutes for the limited land in the Hills. Thus planners in Nepal have to supply more input and complementary services to hill farmers. The provision of food to the Hills is a short-term solution while the supply of agricultural input is a long-term one.

Fertilizer Subsidy

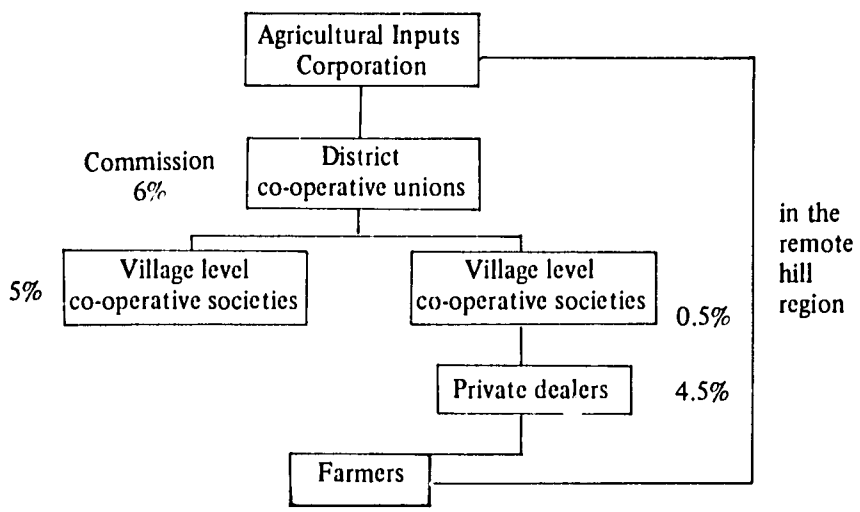
The subsidy programme was introduced by the government in order to encourage hill farmers to use more chemical fertilizer and improved seed to increase their crop yield, and thereby reduce the transportation of food grain from the Tarai to the Hills. In 1973, uniform pricing of fertilizer by type was introduced throughout the country, regardless of transport cost.

This move was criticized by some Nepalese agricultural economists who maintain that such a policy adversely affected Tarai production. They argued that hill farmers are subsidized very heavily at the expense of their counterparts in the Tarai and thus this policy acts as a disincentive to Tarai farmers. Instead, they proposed a fertilizer price policy which differentiates between regions and crops.

On the other hand, there are national and foreign experts who recommend that the uniform fertilizer subsidy policy should continue until hill farmers attain food self-sufficiency. While this, coupled with liberal credit may take some time to realize, effective extension and improved marketing are policies that could encourage Hill farmers to increase their food production.

Appendix 7.1

Distribution Channels and Commissions



Note: An extra 3.5 percent commission over the general rate of 6 percent is paid to co-operatives for lifting input 3 months ahead of each season.

REFERENCES

AIC. 1978. *Distribution of Agricultural Inputs in Nepal.* Kathmandu: Agricultural Inputs Corporation

AIC. 1981. Departmental Statistics. Kathmandu: Agricultural Inputs Corporation (Unpublished).

Nepal. 1980. *Report for the Sixth Five-Year Plan.* Kathmandu: Ministry of Food and Agriculture.

NPC. 1981. *Sixth Five-Year Plan.* Kathmandu: National Planning Commission.

8
Production Incentives for Hill Agricultural Development

S.K. UPADHYAY and G.P. KOIRALA

Introduction

Apart from the Tarai which constitutes only 24 percent of the geographical area, Nepal consists of Hills and Mountains which stretch continuously from east to west. Four distinct strata run almost parallel to each other in this region, namely, the Churia Range, the Mahabharat Range, the lower Himalayan foothills and the upper Mountains including snow laden peaks. The first three strata fall between 750 to 4,000 metres in altitude. While an area as large as the Tarai is permanently covered with snow and is useless for agriculture, there are, however, some fertile valleys, basins and inner pockets between the Churia and the Mahabharat Range. They form the main area of agricultural potential in the Hills and Mountains.

Although there exists scope for adopting the principle of comparative advantage with emphasis on specialization and exchange between regions, the immediate need is to make the hill area self-sufficient as far as feasible. Programmes for increasing food grain production in the Hills and Mountains must be implemented in order to reduce the increasing seasonal and permanent migration southwards.

The Hills also experience serious inadequacy in transport and communication facilities. In 1976 for example, only 13 of the 55 hill and mountain districts were served with roads. In terms of population, 41 percent of the hill dwellers have no road link facilities within their own districts. Only limited improvements have taken place since that date. The hill pockets are, therefore, isolated and they have minimum contact and exchanges of produce with other hill areas and with the Tarai. In such a situation, the distribution of surplus food grain produced in the Tarai to the deficit hill regions becomes tremendously difficult.

It is only after the building of transportation and communication linkages in all directions (particularly north – south) that the proposed specialization of livestock development in the Mountains, horticultural development in the Hills and cereal and cash crop production in the Tarai can take place.

The nature of production incentives should, therefore, be geared towards the creation of a self-sustaining economy within the Hills and Mountains. The subsequent discussions which focus on these incentives, their present status and the desired reforms keep this overall objective in mind.

Potential Yield Levels

Data gathered by various agricultural research stations and socio-economic surveys reveal that a wide gap still exists between the potential yield as recorded in certain research centres, demonstration farms, progressive farmer's fields and the average farmer's actual yield. This is due to a combination of technological and economic factors.

Within farmers' field conditions, the yield variance is often quite high. Those using improved input have been able to produce more than those using conventional methods. Yield gaps of 1,500 kilogrammes in the case of maize, and 1,100 kilogrammes in the case of wheat under irrigated conditions have been observed [APROSC, 1978]. Similarly, the difference between farm stations' and average farmers' yield amounted to as high as 2,100 kilogrammes per hectare in the case of paddy and 1,700 kilogrammes each in the case of wheat and maize.

USAID [1976] has established that the highest average marginal value product is from the use of improved seed (Rs 13 under irrigated conditions and Rs 8 under rainfed conditions). However, its usage remains nominal. In 1977, only 8.5 percent of the area under paddy, 1.5 percent of the area under maize and 20.6 percent of the area under wheat have been planted with improved seed. In the Eastern Hills, the adoption rate is 1 percent for paddy, 1 percent for maize, and 17 percent for wheat. Higher adoption rates are, however, observed in the Kathmandu Valley with 41 percent for paddy, 8 percent for maize and 61 percent for wheat. Chapagain [1976] found that the share of farm expenditure on improved seed, chemical fertilizer and plant protection chemical is only 1 percent. This failure to adopt new technology and the use of higher input levels is due to the lack of adequate incentives to increase production. Since most farmers in the Hills and Mountains are living at the bare edge of subsistence, they cannot afford to use the new technology when this has not been adequately tested on their own or their neighbour's farm. The risks of failure are too great since it could lead to tragic consequences.

The estimated additional average farm income that could be obtained by the use of improved technology is shown in Table 8.1.

TABLE 8.1
IMPROVEMENT IN FARM YIELD WITH USE OF NEW TECHNOLOGY

Size of farm	Irrigated condition	Rainfed condition
	%	
Large	115	78
Medium	95	72
Small	76	93
Average	102	79
Average of irrigated and rainfed condition	92	

Source: USAID [1976].

Prices

Mosher [1966] in his book *Getting Agriculture Moving* stressed that a remunerative price relationship between input and output is the single most influential incentive for farmers to increase their total production. They increase production per unit of land of a particular crop when the price of that crop rises. Therefore, if the nation wants to increase food production, the prices offered to individual farmers must be made more favourable.

The input price subsidy acts as a positive factor in increasing production and is therefore a good incentive. On the other hand, the subsidized sale of farm produce tends to retard production increases.

In Nepal, chemical fertilizer has been heavily subsidized. This price subsidy for hill farmers is financed partly by the relatively higher prices charged in the Tarai.

In addition, there is a transportation subsidy. The total price and transportation subsidy amounted to Rs 40 million in 1978/79 [APROSC 1981]. Nepal does not produce its own chemical fertilizer and has to depend largely on commercial imports or foreign assistance.

But the mere announcement of the provision of a subsidy is by itself insufficient to move farmers to make full use of it. There is a need to ensure that input is made available to them at the required time. Its distribution and sales network therefore becomes more important. The distribution of major farm input is carried out by the Agricultural Inputs Corporation (AIC) through its private dealers and co-operative societies. There are altogether 217 co-operatives and a few private dealers of the AIC catering to the input demands of hill and mountain farmers.

There has also been a government programme supplying food grain at subsidized prices to urban consumers and to food-deficit hill pockets. The cost of this programme was Rs 52 million for the year 1978/79 [APROSC, 1981]. This has both favourable as well as unfavourable consequences for hill farmers. Among the former, it has stimulated the adoption of crops and cultural practices best suited to the ecology of the area. For example, the Mustang district is highly suitable for the production of temperate fruit and vegetable. If cereal is readily available at subsidized prices, farmers in this area would allocate more land for fruit and vegetable. However, transportation poses a major hurdle in the exchange of farm produce from different ecological zones, and hence the output subsidy turns out to be, on the whole, a disappointing proposition.

Price fluctuation is another aspect which requires some elaboration at this point. Seasonal variations in output prices are very pronounced in Nepal. The problem is more acute in the Hills where godown facilities for both input and output storage are very limited.[1] Hence seasonal price variations are more violent in the Hills than in the Tarai. For comparative purposes, the retail prices of some agricultural commodities from two representative locations, one in the Hills, the other in the Tarai are studied for a period of one year.

The price range (difference between the minimum and maximum price) of these commodities showed that 4 of them had higher price fluctuations in the Hills (Table 8.2). Only maize and millet which are rarely sold had lower price variations [Nepal, 1979].

[1]Godown owners are the co-operative societies, AIC offices, Food Corporation offices, and the farmers who by tradition own bins. Co-operative societies, as of 1979, possess a total of 11,580 tonnes of storage capacity in the Hills out of a total of nearly 50,000 tonnes for the whole country. These and the AIC godowns are used both for input and produce storage.

TABLE 8.2
MONTHLY AVERAGE RETAIL PRICES OF SOME AGRICULTURAL COMMODITIES

Commodity	Dec/ Jan	Jan/ Feb	Feb/ Mar	Mar/ Apr	Apr/ May	May/ Jun	Jun/ Jul	Jul/ Aug	Aug/ Sep	Sep/ Oct	Oct/ Nov	Nov/ Dec	Range	%*
							(Rs/kg)							
Hills (Sindhuli)														
Paddy	1.15	1.37	1.53	1.53	1.53	1.53	1.91	–	1.72	1.72	1.72	1.34	0.76	66
Wheat	3.52	3.52	2.52	2.35	1.91	1.91	2.06	–	2.35	2.35	2.35	2.06	1.61	84
Maize	1.76	1.91	1.98	1.99	1.95	2.06	1.91	–	1.76	1.76	1.76	2.06	0.30	17
Millet	–	1.67	1.59	1.44	1.75	1.82	1.82	–	1.52	1.52	1.52	1.52	0.38	26
Mustard seed	4.93	4.58	4.05	4.93	4.78	4.93	4.93	–	5.29	5.64	5.64	5.29	1.59	39
Potato	2.09	1.62	1.25	1.46	1.76	1.25	2.51	–	2.92	2.51	3.34	3.34	2.09	169
Tarai (Dhanusa)														
Paddy	1.50	1.50	1.61	1.58	–	1.58	1.74	1.74	1.74	1.66	1.54	1.61	0.24	16
Wheat	2.57	2.14	2.07	2.03	–	1.82	1.93	1.88	1.93	2.44	2.25	2.20	0.75	41
Maize	2.14	1.13	2.14	1.98	–	2.04	1.50	1.61	1.50	1.47	1.66	1.71	0.67	46
Millet	2.14	1.93	1.93	1.82	–	1.71	1.71	1.50	1.39	1.61	1.55	1.39	0.75	54
Mustard seed	5.00	5.0	4.50	5.0	–	5.50	6.0	–	6.0	6.0	6.0	6.0	1.50	33
Potato	1.50	1.25	1.25	1.62	–	1.75	2.0	2.0	2.5	2.5	3.0	3.0	1.75	140

Note: *Percentage is computed as range/minimum x 100.

Source: Nepal [1979].

Improving and expanding both on-farm storage facilities and the institutional godowns would alleviate this problem. Most farmers have to sell their produce immediately after harvest when prices are at their minimum and buy their consumption needs when prices are at their peak. Minimizing such price fluctuations would benefit this group of farmers. To overcome this, the Fourth Agricultural Credit Project financed by the Asian Development Bank (ADB) proposes to construct 10 batteries of low cost storage bins with 600 tonnes capacity in the Hills.

Regarding a pricing policy, the best agricultural price policy maybe to have no price policy at all. The forces of demand and supply would act as invisible hands in the determination of prices of input and output. If there has to be any price policy at all, it should aim at reducing wide price fluctuations and maintaining stability.

In Nepal, frequent government interference without proper knowledge of markets has disturbed agricultural price structures. The frequent restrictions on interdistrict and interregional movements, the introduction of a levy system and its changes, the growth of institutions and their ineffectiveness, and frequent changes in export regulations have all contributed to increasing market instability for farm products [Mathema, 1978]. The government has in the past attempted to stabilize prices by means of *ad-hoc* measures which have often led to stagnation or a long-run decline in production.

Past input-output price relationships have not been in favour of producers. The ratio of paddy and wheat prices to that of urea followed a declining trend which indicates an unfavourable price structure (Table 8.3). The price ratio of paddy to urea was 0.94 in 1970/71 and it declined to 0.83 in 1980/81. Similarly, the price ratio of wheat to urea fell from 1.07 in 1970/71 to 0.99 in 1980/81.

This unfavourable price ratio as seen in Table 8.3 explains why the yield for most cereal and cash crops has during the past decade remained stagnant or declined even though:

(1) the use of chemical fertilizer quadrupled;

(2) the use of improved seed increased by 500 percent;

(3) the total agricultural loans disbursed through institutional sources increased more than 12 times;

(4) the number of technicians working in the Department of Agriculture increased from 1,400 in 1970/71 to more than 3,200 in 1978/79;

(5) an additional 150,000 hectares were brought under irrigation; and

(6) the government expenditure on agriculture increased more than 7 times [IDS, 1980].

The fixing of a minimum support price for wheat and jute by the government has been ineffective due to the absence of adequate market intervention by the procurement agency. The floor price established in the past is either very much below the market price, in which case the government does not have to enter the market as a buyer, or it is set so high that the government is financially unable to procure. Neither case

Table 8.3
PRICES OF FERTILIZER AND GRAIN AND THEIR PRICE RATIO

Item	70/71	71/72	72/73	73/74*	74/75	75/76+	76/77	77/78	78/79	79/80	80/81≠
						(Rs/tonnes)					
Ammonium sulphate	950	1,000	1,000	1,658	1,658	1,980	1,870	1,870	1,870	1,870	2,400
Urea	1,342	1,535	1,535	2,193	2,193	2,440	2,440	2,440	2,440	2,440	3,100
Compound fertilizer	1,057	1,557	1,557	2,214	2,214	2,270	2,270	2,270	2,270	2,270	2,800
Triple super phosphate	945	945	945	965	945	3,825	3,825	3,825	3,825	3,825	2,700
Muriate of potash	779	895	985	1,553	1,553	1,573	1,573	1,573	1,573	1,573	1,573
Paddy (national average retail price)	1,260	1,410	1,650	1,790	1,740	1,740	1,590	1,920	1,990	1,930	2,560
Wheat (national average retail price)	1,440	1,660	2,290	2,470	3,110	2,510	2,170	2,460	2,600	2,730	3,070
Ratio of paddy and urea price	0.94	0.92	1.07	0.80	0.82	0.71	0.65	0.79	0.82	0.79	0.83
Ratio of wheat and urea price	1.07	1.08	1.49	1.13	1.42	1.03	0.89	1.01	1.07	1.12	0.99

Notes: *February 1974.
+December 1975.
≠September 1980.

Sources: AIC [1981].
Nepal [1981].

provides any incentive for producers. Furthermore, the whole purpose of a floor price is defeated when this price is announced only at the time of harvest. It is thus of no assistance to farmers in making economic production decisions. Ideally, it should be fixed well before planting begins.

Agricultural Credit

Agricultural credit is extremely important in a country like Nepal where most of the farmers are not in a position to bear the increased costs of production which are required in the shift from traditional to improved methods of farming or livestock rearing. Nearly 84 percent of the households in the Eastern Hills and 87 percent in the Western Hills consume all their farm produce and have no savings. Those who could save utilized their savings by allocating 29 percent for improved farming, 4 percent for moneylending, 24 percent for the purchase of land, 24 percent for education, 8 percent for the purchase of gold and silver and 11 percent for consumption or social ceremonies. Since the production of most farmers is barely over the subsistence requirement, the amount available for investment is practically negligible.

The first agricultural credit survey conducted by the Nepal Rastra Bank (NRB) in 1968 revealed that only 25 percent of the total credit needs was met by institutional sources. The rest was supplied by village moneylenders who charged an annual interest rate of as high as 60 percent as against a maximum of 16 percent charged by institutional sources.

Since credit is not a direct input in the production process but it simply augments the input purchasing power of farmers, the higher cost associated with borrowing indirectly increases the input cost. This, in turn, leads to a more conservative use of input. The increased supply of institutional credit and a network of credit facilities conveniently accessible to most farmers could serve as a good incentive for promoting hill agriculture. There is, however, a trade-off in economic terms between making such services easily available to farmers and the creation of a credit network. The financing institutions have to bear greater overhead costs in the Hills and Mountains because of the lesser credit transaction per unit area compared to the Tarai.

There are altogether 217 co-operative societies, 72 field offices of the ADB/N, and 124 field offices of commercial banks which cater to the credit needs of hill entrepreneurs. Most of these offices are concentrated in towns and important centres. In the Kathmandu district alone, there are 34 branches and sub-branches of two commercial banks and the ADB/N. The geographical area served by each office is 258 square kilometres. This density would be further reduced if it is acknowledged that the two commercial banks' share in agricultural financing is very limited. The expansion of a credit network in the Hills is thus constrained by the viability criteria, and heavy subsidization would be required if the government decides in favour of its development in the Hills.

Making adequate arrangements for easy-term credit alone do not fully ensure higher production. The input identified for better yield should be made available simultaneously. If this is not the case, the very purpose of making credit available is defeated. Improved seed, chemical fertilizer and chemicals for crop production as well as better breed, feed and veterinary services for animals are some of the input that has a potential for augmenting production, and should, therefore, be made accessible to interested entrepreneurs.

Irrigation

The advantages of improved seed and fertilizer technology can be fully reaped under irrigated conditions which bring about stability in yield. But the land area under public

irrigation schemes throughout Nepal is only 113,687 hectares. Of this total, the share of the Hills and Mountains is only 32,366 hectares, and the proportion of area perennially commanded by these schemes in the Hills is only 7,096 hectares [IFAD, 1978].

The introduction of lift-irrigation by water turbines without the use of imported fuel has added another dimension to the potential for expanding the area under perennial irrigation in the Hills. A few rivers and streams provide sufficient gradient to allow the operation of turbines which could be used for the generation of electricity, lifting water and the processing of grain. In the Western Hills, water turbines have reduced the grain processing cost from Rs 17.21 to Rs 4.71 per *muri*[2], and reduced the processing time by 19.3 hours per *muri* in the case of paddy.

The possibility of a threefold increase in the perennial irrigated area has been established [IFAD, 1978].

The government should provide a subsidy for covering the material cost of improvements made to smaller irrigation schemes. The existing policy of ignoring such schemes which command an area of less than 50 hectares has to be altered. There is adequate economic rationale to support this recommendation.

As for water management at the farm level, there exist effective water management systems in certain hill pockets which could be replicated in other areas. An excellent example of a well-functioning water management system is in the Arghali *Panchayat* of the Palpa district where 4 parallel channels, built some 2 centuries ago, command nearly 83 hectares with water from the Kurungkhola. The prominent management features here are:

(1) participation of all beneficiaries in the construction and repair of irrigation channels on a proportionate irrigated area basis;

(2) collection of fixed penalty fees from those members absent during the period of communal work;

(3) formation of water administration committees responsible for enforcing the jointly formulated agreements;

(4) collection of funds to cover additional unforeseen expenses on the basis of area irrigated;

(5) equitable distribution of water through the use of velocity corrected holes on wooden frames;

(6) rotational irrigation during peak periods of water requirement; and

(7) enforcement and collection of penalties from members violating the agreed principles.

Irrigation facilities do more than just increase and stablize yield. They greatly enhance the value of land with the indirect consequence of making the farmer more credit worthy in a system where loans are based on the value of land which serves as the collateral.

[2]One *muri* = 48.77 kilogrammes in the case of paddy.

Horticulture

Farmers in the Hills must allocate virtually all their land area for cereal production to meet their family consumption requirement. Fruit trees such as guava, orange, lemon and apple maybe more profitable in the long-run than food crops, but they are not widely grown because the allocation of land to horticultural crops would probably lead to starvation for the farm family during the gestation period of such crops. Thus the growing of fruit trees on a commercial scale is virtually non-existent despite its superiority over cereal crops in terms of environmental suitability.

A possible remedy to this would be to allow on a fairly long-term lease the use of public land by groups of farmers so that they may grow fruit on such land. This has been initiated in the Small Farmer Development Project at the Tupche *Panchayat* of Nuwakot district. A small group of farmers has been allocated public land from the *Panchayat* for a period of 30 years to grow orchard crops.

Another possibility would be to provide consumption credit to those farmers who wish to plant fruit trees. In such cases, the consumption credit should be continued until the orchard reaches maturity.

Livestock

Another important component of the agricultural sector is livestock rearing. The major constraint to livestock development in the Hills is the presently low productivity of pasture. It is estimated that most grazing land produces no more than 0.5 tonne per hectare of feed annually. Feed stuff supplied by pasture, forest, wasteland, crop residue, and fodder trees is in short supply. Excessive grazing on natural grazing land in the Hills has caused severe deterioration in the growth of shrubs and trees so that the ground cover to check soil erosion is either at a minimum or has vanished. It has also been found that the collection of one human porter load (30 – 40 kilogrammes) of fodder from the forest which used to take 3 or 4 hours a decade ago would now require 8 hours or longer [Rockefeller, 1976].

Livestock development should run parallel to pasture development, rotational grazing, and adequate fodder tree planting. Otherwise forest denudation will bring about grave consequences. Animal death due to diseases causes a great loss to farmers. The most prevalent disease in the case of ruminant is the liver fluke and the foot and mouth disease. Medicine for such common diseases should be made available in co-operative societies or through other arrangements convenient to farmers. An identification and insurance scheme, at least for larger and more expensive animals such as the buffalo, could reduce farmers' risks in rearing these animals. A buffalo insurance scheme is included in the proposal for the recently approved International Fund for Agricultural Development (IFAD) loan.

Other Factors

In the absence of essential surveys and land maps, land revenue for 34 out of the 55 hill districts is collected on the basis of previous land ownership records.

In the share cropping system the output is shared on an equal basis, while all input costs are borne by the share tenant. In such a system, share tenants have little or no incentive to adopt improved farming practices for better yield. The fixed rental system, as is being practised in districts where land administration is in force, would be the correct policy for encouraging tenants to increase production. The lack of assured tenancy rights has also deprived them of access to institutional sources of credit.

Strengthening tenancy rights and the enforcement of a fixed rental system in all districts are positive production incentives for tenants. Even those who have formal

tenancy rights have little incentive to increase output as the rights do not qualify them for such institutional credit. Arrangements should be made to allow tenants with formal tenancy rights access to institutional credit. The mere passing of laws by themselves is not enough; they must also be implemented.

The landowner–tenant relationship in Nepal is typical of less developed countries. Tenants rely heavily on landowners who also serve as moneylenders. Breaking this relationship and rendering tenants independent of landowners is a Herculean task. The full enforcement of the fixed rental system would, therefore, be effective only when the government provides those services to tenants that they would otherwise receive from landowners.

Mosher [1966] states that another important incentive to farmers is the public recognition accorded them for being successful. He writes that when a nation holds a celebration on the occasion of the completion of a steel mill and not when a farmer doubles his rice production, it gives the impression that industrialization is an achievement but becoming a modern farmer is not. Arranging recognition awards, such as prizes for the best producers on a regional basis, could, therefore, arouse farmers to do a better job of farming.

Conclusion

To summarize, it is fair to say that there exists adequate potential for productivity increases in agriculture as well as prospects for overall hill development, including the non-farming sector. Past efforts and incentives have been haphazard, *ad hoc* as well as inadequate for augmenting hill production and, therefore, care should be taken to avoid such policy measures in the future.

Nevertheless, there is some benefit to being underdeveloped since what remains to be done can be regarded as potentials for development, while other countries have almost exhausted theirs. Nepal has access to ready-made techniques. For example, with the massive propagation of the presently available seed-fertilizer technology, there could be significant production increases in hill agriculture. Other developed countries would have to look for better varieties at a high marginal research cost (because of diminishing returns in the research process) in order to further increase their agricultural production.

REFERENCES

AIC. 1981. *Progress Report.* Kathmandu: Agricultural Inputs Corporation (Unpublished).

APROSC. 1978. *Agricultural Extension Project, Phase II.* Kathmandu: Agricultural Projects Services Centre.

APROSC. 1981. *Agricultural Price Policy.* Kathmandu: Agricultural Projects Services Centre (Draft Report).

Chapagain, D.P. 1976 "Agricultural Productivity Pattern in Nepal and its Regional Variation." M.Sc. diss. University of Philippines.

IDS. 1980. *Agricultural Sector in Nepal, Report of Phase I Study.* Kathmandu: International Development Services.

IFAD. 1978. *Report of the Special Programming Mission to Nepal.* Rome: International Fund for Agricultural Development.

Mathema, P.R. 1978. *Agricultural Prices Situation in Nepal.* Kathmandu: Department of Food and Agricultural Marketing Services.

Mosher, A. 1966. *Getting Agriculture Moving.* New York: Frederick J. Praeger and Co.

Nepal. 1979. *Agricultural Marketing Information Bulletin.* Kathmandu: Department of Food and Agricultural Marketing Services, Vol. 9 (77)

Nepal. 1981. *Grain Prices.* Kathmandu: Department of Food and Agricultural Marketing Services (Unpublished).

Rockefeller Foundation Study Team. 1976. *A Study of Hill Agriculture in Nepal.* New York: Rockefeller Foundation Study Team Report.

USAID. 1976. *Integrated Cereal Project.* Kathmandu: United States Agency for International Development (Draft Project Paper).

9
Hill Labour Migration: Issues and Problems

M. M. SAINJU and RAM B. K. C.

Introduction

In Nepal, migration and its accompanying array of problems has emerged as the most challenging phenomenon to the government. Its early trend where Nepalese went abroad for employment has been overshadowed by the steady movement of people from the Hills and Mountains to the Tarai. The rapidly increasing interregional migration is more than just a demographic problem. It contains economic, ecological, social and political dimensions and is a matter of great concern to both planners and policy-makers.

While migration during the last two centuries was characterized by many positive features, the recent movement of people from the Hills to the Tarai brought about a number of socio-economic repercussions. The drain on the hill labour force, ecological imbalance and the declining hill economy on the one hand, and encroachment of forest land, resettlement problems and the negative impact on the Tarai economy on the other become critical issues for Nepal, and they are looming larger everyday.

As shown below, there are basically two kinds of migration, each having its own set of reasons and consequences. Firstly, there is migration to and from foreign countries, mainly India, which is of a permanent or long-term nature. The migration of Nepalese to take up service in the Indian or British Gurkha regiments, and of Indians settling in the Tarai are examples of this kind of population movement. Secondly, there is the migration within Nepal itself, which is of both a seasonal and permanent nature. While seasonal migration takes place within the Hills, and between the Hills and the Tarai, permanent internal migration is almost exclusively in one direction, that is, from the Hills and Mountains to the Tarai.

This paper analyzes recent trends and characteristics of the general migration pattern, and focuses particularly on the causes and consequences of Hill to Tarai migration. A few general policy implications are discussed and recommendations made for further research.

Migratory Trends

The data available are inadequate to give precise estimates on the magnitude and importance of different types of migration, but they can provide a general indication of trends. Such data are obtained from the last three population census and some recent studies.

Permanent Emigration

Systematic data are not available on the extent of Nepalese emigration. The Indian census recorded 82,071 Nepalese living in India in 1951 and 133,524 in 1961, but these figures are not consistent with the Nepalese census which estimated 157,323 in

1952 – 54 and 302,162 in 1961 [Rana and Thapa, 1975]. In recent years this population flow appears to be decreasing, whereas the repatriation of Nepalese from India and abroad is increasing.

Long-Term Emigration

In Nepal, long-term emigration involves largely the movement of people for employment as *durbans* (gatekeeper) and *chowkidars* (watchman) or for service in the Gurkha regiments of the British and Indian armies to fulfil the traditional desire of being a *lahure* (soldier). These migrants are away from Nepal for most of their productive years, but they maintain strong ties with their homes through periodic visits and usually retire in Nepal on their pensions.

According to the 1961 Indian Census, 129,000 Nepalese stayed in India from 1 to 15 years; 76,600 from 6 to 10 years, 66,200 from 11 to 15 years, and 132,799 for more than 16 years [Weiner, undated]. Emigration for the purpose of becoming a soldier has decreased recently due to a reduction in recruitment for the British regiment. But other data suggest that emigration for non-military occupations is increasing and diversifying.

Permanent Immigration

Immigration is a matter of concern in Nepal where the population growth rate is still high. Not only have refugees of Nepalese origin returned from Burma, Malaysia and Assam, but Nepal has also received Tibetan refugees, Bihari Muslims, and a large number of other Indians. Most of them have settled in the Tarai, and some have moved to urban areas. Foreign citizens in Nepal constituted 1.2 percent of the total population in 1961 and 2.8 percent in 1971 [Thapa and Bista, 1977]. In 1971, of the foreign-born population, 96 percent were Indians and 95 percent lived in the Tarai, primarily the Eastern Tarai. The other immigrants came from Burma and China.

Internal Migration

Rural-Urban Migration

Migration in Nepal is primarily a rural to rural rather than a rural to urban movement. Even in Kathmandu, only 1.3 percent of the total population can be classified as immigrants. Rana and Thapa [1975] estimated that in 1971 the net migration in the Kathmandu Valley was negative. Although the urban population increased from 336,000 to 462,000 between 1961 and 1971, and to 827,000 in 1980, rural-urban migration did not appear to have played an important role. About two-thirds of a sample of 1,088 rural-urban migrants studied by Thapa and Tiwari [1977] came from the Eastern and Central Development Regions. The Hills and the Mountains were the origin of 75 percent of the total sample.

Seasonal Migration

Seasonal migrants leave their homes for a few months, mostly during the agricultural off-season, for work in other parts of the country. Such migration also occur for (1) trade purposes including the exchange of goods such as herb, fruit, and ghee for manufactured items, (2) pasturing cattle, and (3) collecting land rent. Seasonal migration reaches a peak during the agricultural slack period, that is, from November to March, and is most common among hill residents. According to a 1977 study of the Surkhet region, about 83 percent of the total seasonal migrants in March 1973 were from hill districts, and the rest originated from the Tarai (Gurung, *et al.* 1973).

Permanent Hill-Tarai Migration

Internal migration in Nepal is not a new phenomenon. Migration from the Hills and the Kathmandu Valley into the Tarai was encouraged by the Rana rulers to maintain the political *status quo* and enrich the treasury through forest resources and land revenue. What is new is the unprecedented size of Hill to Tarai migration. Until the early 1950s, malaria, an inhospitable climate, and inaccessibility placed a limit on the scope of such migration. Internal migrants numbered just 13,380 in the 1952/54 population census.

However, with malaria eradication and infrastructure development, the Tarai was rapidly opened up for settlement. Internal migration increased to 178,000 in 1961. By 1971, it rose to 506,921 of which the Hills and the Mountains were the origin of 96 percent of the migrants. They came mainly from the Eastern Hills and settled in the Eastern Tarai. Their number was 2.6 percent of the total population in 1952/54, 4.1 percent in 1961, and 4.4. percent in 1971 [Rana and Thapa 1975].

Records show that 50,000 families were settled in the Tarai by the Resettlement Company and the Department of Resettlement during the Fourth and Fifth Plan period. But illegal settlers were also settled through special commissions and other government agencies. It is estimated that 25,000 families will be resettled by the government during the Sixth Plan [Nepal, 1980]. The breakdown of in and out-migrants according to the 1971 population census is shown in Table 9.1.

TABLE 9.1
INTERNAL MIGRATION IN NEPAL, 1971

Area	In-migrants	Out-migrants	Net-migration
Eastern Mountains	6,385	37,916	– 31,531
Eastern Hills	17,498	186,843	– 169,345
Eastern Plains	185,799	10,267	+ 175,532
Kathmandu Valley	26,440	45,484	– 19,044
Central Mountains	1,223	22,095	– 872
Central Hills*	29,752	140,642	– 110,890
Central Plains	161,751	6,504	+ 155,247
Western Mountains	2,125	9,681	– 7,556
Western Hills	5,063	65,750	– 60,687
Western Plains	70,885	1,739	+ 69,146
Total	506,921	506,921	0

Note: *Excludes Kathmandu Valley.

Source: Nepal [1971].

Information on the age, sex and race of migrants is scanty. The Population Sample Survey of 1976 reported that out of 131,727 internal migrants, 66 percent were males. According to resettlement programmes in areas such as Kanchanpur, Bardia, Banke, Nawalpur, Jhapa, and Sijuwa, 48 percent of the settlers were Bahun and Chhetri, 13 percent were Magar, and the rest consisted of the Tamang, Gurung, Newar, Rai Limbu and other ethnic groups. The average rate of literacy among settlers was 28 percent. Farmers constitute 87 percent of these settlers, while 7 percent were unskilled labourers.

Hill-Tarai Migration: Causes and Consequences

Several models including those focusing on benefits and costs, expected income, and intersectoral linkages have been put forward to explain migration [Rhoda, 1980]. Based on these concepts, a number of hypotheses can be established that relate migration to other variables. This helps us to understand the various causes and consequences of migration and also establishes a framework for empirical testing. The most relevant hypotheses for hill migration in Nepal are:

(1) the flow of migration is associated with income inequality, productivity, and economic development;

(2) high man-land ratios, subsistence and marginal farming, and landlessness encourage migration;

(3) there is a direct relationship between industrial activities and internal migration;

(4) migration occurs from an area of low per capita government investment to an area where per capita government investment is higher;

(5) areas of affluence and better facilities attract migrants:

(6) families with more male members migrate more rapidly than those with fewer male members;

(7) interregional and intercaste marriages cause more migration than otherwise;

(8) interregional migration neutralizes class and group barriers and promotes national unity;

(9) migration drains the origin-areas of its change agents and leadership, and creates socio-political tension in the destination area.

(10) migration is related to the geographical and spatial distribution of population;

(11) interregional migration affects fertility rates in both receiving and sending areas; and

(12) resettlements and land reform programmes directly influence the rate of migration.

Causes of Hill Migration

Reasons for hill migration include income disparity, low levels of economic development, small fragmented holdings, landlessness, absence of economic and social amenities, uneven distribution of population, establishment of new development and settlement programmes in other areas, natural calamities and ecological imbalances. Also important considerations are differences in human capital such as skill, knowledge, training, and education; in economic resources such as land, capital, and technology; and in social factors such as organization and leadership.

Economic

Of all these variables, the economic ones predominate. They act as the "push" and "pull" factors for population movements. "Push" factors include the steadily deteriorating economic conditions of the Hills which have a high population and man-land ratio, limited employment opportunities, low income, income inequality, urban bias of past development efforts, indebtedness, and food shortages. The relatively better economic conditions in the Tarai act as the "pull" factors. The cultivated land per household in the Hills is 0.5 hectare as compared to 1.6 hectares in the Tarai. The annual average family income in the two regions is Rs 4,500 in the Hills as compared with Rs 6,000 in the Tarai. The population living below the poverty line is 72 percent in the Mountains as against 32 pecent in the Tarai.

Institutional

Resettlement and land redistribution programmes in the Tarai are attractive to the land-hungry people of the Hills. The Rapti Valley Development Programme which was started in the Chitwan district in 1956 was the first in a series of such resettlement programmes. They were intended to rehabilitate the landless and flood victims of the Hills. In later years they also catered to marginal farmers, repatriated Nepalese from Assam and Burma, and low income, low caste workers such as blacksmiths, shoemakers, and tailors. With the founding of the Nepal Resettlement Company in 1964 and the Department of Resettlement in 1969, many planned and fringe settlements were developed all over the Tarai. Bu June 1980, the Resettlement Company, assisted by the United Nations World Food Programme and the International Development Agency, had settled approximately 14,000 families in about 30,000 hectares of land. The Department of Resettlement had relocated about 34,000 families by the end of the Fifth Plan period. It provided land, food, education, housing plots and built the minimum infrastructure required for these settlements.

Improved transportation and communication facilities and the availability of temporary jobs, trade and business opportunities, marketing facilities, employment opportunities in construction and agriculture are other economic factors that "pull" migrants from the Hills and Mountains to the Tarai.

Social

Social considerations such as kinship, marital ties, friendship, social relationships, health, and education also influence migration. In a survey of 435 migrants, 84 percent reported that they had prior knowledge of their destination and most of them had acquired this information from friends and relatives. Thirty-five percent of these migrants said that kinship, marriage ties and friends were the main reasons for their relocation. Social infrastructure including education, health facilities, electricity and entertainment accounted for 46 percent of the reasons given for migration.

Natural

Natural factors such as climate, earthquakes, floods, soil erosion, and landslides have also contributed to population movements either within or outside the country. The single most important influence among the "pull" factors is the success of the malaria eradication programme in the Tarai in the late 1950s. Traditionally, farmers would go to the Tarai to cultivate fields and they stayed there for only the minimum amount of time needed before returning to their settlements in the higher altitudes. Only one ethnic group – the Tharus who has genetically adapted to the tropical conditions and is immune

to malaria did establish permanent settlements in the Tarai. However, when this disease was eradicated in later years, it became possible for the hill people to establish permanent holdings in the lowland. Meanwhile, the increasing population pressure in the Hills is causing deforestation, soil erosion and landslides especially when farmers are compelled to cultivate steeper and steeper slopes in their search for new agricultural land. In the recent past, the great earthquake in the Far-Western region and a number of other minor ones have also prompted the movement of people from the Hills to the Tarai.

Demographic

Although migration both within and outside the country is triggered primarily by socio-economic factors, population growth is another relevant reason which influence it. Nepal's population has increased from 9.4 million in 1961 to 11.6 million in 1971, and it is estimated to have reached 14.3 million in 1980 (Table 9.2). The growth between 1971 and 1980 in the Hills and Mountains was 21 percent as against 28 percent in the Tarai. Today, the density per square kilometre in these regions is 76 and 180 as against 65 and 127 respectively in 1971. The Hills, however has a considerably higher population density per unit of cultivable land than the Tarai.

Consequences of Hill Migration

Economic

Some of the current and potentially adverse effects of undirected and unrestricted migration to the Tarai are:

(1) destruction of forest resources and environmental modification which affect long-term productivity;

(2) increasing labour force which could outstrip the opportunities for its productive employment,

(3) aggravated tensions caused by competition for land;

(4) increasing disparity in income distribution; and

(5) a growing class of landless labourers [Rana and Thapa 1974].

Up-to-date records of forest encroachment due to migration are not available, but it is estimated that in 1928, of the total 638,300 acres of forest land in the Eastern Tarai, only 205,000 acres are still under forest today.

The man-land ratio in the Tarai has gradually increased over the years, and in 1980 agricultural land per capita was only 0.3 hectare. The Tarai which is the rice granary for Nepal has not experienced significantly expanded productivity despite the greater use of agricultural input. Rice production increased by only 7 percent during 1967/68 to 1977/78 [Nepal, 1978].

Regional Disparity

The problem of interregional disparity has grown rather than diminished with the flow of people from the Hills to the Tarai. Regional inequalities can be observed with regard to investment in socio-economic infrastructure and other general facilities. The government will be compelled to invest more in the development of the basic needs of the Tarai and thereby cause greater imbalances in regional development within the country. Migration will also drain the Hills of its change agents and leadership, besides transferring

TABLE 9.2
POPULATION OF NEPAL

Region	1952 – 54 Population ('000)	1952 – 54 Density (per sq km)	1961 Population ('000)	1961 Density (per sq km)	1971 Population ('000)	1971 Density (per sq km)	1980* Population ('000)	1980* Density (per sq km)
Eastern Region	1,931	69.0	2,274	81.2	2,798	99.9	3,386	120.95
Hills and Mountains	1,005	52.7	1,318	62.9	1,410	67.3	1,650	78.73
Tarai	826	117.5	956	135.9	1,388	197.3	1,735	246.60
Central Region	2,685	95.2	3,073	109.0	3,866	137.1	4,826	171.05
Hills and Mountains	1,296	68.7	1,747	92.6	2,096	111.1	2,574	136.49
Tarai	1,389	148.1	1,325	142.6	1,770	189.6	2,252	241.27
Western Region	1,779	48.7	1,998	54.7	2,465	67.5	3,010	82.46
Hills and Mountains	1,415	43.5	1,580	48.6	1,870	57.5	2,257	75.48
Tarai	364	91.6	418	105.1	595	149.5	753	189.69
Far-Western Region	1,840	34.9	2,068	39.3	2,427	46.1	3,040	57.69
Hills and Mountains	1,516	39.0	1,698	43.7	1,834	47.2	2,215	52.61
Tarai	324	23.3	370	26.8	593	43.0	825	27.32
Nepal	8,235	56.6	9,413	64.7	11,556	70.5	14,262	98.10
Hills and Mountains	5,331	47.9	6,343	57.0	7,210	64.8	8,697	75.99
Tarai	2,904	85.0	3,070	89.9	4,346	127.3	5,565	179.88

Note: *Projected figures.

Source: Nepal [1952 – 54, 1961 and 1971].

resources and skills from it to the Tarai, and thereby add more strength to the latter's development and deprive the former of its development potential.

On the other hand, it has been postulated that the opening of the Tarai for settlers from the Hills will promote economic and social integration between the two regions, relieve population pressure in the Hills, neutralize class and group barriers, develop national unity and discourage discrimination between the *Pahari* and *Madhishe* (Hill and Tarai people). Some encouraging trends can be seen in these areas.

Socio-Political

Migration has also been encouraged for political reasons. This applies mainly to national integration. It is only after migration that many new settlers have been elected or nominated as *Panchas* (members of village assembly) and even as *Pradhan Pancha* (head of village assembly). This portends well for national integration but there is also a growing concern that this can lead to political and social conflicts between migrants from the Hills and the indigenous Tarai people. In many countries, the movement of people of diverse linguistic groups into competitive economic positions has resulted in social and political tensions. While this situation has not arisen in the Tarai it does suggest that migration should be regulated as well as selective.

Environmental

Migration within the Hills and from the Hills to the Tarai has often enhanced the possibilities of natural disaster. Extensive deforestation has resulted in floods which have frequently caused extensive damage to productive cropland in the Tarai. The forest area of Nepal decreased by 34 percent from 1964 to 1980, and if this trend is allowed to continue, production from Nepal's forest resources will decline to a point where there will be a need in the near future to import from neighbouring countries at very high prices, products which Nepal is currently selling cheaply.

Migration is also stepping up the labour supply in the Tarai while the Hills is experiencing a labour shortage especially in the construction industry and development projects. For example, it is observed in the Dhangadi-Dadelhura Road Project that although more than 50,000 people are partially unemployed in the Dadeldhura and Doti districts, on the whole labour participation from these two districts is very low. Most of the workers for the project are drawn from such districts as Ramechhap, Jumla, Sindhuli, Palpa, Baglung, Rolpa, Gorkha and the neighbouring districts of India.

As pointed out earlier, hill migration to the Tarai will place a greater pressure on the government to organize more resettlement programmes which require additional resources for the setting up of more basic socio-economic infrastructure. The Land Reform Programme which is designed for the equitable and productive distribution of land and greater agricultural production will be greatly affected. With the rising movement of people from the Hills to the Tarai, the man-land ratio in the Tarai will become very unfavourable, affecting the productivity of land and creating many layers of lease, tenancy, subtenancy and even artificial tenancy situations which will ultimately open the way for the eviction of tenants. This may cause further forest encroachment, labour unrest, and more intensive migration both inside and outside the country, and involve numerous national and international problems of a socio-economic and political nature.

Directions of Research on Migration in Nepal

Based on the foregoing analysis and on expected needs, it is possible to identify some of the following major areas which require serious research.

(1) Will the migratory trend which so far has been primarily from rural to rural areas with its negative impact on both the receiving (Tarai) and sending (Hills) ends continue, and does this trend need to be reversed?

(2) The implications and consequences for the country as a whole of a population trend in which external migration has declined and intra and interregional migration has increased.

(3) In-depth and macro-level studies are needed to help planners and administrators in policy decisions which involve the flow of migrants to productive regions, and the utilization of the rapidly increasing labour force in the Tarai. So far only partial studies and general observations have been made.

(4) Measures which should be taken in the Hills to prevent excessive migration from this part of the country. At present economic factors appear to be the most influential which determine both the internal and external movement of Nepalese. Therefore a detailed and extensive examination of these factors is imperative.

(5) As hill migration and the depletion of forest areas are closely interrelated, can migration be directly linked to deforestation and can its control help save and conserve Nepal's forest resources?

(6) Has the country's resettlement programme solved or abetted the migration programme in terms of whether it has succeeded in distributing land to the landless and the needy satisfactorily? How long and to what extent should such programmes be carried out in the Tarai? Can some of them be substituted by Hill Resettlement Programmes?

(7) As inter and intra-regional migration are desired for a spatial and equitable distribution of population and for balanced economic development, to what extent has this been achieved, and if not, what corrective measures should be taken?

(8) As population pressure coupled with economic problems in the Hills have motivated migration, what suitable population policies in respect of both the Hills and the Tarai should be adopted and implemented?

(9) As the addition of repatriated Nepalese from Assam, Burma and other countries has complicated the situation, how can Nepal reconcile repatriated and internal migration and what other alternatives can be adopted apart from resettlement in the Tarai?

(10) For purposes of policy-making and to launch suitable population programmes, detailed information and reliable data are essential, but at present only limited information on regional and international migration, composition, direction and magnitude of migration, and its impact on both the areas of "origin" and "destination" are available. Hence, the data base on migration should receive more attention.

A review of available studies and recent literature on Nepalese migration reveals the information gap facing planners and administrators. Substantive overview studies [Rana, 1973; Rana and Thapa, 1974] have been done, but in-depth subject matter research is scanty. Some of the demographic aspects of migration in Nepal have been studied by Gurung [1975] and Sainju [1974]. Many researchers such as Gurung *et al.* [1973], Thapa and Bista [1977], and Thapa and Tiwari [1977] have used case studies to examine the reasons for migration but its impact on economic, social, and cultural integration has been dealt with in only a limited way. Elder [1976] has analyzed the socio-economic characteristics of migrants in resettlement projects.

The impact of migration on development activities in both the sending and receiving areas should be studied. The quantification of surplus labour and its use for productive purposes have yet to be made. Environmental change and socio-economic integration or disintegration have to be measured. The type of development activities and social changes in the Hills that influence migration have to be identified. The extent to which migration has helped spatial distribution of population and its influence on the fertility rate and population policy have also to be studied. The extent of its contribution to economic development, particularly agricultural production and industrial expansion, has also to be reviewed and evaluated.

Policy Implications

A number of policy implications emerge from the preceding analysis of migration, its composition, pattern, trend, volume and impact.

In Nepal and in many other developing countries, economic factors appear to predominate and determine the direction and magnitude of migration. Since poverty and scarcity have largely acted as the "push" factors, and richness and plenty as the "pull" factors, the most crucial policy implication centres on the economic development of the Hills, especially those areas which suffer from the greatest out-migration. As agriculture is the most important occupation for the vast majority of people, priority should be given to its development, particularly to feed and employ the population who would otherwise migrate to the Tarai or across the border.

Hill crafts and cottage industries should be revived and promoted to meet the demand of tourists, the local population, and also for export. This would assist in the absorption of surplus labour and also increase production and income.

The settlement and resettlement programmes in the Tarai should be well planned and not be merely systematized and legalized. This strategy requires the identification of surplus labourers, landless farmers and victims of natural calamities from the Hills, and their resettlement in well-planned settlements rather than on marginal plots. Resettlement programmes aimed at intensifying hill agriculture and promoting small-scale agro-industries should be attempted in the Hills.

Appropriate land use, soil conservation and flood control measures, and the conservation and development of forest are important measures that will conserve natural resources, expand agricultural activities, and absorb the surplus labour of the Hills. Agrarian activities and forest-based industries should be upgraded and intensified to help reduce the outward flow of labour from the Hills.

In order to reduce the rapid movement of people to other countries, past development patterns should be changed. There should be more investment in rural development programmes and more construction work should be started in the Hills by using local labour and local resources. With appropriate rural development strategies in the Hills, the migration pattern can be altered to movement within the Hills themselves rather than from the

Hills to the Tarai. In this respect, it is also desirable that priority should be given to producing skilled workers such as bricklayers, carpenters, masons, blacksmiths and plumbers who can replace Indian workers in the construction of rural roads, canals, and buildings. Such rural public work projects provide attractive employment opportunities to the hill people and therefore help reduce the level of Hill-Tarai migration.

The development of social infrastructure in the Hills will also contribute towards curbing migration to the Tarai. This includes the provision of education, health services, water, sanitation, electrification, transportation, market centres, and medical facilities. Family planning measures should also be implemented to reduce the birthrate.

The situation of poverty and scarcity in the Hills has been further aggravated by the population pressure. Its population growth should be such that it could make the most productive use of labour and create more employment opportunities for potential migrants. In other words, birth rates should be reduced by the use of direct family planning measures together with indirect approaches such as economic, social, cultural and educational development. The movement of hill people to the Tarai, and within the Hills should be systematized. Likewise, the population should be redistributed according to economic resources and development activities. If it is necessary that internal migration should be regulated, external migration should also be regulated, controlled, and rationalized accordingly.

Although economic and social factors are largely responsible for migration, politics can also sometimes influence migration. Migration policy, however, should above all be motivated by economic and social factors, and not by political issues.

Conclusion

On the basis of the preceding analysis of causes, issues and problems, the policy implications for Nepal can be summarized as follows.

	Empirical observations	Policy implications
(1)	Positive correlation between hill out-migration and its deteriorating economic conditions.	Hill development including agricultural development should be accelerated to generate more income and employment opportunities.
(2)	Positive correlation between hill migration and high population pressure.	Suitable population policy with greater concentration on development activities should be fostered to reduce such migration.
(3)	Positive correlation between hill migration and resettlement programmes in the Tarai.	Controlled and regulated resettlement programmes in the Tarai, selective resettlement programmes in the Hills and more investment in the Hills should be adopted.
(4)	Positive correlation between migration and the unequal distribution of land.	Effective land reform programmes and systematic settlement programmes could help solve this problem.
(5)	Positive correlation between migration and availability of basic facilities.	Social services and facilities including health, education, infrastructure and other amenities should be provided.

(6)	Positive correlation between migration and investment.	Balanced and regional approach to development should replace uneven concentration of investment.
(7)	Correlation between hill migration and urban attractions.	Access to urban facilities should be made through the growth of small cities, markets and commercial centres.

REFERENCES

Elder, J.W. *et al.* 1976. *Planned Resettlement in Nepal's Tarai.* Madison: Institute of Asian Studies, University of Wisconsin.

Gurung, H. 1975. "The Population Aspects of Development." *Population and Development in Nepal.* Kathmandu: Centre for Economic and Development Administration.

Gurung, S. B. *et al.* 1973. *Causes and Impact of Migration: Preliminary Survey in Surkhet Region* Kathmandu: Centre for Economic and Development Administration (Mimeograph).

Nepal, 1952 – 54, 1961, 1971. *Population Census of Nepal.* Kathmandu: Central Bureau of Statistics.

Nepal. 1978. *Handbook of Agricultural Statistics.* Kathmandu: Ministry of Food, Agriculture and Irrigation.

Nepal. 1980. *Sixth Five-Year Plan (1980 – 85).* Kathmandu: National Planning Commission.

Rana, R. S. 1973. *Migration in Nepal: Implications for Spatial Development.* Kathmandu: Centre for Economic and Development Administration.

Rana, R. S. and Thapa, Y. S. 1974. "Population Migration: Causes, Consequences and Policy Implications." *Population and Development in Nepal.* Kathmandu: Centre for Economic and Development Administration.

Rana, R. S. and Thapa, Y. S. 1975, "Population Migration: Nature and Scope." *Population and Development in Nepal.* Kathmandu: Centre for Economic and Development Administration.

Rhoda, R. E. 1980. "Development Activities and Rural-Urban Migration." *Development Digest* 8(4).

Sainju, M. M. 1974. "Population and Development Policy." *Population and Development in Nepal.* Kathmandu: Centre for Economic and Development Administration.

Thapa, Y. S. and Bista, K. B. 1977. *Migration in Nepal: A Study of Far-Western Development Region.* Kathmandu: Centre for Economic and Development Administration.

Thapa, Y. S. and Tiwari, P. N. 1977. *Migration Pattern in Kathmandu Urban Areas.* Kathmandu: Centre for Economic and Development Administration.

Weiner, M. (undated). "The Political Demography of Nepal." *Population and Development in Nepal.* Kathmandu: Centre for Economic and Development Administration (CEDA Study Series, Seminar Paper No. 2).

10
Technological Innovations for Hill Agricultural Development

S.B. NEPALI and I.R. REGMI

Introduction

This paper surveys the technological innovations and improved management practices required for hill agricultural development, and recommends some administrative and institutional improvements necessary for the generation and delivery of new technology to hill farmers. The need for an organization to co-ordinate diverse governmental efforts in agricultural research is highlighted.

Agricultural Development

In the early sixties, the government took the initiative of generating new technology which could increase food grain production in the Hills. Agriculture, horticulture and livestock farms were established in various development regions. Steps were taken to provide veterinary services by creating new veterinary posts and hospitals. Later, such a development strategy and priority was placed on the expansion of food grain production in the Tarai, when it was recognized that this area possessed a better production potential and is more accessible geographically. As a consequence, agronomic farms in the Hills were either abandoned or their activities were diverted to focus solely on horticultural crops. It was the general expectation that the enlarged agricultural investment in the Tarai would have a trickling down effect on the hill agricultural economy. Unfortunately, this development did not materialize.

The Sixth Five-Year Plan (1980 – 1985) recognized that the present technological generation and extension activities were ineffective, and the credit, input, irrigation, co-operative (*Sajha*) and land reform programmes were unco-ordinated. It thus realized that agricultural development programmes to be meaningful must be strengthened to meet the urgently needed improvements of the hill economy.

The current Plan proposes to step up the per capita daily calory intake from 2,181 to 2,266 grams and the protein intake from 56.6 to 59.8 grams. This would represent about 200 kilogrammes of food grain per capita per annum. In the previous Plan, due to a shortage of food availability in the hill and mountain regions, the proposal was to recommend 160 and 140 kilogrammes of food grain per capita per year respectively as against 190 kilogrammes for the Tarai where its food production surpasses its consumption requirement.

To achieve the proposed production target, a greater emphasis is being placed on the provision of irrigation to raise river banks with agricultural potential. All agricultural agencies are also integrated in order to maximize food production. Encouragement is given to develop food grain, cash and horticultural crops in the Hills and Mountains, in addition to encouraging livestock raising in the latter. A stronger stress is laid on grain production and export-oriented crops in suitable areas of the country, reduction of

postharvest losses, an integrated approach to horticultural and livestock production and income-generating activities based on agricultural raw materials. Priority is also being accorded to the development of irrigation and local organizations and the production of agricultural input such as seed and manure.

The basic needs approach of the Sixth Plan has shifted to pay due recognition to the maximization of production and opportunity for productive employment. This approach is meant to offset the deteriorating economy of the country as a whole and in the Hills in particular where a vast majority of the people are struggling for a living.

Against such an economic background, special attention and actions are being taken to sustain the existing hill population within the prevailing agricultural system. It is acknowledged that despite the basic needs approach, the difficulties of meeting the desired target will remain. Nevertheless, the government policy will be one of directing all available resources in the best possible way to meet the economic demands of the hill people and at the same time maintain or even attempt to improve the hill environment.

In adopting this approach, however, the hill areas cannot be regarded as a complete economic unit by itself. It must be viewed as a part of the national and ultimately the international economy. Therefore, in addition to basic food production, the Hills should be developed so as to be able to produce those commodities which other regions are not in a position to do so competitively. This will ultimately lead to the integration of the nation's economy between ecologically different regions and thereby pave the way for the absorption of innovative technology and the progress of hill agriculture.

New Technology and Management Practices

The generation of appropriate technological innovations requires in the first place an identification of technological gaps in the farmers' fields. Shrestha [1978] identified a number of critical issues in the development of hill agriculture such as compost, chemical fertilizer, new seed, intensive farming, irrigation and drainage, terracing, fruit production, improved animal husbandry and fodder production. He also emphasized the need for multidisciplinary research.

Technological innovations should be directed towards the optimum use of resources to maximize production and income of the population without jeopardizing the most important resource base — land. Most hill farmers are aware of the need for good tillage, manuring, timely and proper irrigation, and the importance of good seed for maximizing their production. But they have as yet to receive the required technical support.

Farmland Management

Terracing is the traditional farming method which enables cultivation to be carried out in the Hills [Nepali, 1981]. But the productivity of such terraces diminishes due to soil erosion. Various techniques and methodologies are required to minimize this erosion. One simple technique focuses on improving the terrace slope to allow the rain-water to percolate so that less soil will be washed away. The technology relating to the cultivation of suitable, economical, and acceptable cover crops during the rainy season should also be investigated.

Organic Manure

Due to the loss of grazing and forest land, the amount of farmyard manure that is supplied from livestock has decreased substantially and this has contributed to a decrease in soil productivity. Paradoxically, in spite of the increase in livestock population, the

quantity of farmyard manure applied has decreased. Improved and rapid compost methodology, aided by the use of bacteria culture will assist farmers in adding more nutrient to the soil.

Gobar gas plants which are in use in the warmer parts of the country could be a practical answer for obtaining gas for fuel and slurry for fertilizer [Mahkijani, 1975]. This installation has to be modified to meet the requirement of the Hills.

Seed

The selection and production of high quality seed and plant with high production potential would help hill farmers step up their production. However, modern seed technology has as yet to reach them.

Water Management

The technology of water management is scanty if not absent. Its importance in agriculture is known by farmers, but its use is not regulated as required. Major crops depend on the monsoon rain which is abundant in Nepal. During the monsoon season 75 to 80 percent of the rain-water goes to waste. Its collection at hilltops by dams contructed in certain catchment areas, as in the case of Cyprus or Spain would certainly increase water availability during and after this season. The practice of creating small ponds at high altitudes to collect rain-water for farm animals should be expanded on a scientific basis to ensure its availability over a longer period.

Cropping System

The cropping system is another aspect of hill agriculture which should be evaluated and placed on a scientific footing. Water use, application of plant nutrient, improved labour efficiency during the planting and harvesting period, plant protection, and efficient marketing are some of the factors affecting the returns from cropping systems [Mathema and Van der Veen, 1978].

Such hill farming systems as rotation and intercropping practices have evolved over many years and are intensive. They must be carefully assessed as improved materials and methods are developed and introduced. Special attention must be paid on their improvement as well as on the individual crop or livestock component of the system [Moseman, 1974]. Systematic studies of Nepal's cropping system programmes [Mathema and Van der Veen, 1978] could form the basis for technological innovation in hill agriculture.

Livestock

Livestock plays a major role in Nepalese farming and it is of paramount importance to attempt to increase farm production. The keen competition posed between the human and livestock population on a meagre land resource may be the single most vital constraint of the hill production system. The solution lies in increasing the productivity of livestock. As its productivity expands farmers would need to maintain a smaller stock to meet their domestic requirements.

Fodder

The area available for grazing in the Hills is scarce. The possibilities of using terrace slopes to raise fodder grass are high. In one hill district, it was estimated that terraced slopes constituted about 24 percent of the cultivated land [Field and Pandey, 1969]. Except in specific locations these slopes are not fully utilized. Fodder trees, planted along the edges of terraces, could contribute towards the expansion of fodder production and help check soil erosion.

The proper management of pasture and fodder production would eventually lead to better, higher, and more efficient productivity of livestock. This in turn would aid the production of crops through the increased supply of manure and draught power.

Rotational grazing is conditioned by the environment in the Hills and Mountains. Improvements in pasture would increase the productivity of both land and animals. Rotational grazing and manuring with locally available farmyard manure would help improve the fertility of the soil. The introduction of legume such as white clover, for example, would not only help improve the soil by fixing nitrogen but also enhance the quality of the pasture [Dutta, 1978].

Forest

Forest land is the most important source of fuel-wood for cooking and heating. Its use is too intensive at present to allow for its natural regeneration. The management of forest resources is essential for the sustained development of hill agriculture.

Soil Erosion

The Hills suffer severely from soil erosion brought about by overgrazing, deforestation, intensive farming, heavy rainfall, and poor management of soil and water. Every year soil loss is estimated at 30 tonnes per hectare [Laban, 1978]. In some places, the loss is substantially higher. Soil erosion is one of the most challenging problems confronting hill agricultural development.

One of the innovations which could reduce soil erosion in the Hills is to minimize land tillage. Hill land may be used exclusively for pasture as is normally the case in Europe. But, this is hardly possible in Nepal where the Hills are deficit producers of food. Despite this, minimum tillage technology should be practised so as not to jeopardize production and productivity. To achieve this, major research efforts would be needed to arrive at effective solutions. The simplest practice of minimum tillage and one which could be easily adapted in Nepal is to plant fruit trees which protect the soil. When the efficiency of land use is viewed in terms of income generation, tree crops offer the best hope provided processing facilities and marketing outlets are assured. A combination of horticulture and livestock could also possibly be the answer to declining productivity in hill agriculture [Nepali, 1975].

Processing, Storage, Transportation

The comparative advantage of the Hills lies in the exploitation of its diverse agro-ecological conditions. But its ability to contribute to production is circumscribed by transport, storage, processing, and ultimately marketing limitations. In addition, there is a need to develop technology and to evaluate scientifically such traditional methods of processing and storage to minimize postharvest losses.

Labour

The productivity of hill agriculture depends on the optimal use of all available resources. The seasonal demand for labour is by itself a constraint towards increasing its productivity. Agriculture in the Hills is labour intensive. Labour demand at peak periods of crop planting and harvesting is an important factor which affects production [Mathema *et al.* 1979]. During such times bottlenecks could be overcome by selectively introducing simple machinery and tools to assist in stepping up labour efficiency considerably.

Institutions for Technology Generation

The Department of Agriculture and the Department of Livestock Development and Animal Health are the two main institutions responsible for the generation of technology related to crops, horticulture, fishery and livestock. These organizations are also responsible for technology dissemination. In Nepal, the number of existing institutions appears adequate for undertaking development activities. But answers have to be found on how best they can be utilized to execute the tasks at hand. At present they are part and parcel of the huge government machinery entrusted with the agricultural task of expanding production and productivity. Each and every segment of the machinery can contribute in its own way to the overall development effort but the unco-ordinated individual effort when compared to the collective achievement will be of limited value. Therefore the entire government mechanism demands proper management. The shortcomings of the present system have been well discussed in the Workshop on Interagency Co-operation and Co-ordination in Programme Planning, Implementation and Evaluation [Nepali and Bhattarai, 1979].

In the past, a considerable amount of emphasis has been placed on extension, with very little stress on research. In the absence of new technology, there was very little to disseminate. The formation of a Research Co-ordination Committee (RCC) was proposed as early as 1973 [Nepal, 1973], but attempts to bring it into existence failed until in November 1980 when the RCC was enacted under the chairmanship of the Secretary of the Ministry of Food and Agriculture. The RCC is made up of related executing bodies responsible for research and development. It is headed by a policy formulating organization who will make the necessary decisions but it will not have entire control over their execution.

The foregoing illustrates the need for a distinct and separate institution with a high degree of operational flexibility to be responsible for the generation of technology based on priorities which have been identified by the disseminating institutions. This flexibility is imperative for the effective generation of technology, both in terms of time and incentives. Moseman *et al.* [1979] also indicated similar organizational recommendations and his report gives details on the basic infrastructure required at national, regional and ecological testing sites. Such sites are important because the Hills possesses many ecological niches. Therefore, a well-defined and strong organization is essential for the smooth operation and generation of effective technology.

Conclusion

The development of appropriate technology is the key to its successful dissemination. The institution involved in this process will demand adequate extension staff and subject specialists together with the support of related agencies who are responsible for agricultural input, credit and marketing.

The following quote places the administration of such an organization in its proper perspective:

> The present organization is capable of being very effective to achieve the objectives of better co-ordination, with minor changes, if the present administrative system can be transformed into an efficient and viable one.
>
> For this purpose a clear-cut line of command needs to be established so that all the technical know-how, input, credit and marketing are supplied jointly from the central level to *Panchayat* level to support the needs of the farmers based on their own demands. Due recognition is also required for participating agencies to develop their own capabilities to offer their services more efficiently. This should result

in the success of interagency co-ordination for agriculture, development planning, programming and implementation [Nepali and Bhattarai, 1979: p22].

With this approach, the existing government organizations will be capable of accelerating agricultural production in the country in general and in the Hills in particular.

However, an equally responsive system is required at the receiving end. The present agricultural committee operating at the *Panchayat* level can be one such organization which will lead the way to the utilization of innovative technology.

The generated technology such as compost making, farm management, and livestock management can be utilized by the individual farmers, while forest, pasture and water management will require communal actions, and the supply of fertilizer, chemical and credit will need the support of government institutions. Thus the utilization of new technology is dependent on individual farmers, the government, and market support [Freeman, 1978].

REFERENCES

Dutta, P. 1978. "Grazing and Forest Resource Management and Improvement". Workshop on Hill Agriculture -- Kathmandu, 23–26 January 1978.

Field, D.I. and Pandey, K.R. 1969. *Pasture, Fodder and Livestock Development, Trisuli Watershed Development Project.* Kathmandu. (HMG/FAO Project Report No. 15).

Freeman, W.H. 1978. "Comments on Identification of Technology Gap". Workshop on Hill Agriculture -- Kathmandu, 23–26 January, 1978.

Laban, P. 1978. *Field Measurements on Erosion and Sedimentation in Nepal.* Kathmandu: Integrated Watershed Management, Torrent Control and Landslide Development Project, Department of Soil and Water Conservation, Ministry of Forest.

Mahkijani, A. 1975. *Energy and Agriculture in the Third World.* Cambridge: Prallinger Publishing.

Mathema, S.B. and Van der Veen, M.G. 1978. *Socio-Economic Research on Farming System in Nepal: A Key Informant Survey in Five Cropping Systems Research Sites.* Kathmandu: Department of Agriculture.

Mathema, S.B. *et al.* 1979. *Report on the Cropping Systems, Key Informant Survey, Ratnanagar Village* Panchayat, *Chitwan District.* Kathmandu: Department of Agriculture.

Moseman, A.H. 1974. *A Study of Hill Agriculture in Nepal.* New York: Rockefeller Foundation Team.

Moseman, A.H. *et al.* 1979. *Report on the Formation of the Agricultural Research Council for Nepal.* New York: International Development Service.

Nepal. 1973. *Agriculture Development Plan (1975 – 1985).* Kathmandu: Ministry of Agriculture, Food and Irrigation.

Nepali, S.B. 1975. *Potentiality of Horticulture in the Hills, Mountain Environment and Development.* Kathmandu: Swiss Association for Technical Assistance.

Nepali, S.B. 1981. "Soil Erosion and Traditional Know-How". Regional Seminar on Soil Erosion and Sedimentation in South and Southeast Asia -- Bangkok, 27–29 January 1981.

Nepali, S.B. and Bhattarai, A.N. 1979. "Effectiveness of the Existing Organization System at the Central Level in Co-ordinating Ten Agricultural Development Plans and Programmes." Workshop on Interagency Co-operation and Co-ordination in Programme Planning, Implementation and Evaluation -- Kathmandu, 1979.

Shrestha, A.B. 1978. "Identification of Technological Gap in Hill Agriculture" Workshop on Hill Agriculture -- Kathmandu, 23-26 January, 1978.

11
Institutional Innovations for Hill Agricultural Development

R.P YADAV and T. RAWAL

Introduction

Various countries have followed different paths of agricultural development to increase food production and the incomes of their farming population. Constraints imposed on agricultural development by inelastic supplies of land and labour have been offset by advances in biological technology in the case of Japan and Taiwan, and mechanical technology in the case of the United States. Experiences in these countries show that advances in biological and mechanical technology respond to changes in relative prices, and in the prices of factors relative to the product. Changes in relative prices induce innovative activity, not only by private individuals but also by planners and scientists in public institutions.

In Nepal, public institutions which influence the use of technology and modes of production are assumed to be more innovative and flexible than individuals. The establishment of the Agricultural Development Bank (ADB/N) and the Agricultural Inputs Corporation (AIC), supported by extension services is an institutional innovation designed to make available to the majority of farmers the seed-fertilizer technology developed by crop scientists. In Nepal where realization of the gains of innovative activities is more difficult to achieve, institutional innovation involving public sector activities becomes more essential. The role of public sector institutions in this process is particularly important in the Hills where farmers do not have easy access to credit, input and extension services. This paper traces the growth of various agricultural institutions in the Hills of Nepal. It analyzes the effectiveness of these institutions in supporting development projects. Various recommendations are made to enable these organizations to become more responsive to the current development needs of the hill regions.

Nepalese Experience

No major programmes and projects were designed exclusively for hill agricultural development until 1952 when the first systematic effort at rural progress was made with the implementation of the Tribhuvan Village Development Programme. The establishment of a Co-operative Department in 1954 was an important step in the institutionalization of village co-operatives. The First Five-Year Plan (1956 – 60) aimed at creating co-operative societies throughout Nepal. The second and third Plans also contained institutionalized attempts to improve the livelihood of the farming population by providing new technology inputs for the Hills and the Tarai. The Fourth Five-Year Plan initiated a strategy of "corridor development" to integrate the Tarai with the Hills and the Mountains in order to reduce disparities in the development of the three main geographical regions. The First Development Plan continued this concept of four development regions, each with a development centre and a major growth corridor. The focus of

agricultural development policies outlined in these plans emphasized livestock in the Mountains, horticulture in Hills, and cereal and cash crops in the Tarai. This approach envisaged increased regional interdependence and greater interregional trade, but it required substantial improvements in communications, especially roads, and therefore must be regarded as a long-term rather than a medium-term strategy.

Nepal's Sixth Five-Year Plan (1980–85) accords the highest priority to productive investments in the agricultural sector which would increase productivity and employment through multicrop programmes and improvements in the farming system. Besides encouraging the production of commercial crops such as chilli, ginger, cardamom and fruit in the Hills, the plan stresses the use of farmyard manure and small irrigation projects to raise food production.

Institutions and Hill Agricultural Development

It is often argued that the successful implementation of programmes or projects for rural development depends on mass participation on a self-reliant basis. But where innovative entrepreneurs and leaders are hard to find, and where poverty and ignorance limit the participation of rural communities in development activities, the government and public institutions must take the lead. The main agencies involved in the development of hill agriculture are described below.

Agricultural Development Bank Nepal (ADB/N)

The establishment of the Co-operative Bank in 1962/63 was the beginning of institutional arrangements for agricultural credit in Nepal. The majority of the farming population had no access to institutional credit until the creation of the ADB/N and its merger with the existing Co-operative Bank in 1967/68. A further merger with the Land Reform Savings Corporation in 1975 made the ADB/N a major source of agricultural credit.

The ADB/N provides short, medium and long-term agricultural loans through its 176 offices which are spread out throughout the country. Seventy-five offices are located in the hill areas and these provided loans totalling Rs 68 million in 1980 for input, horticulture and livestock activities to farmers. Hill agriculture can only be developed through such economic assistance to provide a higher income and a better standard of living to the farming population.

Agricultural Inputs Corporation (AIC)

The AIC plays a significant part in the diffusion of seed-fertilizer technology by making timely delivery of input. Currently, the AIC has offices in 38 hill districts to handle input delivery and to take care of the distribution network. The AIC under its Seed Multiplication Programme and the Seed Storage Project is expected to play a vital role in improving the hill production system in the future.

Co-operative Societies and Sajhas

Co-operatives provide a direct link between farmers and government agro-service agencies such as the ADB/N and the AIC at the grass root level. In addition to the creation of co-operative societies in 1954, the formation of village committees in 1964/65, the introduction of a phased programme of guidance of these organizations in 1969 by the ADB/N, and the launching of the multipurpose *Sajha* programme in 1976/77 were important steps towards serving farmers in the Hills. Through the *Sajha* programme, the 216 co-operatives and 300 village committees throughout Nepal were converted into *Sajhas*, and another 487 *Sajhas* were set up. They supply loans and input, market

agricultural produce and consumer goods, and mobilize rural savings. Unfortunately, many of them in the Hills are facing financial problems and the ADB/N and AIC have been reluctant to deal with this problem. The most important financial resource of a *Sajha* is the members' compulsory savings which are deposited in the ADB/N. These constitute 35 percent of its total resources. While the process of transferring compulsory savings into the share capital of *Sajhas* has started, it will have to be accelerated if the financially weak ones in the Hills are to be revitalized.

Agricultural Projects Services Centre (APROSC)

Nepal's heavy reliance on foreign experts to identify, formulate, monitor and evaluate agricultural and rural development projects has gradually declined since the establishment of the APROSC in 1975. The Centre has prepared over 50 projects, focusing on integrated rural development programmes, resource conservation and utilization, agriculture, irrigation, livestock raising, extension and evaluation of agricultural development programmes. Some of the projects prepared by the APROSC such as Rapti, the Morang Hills and the Mahakali Hills Integrated Rural Development Programmes are designed to improve the economy of the Hills. The Small Farmers' Development Project which was prepared by the Centre and to be financed by the International Fund for Agriculture Development (IFAD) is another noteworthy effort for the benefit of small farmers.

Department of Agriculture

The Department of Agriculture plays a significant role in the diffusion of modern practices in the Hills of Nepal. It plans to provide a Junior Technical Assistant (JTA) and an Agricultural Assistant at the *Panchayat* level in the Hills. Every hill district will be divided into 5 to 6 subdistricts, each of which will have an Agricultural Service Centre (ASC) to provide regular in-service training for JTAs and farmers. This plan has not been fully implemented, and at present there is only one JTA for every 3 to 4 *Panchayats*, and Agricultural Assistants do not as yet average one per *Panchayat*. This shortage of staff has slowed down the implementation of many hill development projects. The newly created Department of Livestock will be instrumental in providing the necessary veterinary services in the Hills which have good potential for livestock development.

Integrated Rural Development Projects

All development activities will be implemented through the line agencies of the government. The Integrated Rural Development Projects, however, have to cut across several line agencies, and therefore a separate co-ordinating office is established for the duration of each project. Some of the major projects which were undertaken with multilateral and bilateral aid were the Integrated Hill Development Project, the Small Farmers' Development Project, the Rasuwa-Nuwakot Rural Development Project, the Kosi Hill Area Rural Development Project, the Mahakali Hills Rural Development Project, the Gandaki Agricultural Development Project and the Hill Food Production Project. In addition to these huge projects in the Hills, there are a number of other projects and programmes such as those of the Local Development Department, which is now under the Ministry of Local Development, the Hill Transport Development Project under the World Food Programme's Food for Work Programme, and the Remote Area Development Programme. All have contributed, directly or indirectly, towards the development of hill agriculture by creating trails, bridges, and minor irrigation works.

Recommendations

In the context of hill agricultural development, emphasis should be placed on making

existing institutions more responsive to current development needs rather than on establishing new ones. Since nothing significant can be expected from the private sector at the present stage of development, particularly in the hill areas, the lead has to be taken by public-sector institutions, planners and scientists. For example, the Nepal Rastra Bank's (Central Bank) directive to commercial banks in 1974 to invest at least 7 percent of their total deposits in agriculture and other priority small sectors was an innovative step taken to make available the much needed capital to the agricultural sector.

Cropping System and Technology

The promotion of export crops such as ginger and cardamom can lead to a rapid transfer of resources from food to export crops, but may adversely affect rural welfare by reducing food production. Institutional endeavours should be geared towards mixed cash and food crops development in the Hills. The emphasis should be on a hill development strategy which will improve the subsistence level of consumption and gradually evolve into a more commercially-oriented agricultural economy. Recognizing the interdependence between cropping system, livestock, fodder and forestry in hill agriculture, it is important to reassess production potentials. Farming systems research should take these into account when developing appropriate hill farming technology.

Any technology that is introduced in the Hills should aim at increasing land productivity and productive employment, with emphasis on the greater use of farm family labour, which is a relatively more abundant resource. The development of improved tools, irrigation machinery and animal-drawn equipment can be of considerable help in meeting this objective. The immediate stress should be on the development of a "village technology" whereby both construction and repair can be undertaken by the hill population at little financial cost. The Agriculture Tools' Factory of Nepal should pay special attention to the development of simple labour intensive agricultural tools for the Hills. If basic research to develop new designs is costly, the technicians in the factory should select imported tools and modify these to our conditions.

Marketing, Extension and Research

A well developed marketing system would ensure a fair price to producers and lead to rapid commercialization of agriculture. The absence of an accessible and organized market and processing facilities have checked the expansion of acreage under cash crops such as ginger and cardamom.

It should never be forgotten that the often-mentioned comparative advantage for horticulture and livestock products in the Hills and Mountains can be achieved only when farmers are assured of a minimum level of staple grain and marketing facilities for their products.

Extension programmes should be designed in such a manner that they encourage large-scale participation from small farmers. In this context, it is envisaged that the grouping of farmers into active associations would make interaction among them, extension workers and specialists effective. Although the establishment of extension services as an autonomous or semi-autonomous body may not be feasible for the present, adequate representation of farmers in the extension network should be encouraged.

Priority should be placed on the development of new seed and practices that would increase farm production of cereal. The Integrated Cereals Project has achieved remarkable progress in testing technology packages in farmers' fields. The "mini-kit" programme which conducts demonstrations of technology packages should be implemented more effectively in the Hills.

The Department of Agriculture which has established a crop development programme in the Tarai should also develop a similar programme in the Hills. The agricultural stations at Dhankuta, Jiri and Jumla can be used for developing improved varieties of crops suitable for the Hills such as maize, upland rice, millet and barley. At the same time, research work on livestock and livestock extension has to be strengthened.

Agricultural Technology Services

The majority of small hill farmers in Nepal do not have access to credit from institutional sources. With the exception of the "group liability approach" introduced under the small farmers' development programme in a few selected areas of the country, most farmers only become eligible for institutional credit if they meet the criteria of credit worthiness.

The establishment of ASCs in major agricultural areas could be the single most important short-run stimulus for development. In line with the policy of decentralizing line agencies to the *Panchayat* level, officers from agencies such as the ADB/N and the AIC would be attached to each of these service centres. The establishment of a veterinary dispensary and warehouse facilities at each of these centres would provide better access to animal health care and production input. Improvements in marketing arrangements would encourage farmers to grow more for the market. The provision for these facilities at one centre would be more economical from the government point of view and would save farmers' money and time spent for availing themselves of these services.

The most important institution at the grass root level, the *Sajhas*, could be revitalized with structural changes made in its management. Presently, there is inadequate representation of small farmers on the Board of Directors. Programmes designed to benefit small farmers must involve them in the decision-making process.

Conclusion

Any new innovation or programme for the Hills will have to be oriented to suit hill agricultural development and be heavily dependent on a strengthened agricultural research/extension system. At the same time, in each of the activities to be launched, adequate provision should be made for the people's participation to ensure their active support for new development programmes. The most pressing need is to transform institutions in response to the felt needs and aspirations of the hill dwellers. Although the process of transforming institutions may involve a time lag, and social and political stress, it should be kept in mind that hill agricultural development depends entirely on the flexibility and efficiency of proposals for new innovations in these institutions.

12
External Assistance for Nepal's Hill Agriculture

J. UPADHYAY and B.R. SHRESTHA

Introduction

External assistance has played a significant role in Nepal's development since the nation embarked on planned economic development in 1956/57. Nepal receives assistance from about 20 countries and from 18 agencies and organizations. The major donors among the developed countries are the United Kingdom, the Federal Republic of Germany, Japan, Kuwait, the United States of America, Canada and Switzerland. Both of Nepal's neighbours, India and China, are also providing substantial assistance. Among the multilateral agencies, the World Bank, the Asian Development Bank (ADB), and the International Fund for Agriculture Development (IFAD) have been large contributors.

External assistance received from multilateral and bilateral agencies is for agriculture, industry and commerce, power, transport and communication and social services. The major donor countries involved in the agricultural sector are India, the United States of America, Switzerland, New Zealand, Denmark, the Federal Republic of Germany, Japan and the United Kingdom.

Under the Indo-Nepal Agreement of August 1960, India provided assistance to develop a horticultural and livestock network, including veterinary services for various parts of the country, which focus mainly on the hill and mountain regions. The United Kingdom assisted in the establishment of agricultural centres for the Western Hills at Lumle and the Eastern Hills at Pakhribas. Switzerland provided assistance for a dairy development programme and cheese factories in the Hills. In 1968, the Federal Republic of Germany initiated the Gandaki Agriculture Development Project.

The foregoing description suggests that attempts have been made to channel external resources to develop the hill and mountain regions of Nepal. However, the results from these efforts have been less than expected for the following reasons. The objectives of earlier economic plans were vague, and policy-makers did not focus on specific priority areas for development. Some of the projects were selected by donor agencies and did not necessarily correspond with the nation's priority areas. In those years, Nepal did not always emphasize clearly her priorities when negotiating with donor countries. Moreover, returns to investment in hill agriculture were low given the adverse agro-climatic conditions and the inevitable long gestation period for such investment.

Neglect in the Past

It appears that external resources have on the whole failed to address the minimum basic needs of the people such as food, fuel, drinking water, health care and sanitation, primary and adult education and transportation facilities. The development of animal husbandry, horticulture, poultry and piggery from foreign assistance is not really meant to supplement the consumption levels of subsistence farmers but primarily to benefit

TABLE 12.1
SECTORAL DISTRIBUTION OF FOREIGN AID DISBURSEMENTS, 1974/75 – 1980/81

Year / Sector	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80 (revised estimate)	1980/81 (budget)
				(million Rs)			
Rural development	51.2	125.1	98.6	148.0	227.5	317.5	504.5
Agriculture	26.1	91.4	50.7	76.2	83.3	67.1	188.4
Irrigation	23.5	24.0	36.2	46.2	121.9	200.1	235.2
Forest	1.6	9.7	10.0	24.6	9.4	48.8	76.1
Others*	–	–	1.7	1.0	12.9	1.5	4.8
Power	5.9	22.7	25.4	207.8	208.5	375.3	534.1
Industry and commerce	42.2	62.3	91.8	68.9	30.6	60.9	152.9
Transport and communications	241.7	208.0	265.0	291.7	351.3	444.9	487.8
Social services	44.2	85.9	73.8	130.4	168.5	141.2	337.2
Others+	1.6	1.5	2.3	1.6	3.1	24.00	31.7
Total	386.8	505.6	556.9	848.4	989.4	1,363.8	2,048.2

Notes: *Survey and land reform.
+Statistics and others.

Source: Nepal [1981].

urban consumers. The sectorial distribution of foreign aid disbursements is shown in Table 12.1.

The hill economy is facing a critical stage of its development. Despite Nepal's planned efforts at hill agricultural development for the past 25 years, the overall situation of hill agriculture in the country is continuously deteriorating. Yield rates are declining and the possibility of a further expansion of the crop area is extremely limited. In addition, the level of food consumption is declining. One of the reasons for this can be attributed to the Tarai-oriented development strategy adopted during the first four development plans. Most of the available investment capital, manpower and other resources were diverted for programmes in the Tarai, while other regions in the country, particularly the Hills were neglected in this process. This Tarai-orientation is most apparent in the agricultural sector. The Tarai and the Kathmandu Valley received most of the subsidized inputs which were provided through institutional means and also most of the projects for irrigation were undertaken in these two areas. An analysis of the regional allocation reveals that during a period of two decades 29 percent of all development projects is in the Tarai and 34 percent in the Kathmandu Valley, with only 14 percent in both the Hills and Mountains. The remaining 23 percent is for national development. Furthermore, as most of the projects in the Tarai entail a larger financial commitment the actual financial allocation could have been biased in its favour.

The hill and mountain regions received comparatively lower investment partly because projects geared for them did not meet the then established criteria of economic viability. Perhaps high transportation cost and unawareness among the local people restricted the flow of investment into hill agriculture. The Tarai, on the other hand, is easily accessible. It is only recently, when food grain production in the Hills started to decline alarmingly and the Tarai forests began to disappear rapidly, that planners felt the urgent need to reassess the Tarai-oriented economic strategy. There is now an awareness that the lower rate of contribution to the national economy by the Hills is due to neglect in the previous plan periods to allocate investment for the hill agricultural sector. The disproportionate allocation of available resources, including external ones has not only widened regional disparities but it has also reduced the opportunities of finding comparatively viable projects for investment in the Hills.

The Sixth Plan has within this perspective given top priority to hill food production. This is indeed timely and appropriate.

Development Projects

The Fifth Plan stressed investment in growth-promoting development programmes in the field of agriculture, industry, and water resources. Agricultural development was given due importance and top priority was accorded to irrigation including minor irrigation and ground water projects. In the hill areas, the objectives were to eliminate deficits in food grain production and encourage horticultural and livestock development. The Plan also envisaged area-based integrated development programmes to be the core government policy for the overall progress of the rural sector.

The Sixth Plan accords foremost priority to food grain production in the Hills. Accordingly, a number of bilateral and multilateral-supported projects are directed specifically at hill agricultural development. Some of these projects which have been undertaken are described below.

Hill Agriculture Development Project (HADP)

This was a joint undertaking of the government, the United Nations Development Programme (UNDP) and the Food and Agriculture Organization of the United Nations

(FAO). It was initiated in 1973 to strengthen the development of hill agriculture by raising farm income and productivity. Special attention is paid to the maintenance and improvement of soil fertility in the Hills and the preservation of an ecological balance. Its major achievements have been the identification of factors limiting agricultural production and an assessment of the manpower needs of the Hills.

Integrated Rural Development Projects (IRDP)

There are eight projects in various stages of preparation or implementation (Table 12.2). The Rasuwa-Nuwakot and Mahakali Projects are financed by the World Bank, the Sagarmatha Project by ADB, IFAD and the European Economic Community (EEC), the Kosi Hill Area Project by the United Kingdom, the Rapti Project by the United States Agency for International Development (USAID), the Lamosangu-Jiri Project by Switzerland and the Karnali-Bheri Project by Canada. These projects are spread over 22 districts, 20 of which are in the Hills and they are expected to benefit 600,000 farm families. They support the government's development strategy which seeks to achieve economic growth with equitable income distribution and regional development.

Their aims are:

(1) to increase crop, livestock and horticultural production;

(2) to develop transportation and irrigation infrastructure;

(3) to protect the environment by soil conservation and forestry measures;

(4) to develop social services such as education, health, water supply and family planning; and

(5) to strengthen the capability of *Panchayats* and other local organizations to plan, carry out and sustain local development efforts.

Gandaki Agricultural Development Project (GADP)

The objectives of the GADP which was established in 1968 are to increase agricultural productivity and improve the economic situation of small farmers primarily through the provision of better extension services, training, distribution of high quality breeding animals and the setting up of an efficient agricultural marketing system. This project has made a significant impact on wheat production.

Small Farmers' Development Project (SFDP)

SFDP was started by the government and FAO in two *Panchayats* in late 1975 — one in Dhanusha district and the other in the Nuwakot district. Success has led to its expansion to 31 districts of which 10 are in the Tarai, 2 in the inner Tarai and 19 in the Hills. Credit is provided to Small Farmers' Groups and to their members individually for income-generating activities such as:

(1) small-scale irrigation and riverbed reclamation schemes, orchard and horticultural development, and for the improvement of water mills for agro-processing;

(2) livestock rearing; and

(3) improvement of cottage industries such as weaving, cane and bamboo processing, carpentry, ironmongery and shoemaking.

The total cost is estimated at US$16.1 million. It will be supported by IFAD in the form of loans and grants.

TABLE 12.2
RURAL DEVELOPMENT PROJECTS: COVERAGE AND INVESTMENT

Project	Districts covered	Total project cost (US $ million)	Donor agencies	Commencing year
Rasuwa-Nuwakot IRDP	Rasuwa and Nuwakot	10.90	World Bank	1976
Sagarmatha IRDP	Udaipur, Siraha and Saptari	30.20	1) ADB 2) IFAD 3) EEC	1978
Kosi Hill Area IRDP	Dhankuta, Terathum, Sankhuwasabha Bhojpur	9.40	UK	1979
Mahakali IRDP	Baitadi, Dhandheldhura and Darchula	13.50	World Bank	1980
Rapti IRDP	Dang, Salyan, Rukun, Rolpha and Pyuthan	33.70	USAID	1980
Karnali-Bheri IRDP	Surkhet, Dailekh and Jumla	12.50	Canada	1980
Lamosangu-Jiri IRDP	Dolkha and some parts of Sindhupalchok and Ramechap	6.25	Switzerland	1980

Hill Food Production Project

Under the first International Development Agency (IDA)-financed Rural Development Project in Rasuwa-Nuwakot, Agricultural Service Centres (ASCs) were found to be effective as focal points for promoting development activities in the remote rural areas. Using this experience, the Project will attempt to increase food crop production in the hill districts of Gorkha, Lamjung, Syangja and Tanahu. ASCs will be set up to serve as focal points to:

(1) improve agricultural extension, livestock development and animal health services;

(2) facilitate the services provided by the Agricultural Development Bank, Nepal, (ADB/N), the Agricultural Inputs Organization (AIC) and *Sajhas*; and

(3) introduce regular market days.

In addition, the project will provide:

(1) funds for the purchase of 3,200 tonnes of fertilizer;

(2) irrigation facilities to about 3,000 hectares of farmland under minor (less than 50 hectares) irrigation schemes;

(3) improvements to about 70 kilometres of trails and the construction of 34 bridges to facilitate the movement of agricultural input and improve communications in the project area; and

(4) evaluation and monitoring of services to strengthen project activities.

The overall cost for the Hill Food Production Project is estimated at US$9.7 million. The principal benefit derived from it will be an increase in the production of food crops. It is expected that approximately half of the 150,000 farm families in the project districts will participate. The production of 8,000 small farms (holdings of up to 0.4 hectare) will be increased so that farm families can meet their minimum subsistence needs (1,300 kilogrammes of grain per family), while 18,000 medium-sized farms (above 0.4 hectare) will generate small amounts of food grain surpluses. The remaining 50,000 small farms will increase their food production by about 30 percent, but due to the small farm size, they will still be unable to meet minimum family requirements. However, the increased production will result in considerable savings for the government which is at present moving grain from the Tarai to deficit hill areas where it is sold at highly subsidized prices.

Indirect benefits will be in the form of increased food production generated by improved cultural practices which will help reduce cultivation on marginal slopes, while the promotion of fodder and legume production will increase the supply of animal feed and thus reduce overgrazing and consequent erosion. Besides, construction work during the project period will provide about 4 million man-days of employment.

Hill Irrigation Project

This project focuses on the development of five hill areas, namely, Phalebas, Chapakot-Rampurphant, Syangja, Vijaypur-Begnas and Bulingtar. It aims at improving the socio-economic conditions of farmers who own an average of 1.2 hectares, through intensified agricultural production, improved road access, reduced erosion damage and increased energy and fodder supply. It provides for the construction/improvement of irrigation systems, strengthening of agricultural-support services such as extension, training in crop husbandry techniques and water management, storage and marketing facilities, enhancement of the role of co-operatives and the supply of agricultural input. Erosion control and foothill development, together with the installation of a mini-hydropower plant, will result in significant improvements in the environment.

The Project will directly benefit about 3,400 low-income families. At maturity, there will be an annual incremental production of about 10,800 tonnes of paddy, 2,600 tonnes of wheat, 1,400 tonnes of pulse and 5,000 tonnes of vegetable. The annual cropped area

will have increased from 5,000 to 7,000 hectares and the total incremental agricultural benefit to the five sub-areas is estimated at approximately US$2.5 million a year. During the five-year construction period, the project will create employment opportunities for about 15,000 workers, and the annual per capita income in the area is expected to rise from US$50 to US$130.

The ADB supports this project with a soft loan of US$16.7 million. A technical assistance grant by UNDP financed the feasibility study of this and another irrigation development project in the Seti Zone of the Far-Western Region. These studies include a water and agricultural resource inventory, and an identification and reconnaissance survey to rank potential irrigation schemes, the preparation of an initial project package, and on-the-job training of local technical personnel.

Fourth Agricultural Credit Project

The project covers 42 districts of which one is in the Mountains, 21 are in the Hills, and 20 in the Tarai. Its broad objectives are to increase crop production (particularly food grain) milk and meat, and to promote the utilization of renewable sources of energy for agro-processing, irrigation and household use. Loans will also be provided for pump irrigation, biogas facilities, small-scale water turbines, grain storage, farm mechanization, livestock and fertilizer.

The incremental production from the Project is estimated at 30,000 tonnes of food grain and 4.6 million litres of milk valued at US$5.6 million and 1.0 million respectively. The water turbines for agro-processing will promote small-scale industries and improve the efficiency of agricultural production by harnessing the energy potentials of streams. The biogas units will help Nepal save foreign exchange for fertilizer and avoid further ecological deterioration by substituting gas for firewood used by households for cooking and lighting.

The Project is also expected to generate additional employment and higher incomes for rural farmers who will gain from improved nutrition, transportation and sanitation as well as from the increased supply of food grain, milk production and other services arising from project investment. The financial resources of the ADB/N will be augmented for medium-term lending to individual farmers and groups for project activities.

The Project is financed by an ADB loan of US$15 million and it is expected to complete by 1983.

Future Dimensions for External Assistance

The overall strategy of the Fourth and Fifth Development Plans was to reap maximum benefits from already created infrastructure, and to promote agricultural specialization according to the agro-climatic potential of the Hills and the Tarai. In the Hills, this meant concentrating on high value items such as horticultural crops, tea and livestock products. The Tarai, on the other hand, will specialize in food grain and tropical/sub-tropical cash crops. Because of the more abundant supplies of land here, more employment opportunities will be provided for excess labour from the Hills. In reality, however, Nepal failed to achieve either maximum production benefits from the existing infrastructure or agro-climatic specialization.

The Sixth Plan had to modify the earlier approach of regional specialization in view of the need to ensure adequate food supply to the hill region. In the absence of low-cost transportation between the Hills and the Tarai, food grain moved from the Tarai cost more than those which were produced in the Hills. Hence the medium-term strategy places the highest priority on resolving food problems in the Hills and Mountains. Development efforts are needed to raise food grain production in the Tarai and in selected hill

areas where it is technically feasible. The priority accorded to the Hills is to ensure that farm income is sufficient to:

(1) purchase the goods from the Tarai;

(2) create a market in the hill area for the products of cottage and small-scale industries; and

(3) establish a basis for agro-climatic specialization in the long-run.

The strategy also includes provisions to improve marketing and distribution services. The present integrated rural development approach with small farmers as a major target group is appropriate for the prevailing conditions. However, without major improvements in the hill economy, the present Hill-Tarai food imbalance will continue, and the long-term strategy of agro-climatic specialization will not bear fruit.

Recommendations

In view of the development programme outlined above which spells out a short-term strategy to meet the subsistence needs of hill farmers and a long-term one for regional specialization, the following recommendations are made:

(1) The urgent needs of the Hills demand that it be allocated additional funds on a priority basis. This generalization does not mean that the Tarai should be completely ignored. It merely suggests that the Hills must obtain extra funds to maintain the present crop yield levels. Significant investment channelled to this region will indirectly maintain the yield levels in the Tarai.

(2) At present there is no complete inventory of agricultural resources, possibilities and potentials of the Hills. Land use surveys to map out land areas best suited for specific crops, forage, forest, national parks and villages are urgently needed before definite projects can be suggested. Therefore, attention should first of all be directed to explore and identify the very basic problem besetting agricultural advancement in the Hills.

(3) Feasibility studies for investment in the Hills is an equally important aspect for purposes of external assistance. The socio-economic justification for alternative projects such as irrigation and new crop programmes should be specifically mentioned in this regard.

(4) Another area of concern is to investigate the appropriateness of various kinds of farming systems in the Hills. In theory, the hill farming system appears to be similar for all locations but in practice it has to take into account such factors as elevation, soil type, climate and moisture content.

(5) Since irrigation is the major constraint in the Hills, and the possibility of irrigating additional farmland in the near future is limited, new crop varieties for rainfed conditions must be introduced into the Hills in order to maintain current yield levels. Research until now has focused primarily on crops grown under ideal conditions which do not apply to the Hills. To overcome

this problem, Nepal has been proposing the creation of an International Centre for High Altitude Crop Research for several years. Some preliminary field trials should be conducted to investigate the suitability of various crops under hill conditions. Similarly, other crops such as fruit, vegetable, mushroom, herb, potato and the silk-worm require more definite tests prior to their introduction to farmers.

(6) Research is also needed on crop rotation, intercropping, crop sequence, compost and manure management.

(7) Market studies for various high-value but low-volume produce such as the spice and herb have to be undertaken. Very little is known about the potentialities of such crops.

REFERENCE

Nepal. 1981. "Foreign Aid Disbursement". Kathmandu: Ministry of Finance (Unpublished data).

II
NEIGHBOURING COUNTRIES' EXPERIENCES

13
Developing Agricultural Production in Tibet, China

T.Y. CHANG

Introduction

The Tibet Autonomous Region is situated at the southern tip of China's Quighai-Tibet plateau, with an average altitude of more than 4,000 metres above sea level. It is often referred to as "the roof of the world".

Agriculture in Tibet is confined mainly to the river valleys of the Yalu Ysangbu, Hienchu, Lhasa, Jinsha, Lancang and Nujang. The altitude of these areas ranges from 3,000 to 4,000 metres above sea level. Qingke barley, wheat, pea and rapeseed are the main crops grown and their acreages constitute 90 percent of the total cultivated area. Other crops cultivated are buck wheat, potato, maize, rice, soybean, sorghum and "cock claw shaped"millet. Most of the areas grow only one crop a year. Areas below 3,000 metres are planted with three crops in every two years, while areas below 2,000 metres have two crops a year.

Since the implementation of democratic reforms in Tibet, numerous agricultural projects such as field capital construction, water conservation, popularization of new types of farm machinery, breeding of new varieties and the promotion of chemical fertilizer and chemical usage have been introduced. These measures have contributed to the growth of agricultural production in Tibet, and grain and rapeseed output has increased by a factor of 1.3 and 2.9 respectively from 1959 to 1979.

However, the overall agricultural productivity in Tibet is still poor and farm income is low. This is due mainly to the limiting geographical environment and the low level of technological development in the country.

Climatic Characteristics Affecting Agricultural Production

Temperate and Cool Climate

In most crop growing areas, the average yearly temperature which is equal to or greater than 0°C varies between 1,000° and 3,200°C. The average monthly temperature of the warmer season ranges from 7.6°C to 16.5°C, while the range for the coldest month is from 0.1°C to 1.4°C.

Qingke barley, wheat, pea and rapeseed do not suffer extensive freeze injury from late frost during the seedling stage of their growth. Frost injury only becomes important when the average daily minimum temperature falls below minus 2°C. A frost-free period of 166 to 256 days is sufficient for the planting of local varieties of the above crops. But, crop yields are highly related to the length of the growing period. An example of this is shown in the case of wheat where, in lower altitudes, the longer growing period causes only 10 to 27 percent of dry material to accumulate on the ground after heading and blooming, while the average for cooler areas is 40 to 60 percent.

Solar Radiation

The annual total radiation intensity of Lhasa (195 Kcal/cm) and Changdu (148 Kcal/cm) is higher than in the wheat growing areas of North China (135 Kcal/cm). Thus from this factor alone, Tibetan wheat yield can be expected to be higher than those in North China, and comparable to those of the interior areas of China.

Wide Daily Temperature Range

The daily temperature range from wheat emerging to earing is usually 14° to 20°C. This range is generally greater than that for North China wheat growing regions. The wide fluctuations in the daily temperature range is beneficial for the accumulation of dry material. In fact this is one of the major climatic factors favouring high wheat yield in Tibet.

Precipitation

The annual rainfall is approximately 400 millimetres, of which 70 to 80 percent falls during the months of June, July and August. This rainfall occuring mainly in the night is not intense and there is generally little surface run-off. Drought in early spring is common, and during this period there may be a need for supplementary irrigation.

Measures for the Promotion of Agricultural Production

Wider Use of Genetic Resources

Tibet is rich in crop genetic resources. There are more than 60 common varieties of Qingke barley and 20 to 30 common varieties of wheat. They have been selected for their ability to perform well under the varied climatic conditions of the country. The Tibet Institute of Agricultural Science (TIAS) has collected 1,400 samples of local varieties of Qingke barley, 370 samples of wheat, and 250 samples of beans and oil-bearing crops.

The moderate-maturing varieties of Qingke barley are the most important type and they possess the highest yield. The early and late-maturing varieties are of lesser importance. Yields of the early-maturing varieties are lower than those of the late-maturing varieties. The latter type is a tall and strong plant but it requires more water and fertilizer than other varieties.

The main objective of the country's crop breeding programme is to select high-yielding, moderate and late-maturing varieties of Qingke barley. Twenty-two such varieties have already been selected through systematic seed selection and cross-breeding. They have been introduced extensively, and are widely accepted by farmers. Their yield in the farmer's field is generally 10 to 15 percent higher than the traditional types. Similar breeding and selection work is now in progress for such beans and oil-bearing crops as the "Qushul Big Grain" rapeseed, "Nienchu River No. 1' rapeseed, "Shannan" rapeseed, "Lhasa Black" pea and the "Naidong White" pea.

Popularizing Winter Wheat and Improvements in the Cropping System

Traditionally, winter wheat was produced only at one or two locations, at an altitude of less than 3,000 metres. Its yield is low, averaging 112 – 168 *jin* per *mu*.[1] After a comprehensive survey by the Chinese Scientific Expedition in 1951, 22 varieties of winter wheat were planted in a trial in Lhasa in 1952. Yields as high as 500 to 600 *jin* per *mu*

[1] 100 *jin* per *mu* = 750 kilogrammes per hectare.

were recorded. After 20 years of experimentation, a few varieties were selected and introduced on a large-scale. In the last few years, the area under winter wheat comprises 15 to 20 percent of the total grain crop area, but its output is only 25 to 30 percent of the total grain output for the country.

The introduction of winter wheat has changed the cropping pattern practised by many farmers. Instead of planting only one crop in the spring, farmers are now planting one crop in the spring and a crop of winter wheat in the autumn. This change increases the utilization rate of such resources as manpower and draught animals.

The following factors are important for achieving high winter wheat yield:

(1) A high seeding rate is essential. To achieve an output of 200 to 800 *jin* per *mu*, 300,000 to 400,000 plants are required. The germination of these seedlings requires careful soil preparation, adequate fertilizer, timely sowing and high seedling rate in order to survive the harsh winter.

(2) Proper field management in the early spring is also essential to increase effective tilleting. It is usually arid during this time of the year, and thus good field management, including optimum use of the limited water supply and correct application of a fast-acting fertilizer is necessary.

(3) Topdressing of the field with adequate compound fertilizer is another prerequisite to ensure that the grain is fully filled and there is no premature aging of the plant.

(4) Use of an improved variety called "fat grain wheat" is recommended. It is resistant to lodging, possesses a long bearing period, bigger ears, more and heavier grain and is responsive to fertilizer. In addition, it has high and stable yield. The average yield is over 400 *jin* per *mu*, while yield of 800 to 1,000 *jin* per *mu* has been recorded in highly productive fields.

Development and Use of Green Manure

Traditionally, beans and peas have constituted 30 percent of the total cultivated area. It is common to find rapeseed sown together with pea, or Qingke barley with pea in the same plot. Such mixed cropping and subsequent tilling have maintained and enhanced soil fertility.

In recent years, this traditional practice has been abandoned, causing a depletion in soil fertility and thereby necessitating large applications of organic fertilizer for its maintenance. In areas of high population concentration, there is a shortage of organic manure because animal dung is being used as fuel.

In the absence of animal dung, soil fertility is maintained by either ploughing the straw under or by growing green manure plants. The former approach cannot be regarded as the most feasible as farmers require the straw for animal forage. The planting of green manure plants therefore appears to be the best means of increasing soil fertility because it raises the supply of nitrogen and organic matter in the soil, besides serving as a source for high quality forage grasses. The popular types of green manure plants are the "arrow tongue" pea, alfalfa, "mao shao"and sweet clover. These varieties have a high nitrogen fixation capability, provide a good yield of fresh forage, and are adapted for a wide range of environmental conditions.

The planting and utilization of green manure crops vary for different areas of Tibet. In the low altitude valleys of Eastern Tibet, green manure crops are planted as part of the multiple cropping system. These valleys are characterized by longer frost-free periods, more rainfall and a lower cropping intensity. The winter crop matures early and a green manure crop of the bean or pea family is planted soon after the winter crop harvest.

The usual farming practice in the valleys of the Lhasa river and in the middle reaches of the Yalu Zangbu river is a crop rotation cycle of cereal and forage crops. These areas are densely populated and the land is intensively cultivated during the entire short growing season. The crop rotation cycle results in a higher yield of both cereal and green manure crops. It enhances soil fertility, and a possibility exists to develop animal husbandry which utilizes the forage from the green manure crop. It also lowers the cost of production and is responsible for higher farm incomes.

In contrast, the agricultural areas of the upper reaches of the Nienchu and Yalu Zanghu river leave extensive tracts of farmland to fallow. In such places the recommendation is to plant green manure crops. The cultivation of green manure woody or herbaceous plants along the river banks also reduces damage caused by erosion. In addition, these plants conserve water and soil, besides providing green manure and fodder grasses.

Incorporation of Livestock into the Agricultural System

Tibet has a long history of animal production and husbandry. The combination of agriculture with stock-raising is a traditional farming pattern for most farms. The weakest point in this system is the shortage of forage grasses, which have traditionally been derived from the by-products of agriculture and from pasture land.

However, recent agricultural development efforts have neglected animal husbandry, causing a decline in the natural pasture area, while livestock rearing has expanded. This naturally places a greater pressure on food supply for both man and livestock. The new policy aims at increasing the supply of forage grasses by planting them as part of a crop rotation and by stepping up the utilization of processed straws. This policy has so far been only partially successful. The processing of forage grasses requires further examination. At the same time, efforts are being made to raise the output of animal products without increasing the animal population, that is, through greater productivity per animal.

Better Plant Protection Measures

In recent years, plant protection has been accorded greater importance. This is necessary with expansion in production since plant diseases and pest damage are now posing greater problems to the farmer. The major plant diseases are wheat virus, smut, Qingke barley and wheat stem rust, while the common insect pests are the pea noctuidae sp., grub and aphid. Research workers have focused their efforts on such preventive measures as seed treatment and the adjustment of planting dates to minimize crop damage. Seed treatment of wheat with 10 percent carbendozol, 50 percent thio-phonote methyl or 25 percent benomyl in the proportion of 3:1,000 is effective for preventing and controlling wheat stem rust. Alternatively, the seeds can be soaked with a clarified solution of water consisting of 5 percent cow-dung or 2 percent lime water.

Prospects for the Future

In spite of the rapid progress made in the last two decades, the majority of farmers continue to practise traditional forms of agriculture which are characterized by low yield and income. The primary objective of the government's agricultural policy is to

raise agricultural productivity and improve the standard of living of the farmers. This policy hopes to make Tibet a prosperous country where there is comprehensive development in the areas of farming, forestry, animal husbandry, off-farm production and fisheries, but without sacrificing its beautiful scenery and rich cultural heritage.

The recommended orientation for agricultural development is as follows:

(1) *Integration of agriculture with forestry.* Such an agricultural forestry ecosystem is meant to ensure that both the natural resources and the labour force of the nation are utilized efficiently. Priority will be given to crop production and tree planting, and grass-sowing will also be encouraged at the same time. Animal husbandry and forestry will be permitted as complimentary enterprizes. Better seed varieties, improved cultural practices, effective plant protection measures and appropriate cropping systems will be promoted to ensure higher yield and production. Crop diversification, including the planting of medicinal herbs, sugarcane, fibre plants, oil bearing crops, tobacco and tea will also be encouraged.

(2) *Improvement in soil fertility.* Soil texture in Tibet is generally poor and this is a major constraint to increasing agricultural production. A soil survey has recently been completed, the results of which will be used to draw up a crop and fertilizer programme for the various soil types. Attempts will also be made to enhance soil fertility by the adoption of an appropriate cropping system such as crop rotation, by increasing the use of organic fertilizer and by expanding the area planted with green manure crops. An increase in the application of chemical fertilizer is another important measure to be encouraged for improving production and income. At present, attention is being paid to ascertain the optimum ratio between nitrogenous and phosphate fertilizer.

(3) *Other improvements.* Farm machinery suitable for mountainous terrain should be devised. This will improve the working conditions of farmers as well as raise labour productivity. Agricultural education must be encouraged to expand together with the popularity of new agricultural technology. Equally important, the communication and transportation network must also be developed.

It is an arduous but glorious task for the agricultural technicians in Tibet to utilize fully the natural resources in cold high altitude mountain areas to promote the development of agricultural production and farm income. The task will be facilitated if they succeed in promoting the factors which favour growth and development and at the same time mitigating the constraints that beset agriculture.

The friendly relations between the peoples of China and Nepal date back to historic times. The Tibet Autonomous Region and Nepal are as closely related as lips and teeth and geographically they are joined together by mountains and rivers. Historical and natural relationships exist between the two peoples especially in the areas of economics, geography and culture. The natural conditions are similar in both countries and both peoples cherish a common desire to develop and change the face of the mountainous areas. Therefore, it is hoped that the agricultural scientists of China and Nepal will

strengthen their ties, learn from each other and make concerted efforts to accelerate agricultural production with the help of science and technology, and thereby contribute towards the further improvement of the peoples' material and cultural life.

14
Hill Agricultural Development in Hongkong

C.T. WONG and K.L. TSE

Introduction

The territory of Hong Kong, with a total area of 1,061 square kilometres is, by any standard, very small. However, it is a place where more than 5 million people live and work. More importantly, about 70 percent of the area is hilly and rugged, and most of the population is concentrated in about 166 square kilometres of urban built-up area, making it one of the world's most densely populated places. Agriculture is a minor sector in the economy. Only about 100 square kilometres or 9.5 percent of the total land area is classified as arable land and fish ponds in Hong Kong. About 73 percent of this land is below the 50 metres contour (Tables 14.1 and 14.2).

TABLE 14.1
LAND USE IN HONG KONG, 1980

Class	Approximate area (km^2)	Percentage
Built-up (urban areas)	166	15.7
Woodland	125	11.8
Grass and scrub	616	58.0
Badland	44	4.1
Swamp and mangrove	9	0.9
Arable	83	7.8
Fish pond	18	1.7

Source: Hong Kong [1980].

The purpose of this paper is to provide some factual information about hill agriculture and its development prospects in Hong Kong, to illustrate some of the problems of urban fringe agriculture, and at the same time show how Hong Kong struggles to balance the demands for land by various essential and competing uses.

Role of Agriculture

At the last biennial census in 1976, there were 25,970 persons engaged in agricultural activities in Hong Kong. This represented only 2 percent of the economically active population, and contributed to less than 1 per cent of the Gross Domestic Product (GDP). Industry is the mainstay of the Hong Kong economy providing occupations for the ever-expanding workforce, which now stands at approximately 2.4 million. Hong Kong with its limited land resources can never hope to supply sufficient food for its own population. In terms of value for example, more than 78 percent of all the food requirement (including fishery products) were imported in 1980.

Despite the limited resources and active government support, local agriculture provided some 12 percent of the value of total fresh foodstuff consumed locally. In quantitative terms, local farmers produce about 20 percent, 40 percent and 65 percent of the total consumption of pork, fresh vegetable and live poultry respectively, and they are generally of higher quality than imports. However, the following factors must be borne in mind:

(1) Hong Kong is experiencing rapid industrialization and urbanization;

(2) farming has been operating in a *laissez faire* economy with unrestricted food imports; and

(3) agriculture evolved during the last 30 years from a predominantly subsistence-oriented to a market-oriented business enterprize.

Under such conditions, Hong Kong's farmers have had to struggle for survival through the adoption of technical innovation and improvements in production efficiency.

Agricultural Land Use Pattern

For the most part, the topography of Hong Kong is rugged and mountainous. Agriculture is largely confined to the low lying flat lands, but pockets of farmland are also found in small valleys among the hills. Paddy was the dominant crop during the prewar era (1898 – 1940) and vegetable was grown around villages mainly for home consumption. Enormous effort and skill were expended on the construction and maintenance of terraces to make maximum use of every piece of suitable land. Tea was also grown on many of the north-facing mountain slopes in the seventies and a herring-bone pattern of tea terraces may still be seen on these hills [Wong 1971].

With the passage of time, there have been rapid changes in the agricultural pattern due to various economic and social forces. The general land use pattern from the hills to lowland can now be described as including (1) forestry, (2) cultivation of rainfed crops, (3) fruit growing (4) market gardening, (5) paddy cultivation and (6) fish farming.

The distribution of farmland according to height above sea level is shown in Table 14.2. Any land area which is more than 50 metres above sea level is classified as hill land.

TABLE 14.2
DISTRIBUTION OF AGRICULTURAL LAND BY ALTITUDE

Height above sea level	Area (ha)	Percentage
0 – 50 m	7,280	73
50 – 100 m	1,630	16
100 – 200 m	710	7
200 and above	340	4

Source: Hong Kong [1980].

The general agricultural zones in Hong Kong have been classified by Wong [1976] according to the von Thunen model as follows:

Zone 1. Market gardening

(1) light medium soil, gentle slope to flat land with adequate and regular water supply, good access and free drainage (dry-bed system);

(2) heavy soil, gentle slope to flat land with good water supply, accessible and free from flooding (flood-furrow system); and

(3) as (1) and (2) but in closer proximity to urban areas (mainly flower).

Zone 2. Paddy cultivation
Heavy soil, gentle slope to flat land where irrigation water is less accessible.

Zone 3. Field crop cultivation
Hill or sloping land with irregular water supply, well-drained surface soil or poorly drained sub-soil and low in plant nutrient.

Zone 4. Fruit production
Gentle slope, sandy loam or boulder fan, well-drained, well-sheltered and free from erosion.

Zone 5. Fish farming
Flat land close to sea level with deep clay soil, poor drainage and high salinity.

Zone 6. Abandoned land
Remote inaccessible valleys with inadequate water supply, poor soil, poor drainage and exposure (exceptions are those lands near development zones which are held for speculative purposes).

Zone 7. Forest and grazing land
Rocky, scrubby and precipitous hillside, inaccessible and steep with poor water supply.

Zone 8. Intensive livestock farming

(1) in association with market gardening, fish farming and other types of cropping (mixed agriculture); and

(2) low productive highland amidst crop areas with adequate access and water supply (specialized pig and poultry farm).

The most striking feature is the zone of market gardening adjacent to the urban markets and along the access roads. Vegetable farming has also been developed along the coastal areas where sea transport is convenient. There are three main reasons for this pattern of development;

(1) urban dwellers are prepared to pay high prices for fresh vegetable;

(2) the higher returns from this enterprize are sufficient to enable the market gardeners to pay higher prices for purchase or rent of these lands; and

(3) most locally-produced vegetable and flower are highly perishable and hence rapid transport from farm to market is essential.

Vegetable farming is impractical for those fields that are situated in areas of more than 30 minutes walking distance from road or sea transport.

Since vegetable farming is the predominant agricultural activity and is regarded as having the best potential for future development, its special land use feature will have an important bearing on hill agricultural development.

Any discussion on agricultural land use will not be complete without mentioning the problems of encroachment on agricultural land. In recent years more and more arable land has been lost to non-farm use. During the two decades from 1960 to 1980, the built-up area of Hong Kong has increased by 108 square kilometres. Apart from the area reclaimed from the sea and marginal land, a considerable amount of the built-up area was formerly agricultural land.

A substantial area of arable land has fallen into disuse and now lies fallow owing to the owners' anticipation of further development. Of a total area of 42 square kilometres of abandoned farmland 18 percent is held by owners for speculation and 37 percent is held by owners who are unwilling to lease their land.

Constraints on Hill Agriculture

As urban development accelerates, there will be increasing pressures to relocate agriculture in the hills. Height has a direct effect upon temperature, precipitation, length of growing period and types of vegetation. The gradient of slope also imposes restrictions on cultivation and accessibility. Thus, it is necessary to study the relief, topography and climatic conditions of hill areas to be used for agricultural purposes.

The first study of land utilization in Hong Kong and the New Territories with particular reference to such basic factors as geology, topography and climate was made

by Tregear [1958] and a comprehensive investigation on the soil characteristics in Hong Kong was carried out by Grant [1960].

About 40 percent (16 - 17 square kilometres) of the abandoned arable land is in hilly areas. Such lands, because of their remoteness from existing communication, lack of labour force and deficiency in irrigation water, have not been used for farming for many years. Where such lands are brought back into cultivation they are invariably used for intensive vegetable farming, since the economic return per unit of this enterprize is the highest. Soil in this newly cultivated land must be enriched by fertilization. Road improvement and better irrigation and drainage are also required. Such improvements require considerable resources which must be economically justifiable.

The hill area in Hong Kong is usually classified into four land use categories, namely, natural woodland, scrubland, grassland and badland (Table 14.1). This classification is based upon the nature of vegetation cover and gives little indication of the actual land use.

The first priority is to retain a large area as catchment for reservoirs. Hong Kong is still highly dependent on rainfall for its water supply. The need for fresh water has led to the construction of storage reservoirs and the utilization of one-third of the hill areas as water catchments. Many forms of agricultural activities are prohibited in such areas for fear of contamination. Increasing urban demand for water supplies therefore has had the effect of reducing arable land in the hill areas.

Secondly, for most of the hill areas the best use of the land would be afforestation. An extensive programme of afforestation has been implemented to stabilize the soil, prevent erosion, protect and improve water supplies and prevent damage by floods and silting. Consequently, there is a large acreage of natural woodland which is important for the management of water catchment and at the same time serves as a scenic attraction.

Thirdly, a large area of the countryside has been designated as country parks to meet the growing need for relief from crowded urban areas. Moreover, with improved economic conditions, people actively seek more leisure and a better quality of life. Much of the hilly countryside is scenically very attractive. The steep and rugged slopes rise from sea level to 600 and 900 metres interspersed with rocky creeks, wooded ravines and rushing streams. Some 20 freshwater reservoirs of various sizes nestle among the hills, giving additional charm to the scenery. Accordingly, in 1976 the government implemented a country park programme to develop the recreational potential of the scenically attractive countryside. A country park authority was set up to control and manage the most important areas which have been designated country parks to enable them to develop for recreational purposes and to protect and conserve vegetation and wildlife. At the end of 1979, 21 country parks covering about 40 percent (420 square kilometres) of the total land area have been created.

While development inside country parks is strictly controlled, fruit and vegetable farming is encouraged as they form an integrated part of the hilly landscape. Attention is at present being focused on these lines in order to maximize the economic use of country parks.

Experience in Hill Agricultural Development

Despite the various constraints stated above, hill agricultural activities are not uncommon in Hong Kong. Terracing of arable land for the growing of vegetable and flower is quite popular particularly on hillslopes near urban areas. In fact, one of the best watercress growing areas is located in a valley situated at about 300 metres above sea level. Fruit trees and pineapple are grown on some hill slopes.

Local farmers also rear pig and poultry in farms located in selected foothill areas which may not be suitable for intensive cropping. Field crops such as sweet potato, groundnut and sugarcane are grown on sites which cannot be irrigated and are situated far up the hillslopes. There have been some attempts to grow tea on Tai Mo Shan, the highest mountain in Hong Kong.

Research has beeen conducted on the feasibility of hill farming in Hong Kong. As early as 1953, the government established a high-altitude experimental station in Tai Mo Shan at 600 metres above sea level with a view to determining the potential of hill agricultural development. The findings on irrigation, soil conservation and crop varieties nave been useful. For example, it is found that to overcome such physical problems as soil erosion, strong wind and a prolonged wet season, terraces, stone walls, windbreaks and mulching are required. Because of the difference in temperature, many cool season vegetable such as the white cabbage and flowering cabbage can be grown successfully during summer.

An example of how the hilly and mountainous areas of Hong Kong can be utilized for farming can be seen from the experimental work conducted by the Kadoorie Agricultural Aid Association (KAAA) which was founded in 1951. An experimental farm was established on a hilly slope to test various cropping system and livestock techniques. The available land consisted of a few barren hills with an area of 150 hectares, at an altitude of 100 to 600 metres. The soil was poor and infertile and various slopes suffered from exposure to severe wind. This area was regarded as being incapable of supporting any form of agrarian activity. Under this programme, pigsties were built, land was cleared, rocky slopes were ingenuously filled and terraced, a drainage system and irrigation channels were constructed, and soil fertility was enhanced. Within a few years, the farm became an unparalled success as far as crop and livestock experiments are concerned. Over 15,000 fruit trees of various species flourished and new methods of cultivation and livestock breeding have been developed. It is also the Territory's most beautiful botanical garden, wildlife and conservation centre [KAAA, 1979].

The experience and knowledge gained from this hill agricultural farm proved to be of great value not only to Hong Kong but also to the people of Nepal through the involvement of the KAAA in providing agricultural training facilities to Gorkha soldiers stationed in Hong Kong. The basic objective of this scheme is to assist the soldiers, many of whom will become farmers upon their return to Nepal, to work on hilly agricultural land of a similar environment. Since 1968, over 3,340 soldiers have been given six-week courses with lectures and field practice, covering vegetable cultivation, fruit growing and poultry and pig rearing. To supplement this training, wide-ranging gifts to the agricultural resettlement centres in Nepal have also been made. These include an irrigation project, agricultural and veterinary equipment, pig, poultry, feed, planting material, fertilizer, and pesticide. Since 1973, the KAAA staff has made annual visits to the assisted centres in Nepal to provide follow-up advice [LAC, 1980].

Development in hill agriculture in areas neighbouring Hong Kong also shows some promising signs. One major problem of hill agriculture is the difficulty of water conservation due to steep slopes. Terracing has largely overcome the problem. Spencer [1961] traced the development and spread of agricultural terracing in Southern China and found that both dryfield and water controlled wetfield terracing can raise agricultural productivity higher than shifting cultivation or cultivation on slopes.

Conclusion

Assuming a normal pattern of population growth and a constant level of consumption per capita of fresh vegetable, poultry, pig and freshwater fish, projections of demand

and supply indicate that at the present production levels, there will be an increasing gap between consumption and local supplies. The options open to Hong Kong are clear – either to increase the quantity of food imports or to expand the scale of agricultural activities to increase local supplies. If the latter option is chosen, the existing good agricultural land outside town development zones should as far as possible be preserved from further industrial encroachment and the marginal land in hill areas, both abandoned and potential, must be brought into cultivation.

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REFERENCES

Hong Kong. 1980. Agriculture and Fisheries Department. Hong Kong (Unpublished Data).

Grant, C.J. 1960. *The Soil and Agriculture of Hong Kong.* Hong Kong: Government Printer.

KAAA. 1979. *Experimental and Extension Farm and Botanical Gardens.* Hong Kong: Eurasia Publishing.

LAC. 1980. Report. Pokhara, Gandaki Anchal: Lumle Agricultural Centre.

Spencer, J.E. 1961. "The Development and Spread of Agricultural Terracing in China". *Symposium on Land Use and Mineral Deposits in Hong Kong, Southern China and South-East Asia, September 1961.* Hong Kong: University Press.

Tregear, T. R. 1958. *A Survey of Land Use in Hong Kong and the New Territories.* Hong Kong: Geographical Publications, Hong Kong University Press.

Wong, C. T. 1971. "Vegetable Farming in Hong Kong: A Study in Agricultural Georgraphy". Ph. D. diss. University of Hong Kong.

Wong, C. T. 1976. "Urbanization and Agriculture: The Impact of Agriculture and Town Development on the Rural Environment in Hong Kong." *Geography and the Environment in South-East Asia.* Hong Kong: Hong Kong University Press, 1978.

15
Agricultural Planning and Development in the North-Western Himalayas, India

S.L. SHAH

Introduction

The entire Himalayas in India may be divided broadly into two regions for development planning and management, namely, the north-western Himalayas comprising the states of Jammu, Kashmir, Himamchal Pradesh, and Uttar Pradesh, and the north-eastern Himalayas encompassing the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura.

The hill regions in India, consisting mainly of the Himalayas, cover an area of 514,000 square kilometres or over 16 percent of the area of India, with a total population of 50 million or about 8 percent for the country. This paper pertains to the state of Uttar Pradesh which is located in the north-western Himalayas. The area discussed is made up of 51,123 square kilometres which corresponds to about 17 percent of the area of the state, and is inhabited by 4.5 million people.

The kind of agricultural planning and development in the Himalayas is not well suited for its mountainous terrain and as a result, it has brought about undesirable effects on the ecology of the mountains and north India.

The main objective of agricultural planning and development in the hills should be the proper management and conservation of soil and water resources. At present planners merely estimate demand and supply projections of food grain in hill districts and suggest ways of achieving food grain self-sufficiency. This blind adherence to the objective of self-sufficiency has had a disastrous effect on the ecology of the country, as agriculture is being extended to steep slopes. Agricultural planning in the hills should aim at increasing income per hectare through several alternatives such as silviculture, floriculture, and horticulture, besides cereal cultivation. The optimum enterprize mix will differ in the low, middle and high Himalayas, since agricultural problems differ from region to region. For example, the problems in the eastern Himalayas, where *jhuming* (shifting cultivation) is practised, are quite different from those in the north-western Himalayas where settled agriculture is common. Based on information generated in several studies conducted on the Uttar Pradesh hills, this paper describes the rationale for a new planning process for hill agriculture. An optimum enterprize mix for watershed areas, and the technological, socio-economic and institutional constraints to agricultural development are discussed, together with recommendations for overcoming these constraints.

The Watershed Approach

The Himalayas are the source of almost all major rivers in north India. The rainfall varies from 750 to 2,500 millimetres. This water flows down to the sea without being properly harnessed, and causes damage to land and soil. It is now generally accepted that in the hill areas, a watershed should be the planning unit. Such an approach links land

to the flow of water through the basin to the plains, facilitates the recognition of appropriate soil and water conservation measures, and is a useful technical and economic unit for land and water management. A watershed may be demarcated into macro, micro and mini-watersheds for planning and management. This approach offers a good means of internalizing the externalities inherent in land use planning in the hills.

The present planning unit in Uttar Pradesh is a block which consists of several villages. These villages may conform to micro or mini-watershed boundaries. Socio-economic data with respect to the villages already exist and it is therefore not necessary to collect such data for watershed planning. The existing development structure such as the block district and the commissioner's division may retain their separate identities and each continue as administrative units for the supply of input, marketing of output, agricultural extension and credit management.

In watershed planning, the first step is a soil survey and land capability classification. On this basis, land suitable for cereal crops, plantation crops, forest, orchard, and wildlife are determined. The American Soil Classification System, where there are 9 to 12 classes of land, is not adjusted for hill agriculture because almost all soil types appropriate for crop production are either non-existent or exist only in insignificant proportion. The relevancy of this classification system is questioned on the basis of its cost, time, logistic difficulties and its tendency to classify hill soil as being unsuitable for crop production. To illustrate this point two studies are cited below.

A soil survey and land capability classification in the Naurer Watershed of Almora District found no Class I and II land and a small proportion of Class III land [Ghildyal, *et al.* 1975]. Most of the land belonged to Class IV and VI (Table 15.1).

In another survey [IAIR, 1978] no land was classified in the first three land use capability classes (Table 15.1). For the watershed in Chausli Village, two-thirds of the land was placed in capability Class VIII.

The land settlement reports from the state revenue department follow a more simplistic and perhaps better methodology. Irrigated lands classified as *Seras* (perennially irrigated), *Pachar* (intermittently irrigated), and *Simar* (water-logged) [Jalal, 1975]. Unirrigated terraced lands are called *Upraon Abbal* and *Upraon Doyam.* Unterraced unirrigated, cultivable lands are called *Khil* and *Katil.* This information together with some other information such as slope, elevation and existing vegetation may be adequate for watershed planning.

A watershed sheds water. It is very necessary that this water be harnessed for increasing the productivity of land in the watershed. Due to a mountainous terrain and undulating topography, new techniques of water harvesting and distribution are needed. Its management in hill agriculture is a neglected area of research.

The availability of irrigation water itself leads to an improvement of the terraces. Thus there is a complementary relationship between irrigation water and the terracing of fields. The new water harvesting techniques in watershed management may utilize hydraulic rams, storage ponds with polythene lining, steel pipes for conveyance and sprinklers. It maybe a misnomer to call it irrigation, and maybe better termed life-saving or supplemental water in a rainfed farming system.

Potential for Increasing Production

A mini watershed was selected in the Naurer Watershed to analyze the potential for increasing production. The optimal farm plan presented in Tables 15.2 and 15.3 demonstrate the possibilities of enhancing farm production and income [Singh and Rahim, 1978].

These plans were formulated for areas suitable for intensive cultivation and where new high-yielding varieties and cash crops have been introduced.

TABLE 15.1
DISTRIBUTION OF LAND UNDER VARIOUS CAPABILITY CLASSES FOR THREE MINI WATERSHEDS IN ALMORA DISTRICT

Capability class	Watershed area (ha)		
	Adbora	Dhampo	Chausli
I	0	0	0
II	0	0	0
III	4.3	16.7	0
IV	15.3	46.3	37.7
V	0	3.3	0
VI	21.1	15.3	27.7
VII	1.2	18.0	36.4
VIII	2.4	3.3	198.7
Total	44.3	112.9	300.5

Sources: Ghildyal *et al.* [1975].
IARI [1978].

The percentage increase in farm income was highest under optimum crop plan with improved technology and unlimited credit. These results indicate a wide scope for increasing agricultural production by introducing suitable high-yielding varieties of cereal crops, vegetable, improved cropping practices, crop rotation and the use of modern input. The preceding study and other research on cultivable and community land show that agricultural production and productivity can be considerably increased by proper planning and resource use in the hills, although several technological socio-economic and institutional constraints limit their production potential.

Technological Constraints

In the irrigated lower valleys of the hills, the high-yielding variety (HYV) technology as practised in the irrigated areas of the Tarai or plains is applicable and generally, two crops of either paddy, wheat, or vegetable can be grown in one year. In contrast, more than 90 percent of hill agriculture is rainfed where a two-year rotation of coarse millet–fallow–paddy–wheat is followed. Local varieties are commonly used. The system of mixed cropping comprises pulses with finger millet, paddy with mustard and lentil with wheat. The farmers practise the art of survival by diversification of crops and thus minimize risk and uncertainty.

Another technological constraint is the lack of implements and tools which can reduce the drudgery of agricultural labour in the hills. Tools and implements designed and developed by agricultural engineers have not been adopted by hill farmers.

TABLE 15.2
ALTERNATIVE OPTIMAL PLANS FOR A REPRESENTATIVE FARM (0.86 HA) IN NAURER WATERSHED

Production activity	Existing crop pattern	Alternative plan			
		A1	A2	A3	A4
	Percentage of total cropped area				
Local paddy + *Jhungra*	19.4	22.2	11.7	11.7	11.7
High-yielding paddy	0	0	11.9	8.4	0
Ragi + *Bhat/Urd*	19.8	22.1	18.6	18.6	35.5
Capsicum	0	0	0.2	0.6	0
Chilli	1.3	3.5	1.2	1.2	1.2
Tomato	0	0	0.6	0.6	0.5
French bean	0	0	1.1	1.1	1.1
Soybean	0	0	4.7	4.7	0
Summer potato	0	0	0	2.3	0
Rabi potato	0.2	5.8	0	5.2	0
Local wheat + barley/*lahi*	21.6	22.2	0	0	0
High-yielding wheat	0	0	19.5	22.9	7.2
Pea	0	0	3.5	0.6	3.5
Oat	0.1	0	0	1.1	0
Maize	2.1	0	0	0	0
Rabi fallow	35.5	24.2	18.6	21.0	18.6
Land left unused (slack activity)	0	0	8.4	0	20.7
Local buffalo (no)	1	0	0	0	1
Improved cow (no)	0	0	0	0	1

Notes: A1 = optimum crop plan with existing technology.
A2 = optimum crop plan with improved technology and limited credit.
A3 = optimum crop plan with improved technology and unlimited credit.
A4 = optimum crop-cum-livestock plan with improved technology and limited credit.

Source: Singh and Rahim [1978].

TABLE 15.3
RETURNS OVER VARIABLE COST, MARGINAL VALUE PRODUCT OF SCARCE RESOURCES, EMPLOYMENT POTENTIAL AND CREDIT REQUIREMENTS UNDER VARIOUS ALTERNATIVE FARM PLANS IN NAURER WATERSHED

Data category	Existing situation (1973–74)	Alternative farm plan			
		A1	A2	A3	A4
Returns over variable cost (ROVC) (Rs)	1,813	2,385	3,634	4,124	3,972
Percentage increase in ROVC over the existing situation	–	31.54	100.40	127.47	118.53
Marginal value product of scarce resources:					
Kharif irrigated land (Rs/ha)	–	1,415	3,804	3,890	1,779
Kharif rainfed land (Rs/ha)	–	2,045	1,996	1,925	1,779
Rabi irrigated land (Rs/ha)	–	1,351	2,966	8,199	2,966
Rabi rainfed land (Rs/ha)	–	1,544	0	955	0
Human labour during Oct. – Nov. (Rs/ha)	0	0	0	5.60	0
Kharif cash (Rs)	0	0	1.56	0	4.76
Rabi cash (Rs)	0	0	2.70	0	2.70
Employment potential (man-days used per annum)	230 (19.1)	308 (25.7)	515 (43.0)	562 (46.9)	312 (26.0)
Credit requirement (Rs/ha)	0	0	868	233	233

Notes: Figures in parenthesis indicate percentage of total man-days utilized per annum.
In June 1981, US$1.00 = Indian Rs. 8.20

Source: Singh and Rahim [1978].

There are no suitable high-yielding varieties of rice for rainfed areas. New techniques of water harvesting, and silvicultural information on social forestry are also absent. There is also a lack of emphasis on vegetable and fruit production research where the hills have a regional and seasonal advantage.

Animal husbandry and social forestry may be major catalysts in hill agricultural development. An integrated programme of cattle development involving breeding, feeding, disease control and management is needed. The natural service of Murrah bulls for buffalo and the artificial insemination of Jersey semen for nondescript unproductive cows have good potential. The scope for growing fodder crops is limited but the planting of fodder trees in private and community land should be encouraged.

Socio-Economic Constraints

In the hill regions, 88 percent of holdings are less than 2 hectares while 68 percent are less than 1 hectare. Since less than 10 percent of land is irrigated, most of the holdings are uneconomical.

The farm size for typical districts is given in Table 15.4. It shows that 97 percent of holdings are less than 1 hectare (the average size being .38 hectare) and these account for 88 percent of the cultivated land. Only 8 percent of the land is irrigated. The holdings are spread over 5 separate locations. There are 32 terraced fields, and the average area of a field is only 0.01 hectare. Even with improved practices it is difficult to generate a sizeable increase in income with such fragmentation and scatteredness. Moreover, considerable human and bullock labour is lost in moving from fields in one location to another.

The income composition of farm households in a typical watershed in the Tehri-Garhwal district is given in Table 15.5. On the average, the income of farm families is at a subsistence level. They survive by combining several farm and off-farm occupations. The most important farm occupation is animal husbandry followed by off-farm activities. Crop production only ranks third as a contributor to total income. Most cash income comes from off-farm activities.

The data in Table 15.5 suggest that an integrated approach of animal husbandry, crop enterprizes, horticulture, and social forestry has to be adopted to increase farm family income.

Labour is generally regarded as not being a constraint in agricultural development in the hills, because of its surplus in rural areas. But this is not always true. Labour availability should be considered in terms of male and female labour. Except for ploughing, all farm operations are carried out by women. There is a surplus of male labour and a shortage of female labour, and women often have to work 12 to 16 hours a day.

In Chausli village, the per hectare average yearly labour requirement per crop is 363 and 60 days for human and bullock labour respectively. Human labour utilization by sex shows that on an average 303 woman-days and 60 man-days are required per hectare. Due to this inequitable division of labour, which has become customary, the men idle away their time and women work between 12 and 16 hours per day.

The new technology is labour-intensive as more labour is needed for line sowing, interculture operations, and fertilizer and pesticide application. Sanwal [1965] found that when the Japanese method of paddy cultivation was introduced, nearly every farmer adopted it in the first year, a few dropped out in the second, and more in the third. In the fourth year after its introduction hardly any farmer followed the method. Farmers reverted to their traditional practice because they had to replace summer millet with green manure (thereby losing one secure food crop) and because more male labour was

needed which the men were reluctant to supply. If men do not undertake the new operations or if the customary inequitable division of labour is not broken, the overburdened women will not take interest in the new technology, and labour becomes a severe constraint to increasing agricultural production.

TABLE 15.4
DISTRIBUTION OF LAND BY SIZE GROUPS OF HOLDINGS, CHAUSLI VILLAGE

Size of holding (ha)	Number of farm families	Percentage of farm families	Area of holdings (ha)	Percentage of total area
Below 0.50	98	83.1	27.8	61.5
0.51 – 1.00	16	13.3	12.2	27.2
1.01 – 1.50	3	2.5	3.5	7.7
Above 1.50	1	0.9	1.6	3.6
Total	118	100.0	45.1	100.0

Source: ICAR [1979].

TABLE 15.5
SOURCE OF INCOME IN BHAINTAN WATERSHED IN THE TEHRI-GARHWAL DISTRICT

Source of income	Gross income (Rs)	(%)
Cereal	80,390	23.1
Cash crop	6,601	1.9
Fruit	1,291	0.4
Pulse	1,862	0.5
Milk products	120,774	34.8
Livestock	39,365	11.3
Off-farm income	97,091	28.0
Total	347,374	100.0
Average family income	3,695.5	

Note: Based on 94 households.
Source: ICAR [1980].

The extension, training and education programmes for agricultural development should be farmer-oriented. A proper identification of the farmers would show that most of them are women. They may not control the purse strings in farm households but they are the decision-makers in all agricultural activities. There is a dire lack of women extension workers and a lack of involvement of women in agricultural training, extension, and education programmes.

In their enthusiasm to push agricultural development, government programmes have given farmers liberal subsidies. As a consequence, the hill people have lost sight of development programmes and think only in terms of subsidies. In any village with a development programme, the first question asked is about the subsidy in this programme. Thus subsidies, instead of becoming incentives for development, have become the bane of agricultural development programmes in the hills.

Institutional Constraints

Strong local level institutions are a necessity but are by themselves inadequate to accelerate agricultural development. A recent study revealed several weaknesses in the present status of these rural institutions and in their functions at various levels [Shah 1976].

No institutions exist to supply credit to farmers and to market their output because the co-operative credit society is defunct. Instead, the block is the only functional development organization. Unfortunately, there is general apathy and disinterest in its activities among farmers. There is very little popular participation because it is regarded as a distributor of dole.. The *Kashetre Samiti* and *Gram Panchayat* are the other local institutions for promoting agricultural advancement but they functioned in a rather irregular manner. To begin with, the block development officer and his staff who come under the purview of the district magistrate and are responsible for promoting development have little faith in the *Kashetre Samiti* as they view its members (local farmers) as being illiterate and ignorant.

The district agricultural officer is equally helpless in getting things done. New institutions such as the *Mahila Mangal Dals* and *Nav Youvak Dals* have also been very weak. They are engaged primarily in social welfare and entertainment activities. From the foregoing, it appears vital that institutional innovations be implemented and that all local level institutions be linked up with the proposed watershed authority which will be an autonomous body formed for the purposes of watershed development.

Policy Recommendations

The existing technological gaps in the field of animal husbandry, social forestry, and hydrology can be filled by strengthening existing research institutions. It is also essential that these institutions co-ordinate their functions to avoid duplication.

The watershed should be the planning unit and, instead of emphasizing food self-sufficiency, optimization of land and water use with ecological considerations should be the objective. An autonomous watershed authority with technical experts in all relevant fields should be set up at the regional level. This authority should prepare watershed plans and evaluate their implementation.

To reduce the wastage of labour and power and to encourage horticultural and farm forestry enterprizes, there is an urgent need not only to consolidate holdings but to prevent further sub-division and fragmentation.

No subsidy should be given for seed, fertilizer, and other production input. However, they should be made available in markets, and their packaging and transportation costs

should be subsidized. All the investment cost associated with soil and water conservation, water harvesting, and perennial crop planting should be subsidized, as these are long-term investments which will benefit the society greatly.

Active participation on the part of the people at the local level is necessary to ensure superior performance and sound achievements. There is also a need to search for new institutions and new approaches. The schools and colleges should become centres of community activity, with the school farm demonstrating a model silvicultural system for the area. Students should both learn and earn from this farm which should be used to educate local men and women in the scientific and technological aspects of the farming system.

A water users' association should be formed to manage hydraulic ram installations, storage tanks, sprinkler systems and the distribution of water from the source to the field. Informal co-operatives for marketing, and the distribution of social forestry produce and forest labour supply have been found to be effective.

Women should form unions to fight the traditional division of labour and to coerce the men to carry out labour operations under the new technology, besides sharing equally in the work of agricultural production.

A task force of selected young men and women graduates belonging to the local area should be trained in the integrated approach for agricultural, horticultural, forestry, soil conservation and animal husbandry development. This task force should function under the watershed authority.

REFERENCES

Ghildyal, B.P., Sharma, A.K. and Virendra, K. 1975. "Soils of Kumaon and Garhwal Hills of Uttar Pradesh: Their Potential and Problems." *Seminar on Problems and Potential of Hill Regions, New Delhi, 1975.*

IARI. 1978. *Soil Survey and Land Capability Classification of Chausli Village, New Delhi:* Vivekananda Laboratory for Hill Agriculture, Indian Agricultural Research Institute.

ICAR. 1979. *Socio-economic Survey of Village Chausli.* Almora: Indian Council for Agricultural Research (Report fo the Vivekananda Laboratory for Agriculture (Mimeograph).

ICAR. 1980. *Operational Research Project Watershed Management Fakot (Bhaintan Watershed) District.* Dehradun: Central Soil and Water Conservation Research and Training Institute, Indian Council for Agricultural Research.

Jalal, D.S. 1975. "Classification and Potential Productivity of Usable Land in Kumaon Himalayan with Special Reference to District Pithoragarh, Uttarakahand Bharati." *Quarterly Journal of Himalayan Studies* 1 (3).

Sanwal R.D. 1965. "Agricultural Extension in a Kumaonese Village." *Journal of Development Studies* 4.

Shah, S.L. 1976. *Rural Area Planning Research and Action in Naurer Watershed in Bhikiasen Block of Almora District.* Pantnagar: G.B. Pant University.

Singh, K. and Rahim, K.H.B. 1978. "Identification and Evaluation of Optimal Cropping Systems for a Typical Watershed in Uttar Pradesh Hills." *Indian Journal of Agricultural Economics* 4, p. 29 – 35.

16
Upland Agriculture in Indonesia

B. SOEWARDI and K. MUSTARI

Introduction

Upland agriculture in Indonesia is currently receiving more attention because of its vast potentials as well as its challenging limitations. Although 90 percent of rice production comes from the lowland, the area available for future expansion of irrigated and rainfed lowland rice is limited. Satari *et al.* [1977] estimated that the cost of establishing one hectare of irrigated or rainfed rice field is Rp 1.5 or 0.3 million respectively.[1] Not all lowland can be converted to irrigated rice land because of limited water resources. The control of water in tidal swamps is even more expensive and difficult.

This paper deals primarily with the problems and programmes for the development of annual upland crops. It has been claimed that the cultivation of the these crops causes erosion, siltation, flood and drought in the lowland. But their development is essential since they are being cultivated by a large number of smallholders who possess limited capital, skill and knowledge.

Resources

Latitudinally, Indonesia extends from 6° to 11° south and longitudinally from 95° to 141° east. The furthest distance from west to east is 5,100 kilometres, while the greatest distance from north to south is 1,888 kilometres. The country consists of more than 13,000 islands and its total land area is approximately 200 million hectares.

According to the 1980 census, the population of Indonesia is 147 million and its annual growth rate is 2.34 percent. This population is unevenly distributed. The island of Java represents only 7 percent of the total land area but it accommodates 62 percent of the total population.

In 1978, agriculture contributed to 31.1 percent of the Gross Domestic Product and provided employment for 61.6 percent of the labour force. The increasing imports of food and other agricultural products imply that the growth rate of agricultural production has been smaller than that of consumption. To cope with this problem efforts have been made to:

(1) increase agricultural production;

(2) develop agricultural based industries;

(3) reduce the rate of population growth through birth control programmes; and

[1] In June 1981, US$1.00 = Indonesian Rp. 600.00

(4) move people from densely populated islands to sparsely populated ones a programme known as transmigration.

Challenges in Agriculture

The population pressure makes food production a major cause for concern. According to Satari *et al.* [1977] by the year 2000, Indonesia has to produce 33 million tonnes of rice to feed a quarter billion people. This means that she must increase rice production by 5 percent per annum. Previous experience has shown that the intensification of existing areas could contribute to only 2 percent annually. Consequently, the rest has to be met by expansion or the opening up of new land at the rate of 400,000 hectares a year, 300,000 of which will be dryland and the rest wetland.

There is tremendous potential for the extension of agricultural activities to areas outside Java and Bali where their development has so far stagnated. However, this would entail the utilization of marginal soil (Class IV, V and VI) as shown in Table 16.1. About 60 percent of the 35 million hectares of land suitable for food crops is made up of Red Yellow Podzolic soil with the following characteristics:

(1) acid, pH between 4.5 – 5.0;

(2) poor in plant nutrient;

(3) low in cation exchange capacity (CEC);

(4) low in water holding capacity and water permeability; and

(5) erodable.

There are 42 million hectares of waste land which constitute 22 percent of the total land area of Indonesia. This is increasing at an annual rate of 12 percent. Swidden cultivation is the main cause for this, while more recently, improper logging operations are known to have brought about similar consequences. Even semi-permanent and permanent farming are detrimental when soil conservation measures are neglected.

Problems in Farm Operation

Size of holding

Indonesian farming is characterized by small farming units in terms of both land holding and capital investment.

The average size of farm is about one hectare while in Java it is only 0.62 hectare. Even with the new settlement programme (transmigration) the allocation is only 2 hectares of land per family comprising of 0.25 hectare for the house and home garden, 0.75 hectare for rainfed farming and 1.0 hectare of irrigated land. The danger of fragmentation, especially in Java, is on the increase, causing farming units to become smaller and swelling the number of landless labourers in rural areas.

Accessibility

When compared with lowland cultivation, most upland agriculture is located in less accessible areas. The greater distance from urban centres and the lack of transportation result in a lower farm-gate price for the agricultural product and a higher cost for agricultural input.

TABLE 15.1
AREA AND LAND CAPABILITY IN INDONESIA

Class	Java	Bali	Sumatra	Kalimantan	Sulawesi ('000)	Irian Jaya	NTB/NTT	Maluku	Total	%
I	275	–	–	–	–	–	–	–	275	0.14
II	344	19	–	–	275	–	94	–	732	0.38
III	969	–	631	–	806	–	138	25	2,569	1.35
IV	3,369	144	7,781	1,319	1,869	1.144	2,069	1,113	18,808	9.85
V	2,344	125	26,306	23,281	2,106	17,756	2,200	3,425	77,543	40.61
VI	3,312	206	5,206	13,263	3,425	6,688	481	1,206	33,787	17.69
VII/VIII	2,606	62	7,439	16,137	10,614	16,612	2,056	1,706	57,232	29.91
Total	13,219	556	47,363	54,000	19,095	42,200	7,038	7,475	190,946	100.00

Source: Muljadi and Soepraptohardjo [1975].

Marketing

The market for the *palawija*[2] is unstable. In the past, successive attempts at enhancing *palawija* production have ended up in failure because of the lack of markets for these items.

Storage

Farmers are unable to wait for better prices because of the risk involved in storage. Loss due to insect and rodent is substantial. This problem is faced by both farmers and traders. Indonesia has to import maize for animal feed because of the lack of good storage facilities. This phenomenon demonstrates the importance of developing postharvest technology for *palawija* which is the main produce of upland agriculture.

Seed

Seed of improved varieties is either not easily available in the market or the price is often so high that upland farmers cannot afford to buy them.

Policy and Programme

At the national level, the government's priority is on rice, *palawija,* and horticultural crop production. In terms of methods utilized to expand production, the order of priority is intensification, extensification and diversification.

Policies in food crop production include the following criteria:

(1) to increase food production through intensification and extensification;

(2) to promote agricultural extension;

(3) to enhance the supply and use of improved seed;

(4) to improve the credit system;

(5) to improve the supply and distribution of input production; and

(6) to improve infrastructure both physical and institutional.

The BIMAS/INMAS project is exclusively managed by the BIMAS co-ordination body, while other projects are under the management of the Directorate-General of Food Crops. BIMAS literally means mass guidance, and it is an intensification project conducted through improvement in variety, irrigation, cultural technique, fertilization, and disease and pest control. The difference between BIMAS and INMAS is the provision of credit. INMAS does not provide any credit.

Results of Development

As shown in Table 16.2, the increase in harvested area is 44,000 hectares per year or at an annual rate of 0.63 percent. This increase in area is much lower than the population growth rate (2.34%). The situation is compounded by the rate of increase in consumption which is higher (3.9%) due to the increase in per capita consumption (1.7%) and the switch from other sources of staple food to rice. Most of the increase in area is in the form of wetland rice in contrast to upland rice which is declining steadily.

[2] *Palawija* refers to non-rice food commodities such as maize, cassava, groundnut, soybean and mung-bean.

TABLE 16.2
AREA HARVESTED, PRODUCTION AND YIELD OF PADDY

Year	Area harvested ('000 ha)		Production ('000 tonnes)		Yield (kg/ha)	
	Wetland	Dryland	Wetland	Dryland	Wetland	Dryland
1969	6,544	1,470	21,474	2,282	3,282	1,146
1970	6,679	1,456	23,149	2,121	3,466	1,437
1971	6,893	1,432	24,308	2,084	3,527	1,456
1972	6,602	1,296	23,402	1,949	2,545	1,545
1973	7,064	1,340	25,902	2,189	3,667	1,634
1974	7,340	1,168	27,531	1,846	3,751	1,580
1975	7,334	1,161	20,850	1,481	2,843	1,276
1976	7,229	1,139	21,851	1,449	3,072	1,272
1977	7,202	1,157	21,808	1,539	3,028	1,330
1978	7,653	1,240	24,265	1,614	3,171	1,302
Mean	7,054	1,286	23,454	1,855	3,335	1,420
Percent	84.55	15.45	92.69	7.31		

Note: One tonne of paddy is equivalent to 0.5 - 0.6 tonne of rice.

Source: Indonesia [1974 – 1979].

To meet the growing demand for rice, the intensification of existing rice land is imperative. The area adopting intensive farming has grown at a much more rapid rate than the growth of total harvested area. This is the main reason for expansion in production on the whole and productivity increases have been higher than the increase in harvested area. In fact, the yield levels for intensification is 49.7 percent higher than that for non-intensification (Table 16.3). However, when BIMAS was changed to INMAS production declined. This shows the need for improvements in agricultural extension.

The area under upland rice is only 15.4 percent of the total harvested rice field and it contributes to 7.3 percent of total rice production. Upland rice is relatively more important in the outer islands (25.5%) when compared with its production in Java (6.8%) where irrigation schemes have been well established for a long time.

The response to intensification projects from upland rice production is lower. In 1977 for example, its percentage was 33 percent in contrast to 55 percent in the case of lowland rice. This is due to the lack of appropriate technology and the higher risk associated with upland production.

As stated, *palawija* takes second place after rice. No clear pattern of change is observed in terms of its harvested area, although it is on the whole constant (Figure 16.1). In 1973 there was a slight increase in production due to an increase in the yield rate as a result of BIMAS *PALAWIJA*.

The erratic price of *palawija* and the non-availability of improved seed are the main causes of stagnation. Therefore, vertical integration involving improvement in production, storage, and marketing is essential.

So far, there is little priority on horticultural crops. This is reflected in the data on harvested area which has remained constant over the period from 1969 to 1976. However, production as well as productivity have increased due to intensification measures which were adopted long before its promotion by the government in 1975. Besides, vegetable production has been more commercially oriented than other food crops. The present focus of the intensification project is on the home gardening of vegetable. This is in line with government efforts to improve the nutrition of the people. Less attention is paid to fruit crops. Orange is an exception because of *citrus vein phloem degeneration* (CVPD) disease which attacked more than 500 million trees.

Over time, fruit production has increased because of the growth in demand due to rising income and standard of living (Figure 16.2). In densely populated areas fruit trees should be developed on upland stretches because they generate a high income.

Recommendations

There are two remedies which are worth considering to create a more viable upland agricultural economy for smallholders, namely, *multiple cropping and the synergic farming system.*

McIntosh *et al.* [1980] demonstrated that the productivity of tropical upland soil can be maintained and improved. This proposal comprises;

(1) a perennial crop based cropping pattern; and

(2) a food crop based cropping pattern.

The first cropping pattern has been spontaneously adopted by the indigenous people who has access to new land. Its sequence of development is as follows:

First year. Forest trees are cut when they are sufficiently dry and burnt. Rice is planted by dibbling seed on untilled soil at the beginning of the rainy season. At about the same time small trees are planted for shade and living poles are erected for pepper vines. Two months later, rice, coffee and cassava are planted. A five-month variety of cassava is planted after the rice harvest. Groundnut is planted in the cassava, pepper and coffee areas. The net profit per hectare is Rp 200,700.

Second year. Some reduction in yield is expected. There will be no cost for the felling and burning of trees. The net profit per hectare is Rp 169,200.

Third year. No food crops are planted. Perennial crops are still unproductive. The cost of maintaining pepper and coffee is about Rp 30,000 per year.

Fourth and subsequent years. The coffee begins to bear fruit and reaches maximum productivity at year 6 or 7.

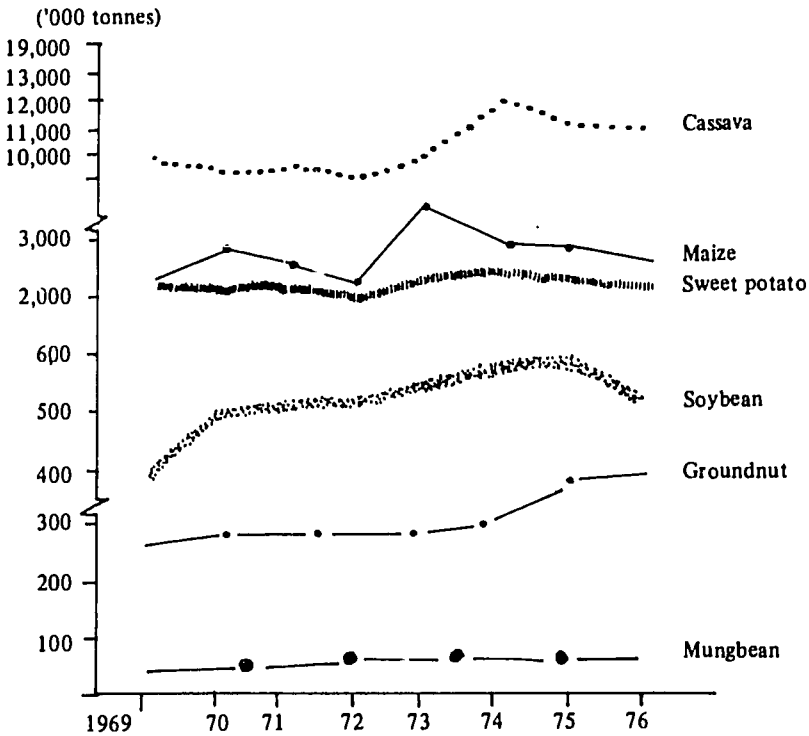

Figure 16.1 Palawija *production*

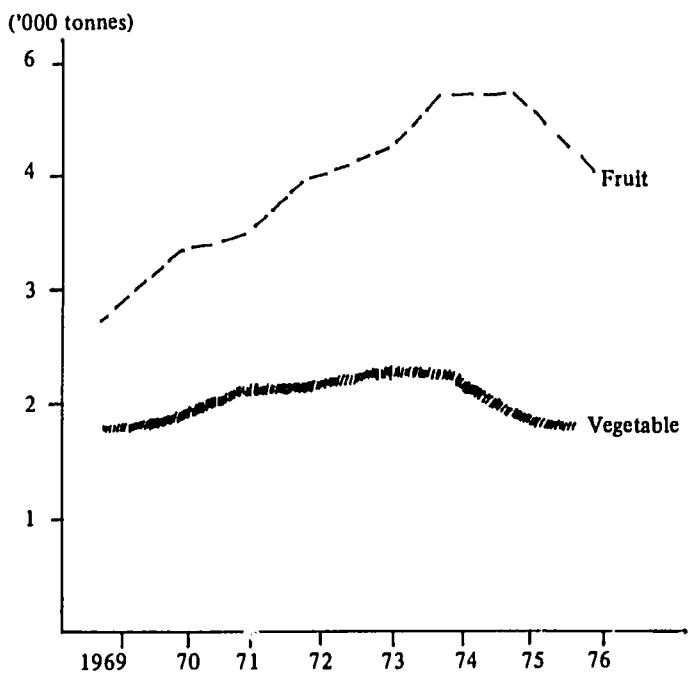

Figure 16.2 Horticultural production

Source: Indonesia [1978].

TABLE 16.3
YIELD RATE FOR RICE

Year	Non-intensification	Intensification (tonnes/ha)	Bimas	Inmas
1969	1.40	1.89	1.46	1.72
1970	1.41	2.18	2.33	1.88
1971	1.45	2.15	2.30	1.81
1972	1.27	2.26	2.56	2.07
1973	1.19	2.37	2.70	2.08
1974	1.62	2.27	2.33	3.12
1975	1.65	2.22	2.29	2.01
1976	1.74	2.23	2.41	2.18
1977	1.54	2.26	2.38	2.15
Mean	1.47	2.20	2.31	2.11

Source: Indonesia [1978].

A cropping system based on food crops has also been proposed [McIntosh *et al.* 1980].

Three cropping patterns are tested and a summary of their yield data is given in Table 16.4

These results demonstrate that sustained and economically viable crop production can be developed in upland areas. Five years of research in Sumatra have shown that the Red Yellow Podzolic soils are responsive to fertilizer and good crop management.

Soewardi [1977] proposed the development of a *synergic farming system* in the upland areas based on observations in Central Java where the farmer's rationale for selecting the combination of enterprizes -- species of crops and livestock -- have borne fruit. The combination of annual food crop, perennial crop, and livestock is optimum in terms of meeting the multiple objectives of farming. Contrary to the established opinion that farmers are profit maximizers or risk averters, it is observed that they have reasons or objectives for operating their farms in a particular manner. These include:

(1) food production;

TABLE 16.4
YIELD OF MAIZE, UPLAND RICE, GROUNDNUT, RICE BEAN AND CASSAVA -- MULTIPLE CROPPING EXPERIMENT, BANDJARJAYA, LAMPUNG*

Fertility treatment	Maize	Upland rice Dry grain (kg/ha)	Groundnut	Rice, bean (tonnes/ha)	Cassava (fresh tuber)	Approximate net return (Rp/ha)
		Mixed cropping				
No lime+no NPK+no mulch	467	690	161	55	12.7	65,000
Lime + NPK + mulch	1,165	1,358	356	248	28.3	132,000
		Intercropping				
No lime + no NPK + no mulch	455	769	222	93	14.6	91,000
Lime + NPK + mulch	1,350	2,724	567	627	23.2	265,000
		Sequential planting				
No lime + no NPK + no mulch	606	850	–	153	–	6,000
Lime + NPK + mulch	2,935	3,536	–	723	–	74,000

Notes: Wet season 1973/1974.
Dry season 1974.

(2) generation of daily cash;

(3) accumulation of savings for investment purposes;

(4) fuel-wood production;

(5) soil fertility;

(6) production of building material;

(7) other household consumption; and

(8) production of animal feed.

The relative importance (or weight) for all the objectives is not similar. Food production is the most vital followed by the generation of cash and the other factors enumerated above. The sum product of weights and the value of output is the total score for each species of crop or livestock, while the sum product for each column is the total score for each objective (Table 16.5).

From this analysis it is clear that the higher the total score the higher the preference. The higher score is associated with the higher number and heavier weight of objectives served by the species of crop or livestock.

Farmers try their best to meet all the objectives to the fullest extent. If the total score for a certain objective is too low they try to obtain this at least cost. This is the case for harvesting natural grasses for animal feed and bamboo for building material.

This type of farming system represents one of the essential characteristics of a system with each component contributing to the common objectives. The structure and the function are interdependent and synergistic. For example, to regenerate soil fertility, relay planting with shrubs *(Lantana camara* and *Titonia diversifolia)* is practised to simultaneously produce fuel-wood and animal feed. Livestock consumes feed, it produces meat which generates cash to provide savings for future investment, and at the same time produces manure for the maintenance of soil fertility.

REFERENCES

Indonesia. 1974 – 1979. *Statistical Pocket Book.* Jakarta: Bureau of Statistics.

Indonesia. 1978. *Sepuluh Tahun Departmen Pertanian.* Jakarta: Department of Agriculture.

McIntosh, J.L.; Effendi, S. and Ismail, I.G. 1980. Productivity of Tropical Upland Soils can be Maintained and Improved. *Indonesian Agricultural Research and Development Journal* 2(1).

Muljadi, D. and Soepraptohardjo, M. 1975. Masalah Data Luas dan Penyebaran Tanah-Tanah Kritis. Pencegahan dan Pemulihan Tanah-Tanah Kritis dalam Rangka Pengembangan Wilayah, Jakarta.

Satari, G.; Sadjad, S. and Sastrosoedardjo, S. 1977. "Pendayagunaan Tanah Kering untuk Budidaya Tanaman Pangan. Menjawab Tantangan Tahun 2000." Symposium I Pendayagunaan Tanah Kering Kongress Agronomi Jakarta, 27 – 29 October.

Soewardi, B. 1977. "Rehabilitation of Critical Lands through Integrated Farming." Symposium on Critical Lands in Densely Populated Areas Semarang, 22 – 23 December, 1977.

TABLE 16.5
OBJECTIVE OF FARMING AND RELATIVE UTILITY Of CROP/LIVESTOCK

Crop/livestock	Food	Cash	Capital	Fuel	Soil fertility	Building material	Other household consumption	Livestock feed	Total
Maize	5+	+		+			+	3+	34+
Cassava	3+	+		+				2+	22+
Vegetable	4+	2+			+			+	29+
Sugarcane		5+		2+			2+	+	22+
Clove			5+		3+		+		17+
Coffee			5+		3+		+		17+
Tobacco			3+				2+		8+
Tea		2+					3+		9+
A. falcaturia			+	2+	2+	5+		2+	22+
Acacia		+	+	2+	+	+			13+
T. diversifolia				5+	4+			2+	20+
L. camara				4+	2+			+	13+
E. pallescens				2+	4+			3+	15+
L. leucocephala							+	2+	3+
Sheep/goat		+	3+		5+		++		20+
Poultry		4+	+		+		+		17+
Relative importance	5	3	2	2	2	2	1	1	
Total score	60	54	36	50	52	12	13	18	
Additional sources to balance objective fulfilment						Toona sureni bamboo		Natural grass	

17
Prospects and Problems of Hill Agriculture in Malaysia.

B.T. TAN

Introduction

Only about 2.5 percent of the cultivated agricultural land in Malaysia is devoted to hill agriculture. Two distinct types of farms are found in these areas -- commercial vegetable farms and those which are operated by shifting cultivators. Commercial vegetable farms are located in small pockets on the highland plateau, and they constitute the most important source of fresh vegetable for the country. Shifting cultivators are still a large and important community but their traditional agricultural activities and way of life are slowly being curtailed as land becomes less and less easily available, and as development programmes are being implemented to provide them with permanent farm land for commercial agriculture. This paper reviews the position of hill agriculture within the context of the overall Malaysian agricultural economy, and highlights the prospects and problems of this farming sector.

Malaysia comprises peninsular Malaya and the states of Sabah and Sarawak on the island of Borneo. It has a population of 14 million and a per capita Gross Domestic Product of US$1,710 in 1980. Agriculture is the major sector of the economy and employed 44 percent of the labour force in 1978. It contributes to 25 percent of the Gross Domestic Product.

In recent years, the contribution of agriculture in terms of Gross Domestic Product and percentage employment has declined as more and more people migrate to the urban sector where secondary and tertiary industries are concentrated. Nevertheless, the agricultural sector continues to remain an important sector for several reasons. Firstly, it accounts for 65 percent of total export earnings. Secondly, it provides employment for nearly half of the active labour force. Thirdly, it is the main source of Malaysia's food supply. Local rice production, for example, contributes to nearly 90 percent of the domestic requirement.

The government has in its Third Malaysia Plan [Malaysia, 1979] focused on the objective of improving income distribution in all sectors of the economy. Increasing attention is being paid to the agricultural sector since it is the sector which is characterized by the largest poverty group in the country. Nearly 55 percent of agricultural or rural households are considered to be poor, or have an average income below the poverty level. The highest incidence of poverty is found among the rice farmers (74 percent), agricultural labourers (73 percent) and fishermen (55 percent).

Efforts to improve the standard of living among these groups have concentrated on raising the agricultural productivity of existing arable land through improvements in irrigation and drainage, and on the development of new areas for poor or landless farmers. The latter activity has been the more impressive feature of the agricultural programme

in Malaysia, and in the past decade, a total of 100,000 hectares of new land have been developed annually.

Review of Agriculture in Malaysia

Rubber is the major crop in Malaysia. Lately, its acreage has declined as more and more farmers turn to the planting of oil palm because of higher profitability. The other major crops are coconut, rice and cocoa.

There are several important features of Malaysian agriculture. These are cited below:

1. *Predominance of tree crop agriculture.* Over 80 percent of the crop area in Malaysia is planted with tree crops. These crops, such as rubber, oil palm, coconut and cocoa are grown mainly or entirely for international markets. The prices of these commodities are highly unstable depending on world economic conditions.

2. *Presence of estate and smallholding agriculture.* Nearly 30 percent of agricultural land is under estate management. These estates which are made up of holdings between 500 to 5,000 hectares in size employ professional managers. They tend to be highly efficient and have yield levels which nearly double those of the smallholdings. Only a few crops such as rubber, oil palm, coconut, cocoa and tea are under estate management.

   The smallholder sector comprises over 700,000 farms with sizes ranging from 1 to 5 hectares. These are either cultivated by the owner-operators or by tenants who hand over about half of the farm produce to the landlords. These farms tend to be poorly managed and are slow to adopt modern technology. They grow several crops, the most common ones are rice, rubber and fruit.

3. *Small areas of land devoted to food crops.* With the bulk of the produce from tree crops being geared for the export market, the domestic food supply is derived from only 10 percent of the agricultural land. The major portion (80 percent) of this area is devoted to rice cultivation. As a result, a wide range of food items are imported and in 1977, food imports made up nearly 20 percent of the country's total imports.

4. *Highest incidence of poverty is recorded in the food producing farms.* In 1975, over 300,000 households were involved in producing food items such as rice, coconut and other agricultural crops. The incidence of poverty among this group of farmers is above 50 percent. Table 17.1 shows the relevant statistics on smallholder agriculture in Peninsular Malaysia. The total population in smallholder agriculture is 4 million and the average farm size is 2.8 hectares.

5. *Lack of expansion in food crop acreage.* For the period from 1964 to 1977, there has been virtually no change in the total acreage for food crops in Malaysia. Practically all the new land which is being developed is for export-oriented agricultural commodities. Although some of these produce such as oil palm and cocoa are consumed locally, the quantity involved is very small.

The stability in crop area in the face of a rapidly increasing population at both the farm and national level implies a growing population pressure on land and an urgent need to increase land productivity if Malaysia is to avoid drastic increases in her reliance on food imports. An indication of this pressure on land can be gleaned from the fact that in 1964, there were 6.7 persons for every hectare of food crops while in 1977, this figure has risen to 11 persons. During this period, the number of persons per food producing farmer in the country has also increased from 21 to 25.

TABLE 17.1
MAIN CHARACTERISTICS OF THE SMALLHOLDER AGRICULTURAL SUB-SECTOR IN PENINSULAR MALAYSIA, 1975

Agricultural sub-sector	Area ('000 ha)	Number of households ('000)	Population ('000)	Hectare per household (%)	Incidence of poverty (%)
Rubber	1,134	396	2,140	2.86	28.0
Oil palm	11	10	53	1.10	9.1
Coconut	199	34	183	5.85	50.9
Rice	379	149	802	2.54	77.0
Other agriculture	164	157	850	1.04	78.8
Total	1,887	746	4,028	2.53	63.0

Source: Tan and Cheam [1979].

Cropping Pattern in Malaysia

The estimated area under various important crop categories for Peninsular Malaysia is shown in Table 17.2 From 1967 to 1977, the total agricultural area for Peninsular Malaysia increased by 739,000 hectares or at an annual rate of 73,900 hectares. The bulk of this new land is for oil palm cultivation. There has been little or no change in crop area for other crops.

Table 17.3 provides estimates on the land area available for future agricultural development in Malaysia. Only 12.2 percent of the total land area in the country is at present being utilized for agricultural purposes. It is estimated that there is an additional 7.0 million hectares (or 21 percent of the total land area) available for new agricultural development. The bulk of this new agricultural land is in Sabah and Sarawak.

As mentioned earlier, the major activity in Malaysia's agricultural development programme is in the development of new land. Thus for the years from 1976 to 1980, an additional 404,700 hectares have been opened up for agriculture (Table 17.4). Virtually all of this new land will be developed by government agencies in large units (ranging from 2,000 to 5,000 hectares) under central management, and with each settler either being promised 4 to 6 hectares after he had repaid the cost incurred in land development

or given regular employment in the land scheme with the promise of a share of the profits from its operation. At an average of 5 hectares per settler, a total of 16,200 families will be resettled in these new land development schemes annually.

It is expected that the pace of new land development will be increased during the next five-year plan, that is, the Fourth Malaysia Plan. For instance, Sabah alone has plans to develop 120,000 hectares over the next five years. This new land will cater to the needs of 25,000 settlers who represent over 15 percent of the total population of the state.

TABLE 17.2
ESTIMATED CULTIVATED AREA IN PENINSULAR MALAYSIA

Item	1967	1972	1977
		('000 ha)	
Rubber	1,760	1,702	1,703
Oil palm	153	347	712
Coconut	203	214	237
Paddy	440	572	567
Other crops	142	163	218
Total	2,698	2,998	3,437
Percentage of land under tree crop	82.9	80.2	83.0
Percentage of land under smallholding	70.0	73.1	73.5

Source: Malaysia [1981].

This rapid rate of land development has created some serious problems with regard to labour availability. The two most obvious symptoms of agricultural labour shortage are the increasing areas of existing agricultural land being left idle, and the increasing need of the agricultural sector to rely on foreign labour. While accurate statistics on idle land are not available, it is estimated that this could range from 400,000 to 600,000 hectares or between 10 to 15 percent of the existing agricultural land area. Similarly, it is estimated that there are over 100,000 foreign agricultural workers involved in developing new agricultural land in Malaysia.

Hill Agriculture in Malaysia

Despite the availability of good agricultural land in Malaysia and the rapid rate of new land development, extensive agricultural activities are being carried out in large areas

of land regarded as being too steep for agriculture. These lands have generally more than 20 to 25 degrees of slope or are located at altitudes of over 300 metres.

TABLE 17.3
ESTIMATED AREA UNDER CULTIVATION AND WITH AGRICULTURAL POTENTIAL, 1978

Land use	Peninsular Malaysia	Sabah	Sarawak	Total
	('000 ha)			
Land under cultivation	3,437	303	303	4,040
Unused land with agricultural potential	3,084	1,842	2,042	6,968
Other land	6,620	5,240	10,184	22,044
Total land area	13,141	7,385	12,526	33,052

Sources: Lee and Panton [1971].
Lee [1970].
Malaysia [1979].

TABLE 17.4
LAND DEVELOPMENT TARGETS FOR 1976 – 1980

Agencies/institutions	Area (ha)
Federal Land Development Authority (FELDA)	202,400
Federal Land Consolidation Authority (FELCRA)	20,200
Rubber Industry Smallholders' Development Authority (RISDA)	40,500
State programmes	97,100
Joint venture/private sector	44,500
Total	404,700

Source: Malaysia [1979].

Agriculture in these hilly areas is confined to two main categories. The first category covering over 3,000 hectares of land above 1,000 metres in altitude is used for commercial vegetable and tea production. This type of agriculture can be regarded as commercial hill agriculture since virtually all the farm produce is sold. The land here is farmed intensively utilizing high levels of input. Tea production is restricted to a few large plantations, while vegetable is grown in many small farms.

The other type of hill agricultural activity is that of shifting agriculture. This is still being practised by a large number of farmers, probably 30,000 to 50,000 in number. They clear about 100,000 hectares of land annually for the planting of rice and other crops for their own consumption. This farming activity is basically subsistence agriculture with labour being the major farm input. Since these farmers practise a ten to fifteen-year rotation cycle, as much as one to one and a half million hectares of land could be involved in shifting agriculture. It is estimated that in Sarawak alone over 2.5 million hectares have been used by shifting cultivators. This includes land abandoned by shifting cultivators when they find other sources of employment.

A review of these two types of hill agriculture is presented below.

Commercial Hill Farming

Temperate agricultural farming is carried out in three hill areas, namely, Cameron Highlands and Fraser's Hill in Peninsular Malaysia and the Kundasang Bundu Tuhan area in Sabah. Temperate vegetable and highland tea are grown in these areas. Tea which is grown as a plantation crop is processed for the local market. Temperate vegetable farming is the main activity for over 2,000 farmers. Each cultivates about one hectare of land. In terms of land area, this highland vegetable acreage represents about 25 percent of the total vegetable growing area in Malaya. However, since the produce is highly priced in the local market, its total value represents as much as 40 percent of all vegetable produced in Malaysia.

Cameron Highlands

The farmers in this area practise a diversified system of vegetable farming, with English cabbage, Chinese cabbage, tomato, lettuce and sweet pea being the main crops. The production of citrus fruits and fresh flowers, and animal husbandry serve as supplementary enterprizes. These farms are highly commercialized with virtually all the purchased input coming from the lowland, and the vegetable produced being shipped daily to all the major towns in Malaysia as well as to Singapore.

The average farm size is 1.13 hectares. However, the land is cultivated intensively and at all times of the year. The cropping intensity averages approximately 2.8. All the vegetables planted have a crop cycle which ranges from three to five months. Thus, as soon as one crop matures, the land is prepared for planting of the following crop. In many cases, intercropping or multiple planting of various types of vegetable on the same plot of land is practised.

An average of 3.3 members of the family work on the farm. Including hired labour, a total of 1,200 man-days is spent for each farm. The other major inputs are organic fertilizer, chemical fertilizer and insecticide.

The annual farm receipt, expenditure and family earning are shown in Table 17.5. The family earning per farm for highland agriculture is high by Malaysian standards and on the whole, each family farm earns two or three times more than that of the average smallholder in Malaysia. The farm earning per cropped and planted hectare is three to five times the average for farms in the lowland. However, in view of the high labour

requirement, the family farm earning per worker and per man-day is about average for Malaysian smallholdings.

TABLE 17.5
ANNUAL FARM RECEIPT, EXPENDITURE AND FAMILY FARM EARNING, CAMERON HIGHLANDS, 1976

Item	Average (M$)
Receipt per farm	
total cash receipt	13,903
farm privilege	120
total receipt	14,023
Expenditure per farm	
total variable cost	6,337
cost of hired labour	536
cost of land licence	25
depreciation on capital	400
total expenditure	7,298
Family earning per farm*	6,725
Family earning per cropped hectare	2,125
Family earning per planted hectare	5,951
Family farm earning per worker	2,038
Family farm earning per man-day	5.60

Notes: *Family earning per farm equals total receipt minus total expenditure.
In June 1981, US$1.00 = Malaysian $2.40.
Source: Chiew [1976].

Kundasang Bandu Tuhan

In contrast to the highly commercial farmers of Cameron Highlands, those in this area are basically shifting cultivators who have recently been encouraged to grow temperate vegetable on a permanent basis. The average farm size is larger (2.0 hectares) than in the Cameron Highlands but the cultivated area per farm is smaller (0.6 to 0.8 hectare). The vegetables grown here are similar to those which are cultivated in Cameron Highlands.

The level and type of inputs utilized are, however, different in these two areas. The major type of fertilizer applied in Kundasang Bandu Tuhan is chemical fertilizer. Organic manure is only used in negligible amounts. Terracing is not practised everywhere, and soil erosion is a severe problem. The cropping intensity is only 2.2. On the average, there are 4.3 workers per farm but the total man-days spent on farming is only 650.

It can be seen from Table 17.6 that family earning per farm in this area is much lower than that for Cameron Highlands. This lower income is due primarily to the lower intensity of farming, lower yields and prices.

The development of Kundasang Bandu Tuhan will require the introduction of new farm technology, higher levels of input especially organic manure, better extension services, and improvements in transportation and marketing.

TABLE 17.6
ANNUAL FARM RECEIPT AND FAMILY FARM EARNING, KUNDASANG BANDU TUHAN, 1976

Item	*Average* (M$)
Receipt per farm	4,000
Expenditure per farm	600
Family earning per farm	3,400
Family earning per cropped hectare	2,207
Family earning per planted hectare	4,857
Family earning per worker	791
Family farm earning per man-day	5.23

Source: Sabah [1976].

Shifting Cultivators

These cultivators are essentially subsistence farmers who follow the traditional system of slash and burn agriculture. On an average, they cultivate 1 to 2 hectares per year but because of their fifteen-year crop rotation, as much as 30 hectares per family may be utilized. In fact, the evidence from land use photographs suggests that a larger area — perhaps some 50 to 60 hectares have been cultivated per household, since in many cases these cultivators migrate to new land instead of repeating the fifteen-year cycle.

Farmers usually cultivate 0.8 to 1.2 hectares of paddy and one hectare of tapioca. Only one crop of paddy is planted a year and the yields are low, ranging from 0.6 to 1.2 tonnes per hectare of paddy. The produce is rarely sold, nearly all of it is consumed at home either as food or as an alcoholic drink.

The main disadvantages of this traditional form of cultivation are:

(1) *Low productivity of labour.* The labour demand for jungle clearing and land preparation is high. This operation needs to be repeated year after year as the cultivators are constantly on the move. In addition, considerable efforts are spent on house construction or relocation.

(2) *Low productivity of land.* Each family requires a large land area in order to practise this system of agriculture. The lack of soil conservation measures often leads to severe soil erosion and loss in soil fertility.

(3) *Scattered location of cultivators.* Each house is situated in the individual farming unit. Thus, the possibility of providing communal facilities and schooling for such communities is remote.

(4) *Low level of income and standard of living.* In many cases, these cultivators report receiving no income at all. The little earning that they accrue is likely to be from the sale of jungle produce such as rattan, gum and wood produce.

The traditional way of life of such shifting cultivators is increasingly being threatened by the development programmes of both the government and the private sector. The high demand for land by the government for development purposes and by the private sector to either open up new land or hold it for speculative purposes, poses a limit on the area available for shifting cultivators. At the same time, the logging industry is eliminating a supplementary source of their income, that is, the sale of jungle produce. An indication of this pressure on land can be observed from the compulsion to cultivate on steeper slopes even in areas where arable land is still available.

Shifting cultivators are more aware of the benefits of improved health facilities and schooling with the introduction of community and education facilities in the rural sector of the country. There is now a preference on their part to locate their farmland adjacent to such centres and to make permanent settlements.

This increases the pressure on farmland near community centres, and farmers are forced to reduce their cropping rotation from one in fifteen years to one in three or four years. This shorter cycle invariably lowers the crop yield unless cultivators adopt modern technology and make use of such input as fertilizer and chemicals.

In short, modernization has caused more and more cultivators to be conscious of the need to move into some form of permanent agriculture. Opportunities for participating in various government-sponsored land development schemes are open to them. However, the rate of success in converting shifting cultivators into permanent settlers has not always been high. Shifting cultivators often find it difficult to switch to single crop agriculture which is oriented solely to the export market. In many instances, they have either left these schemes in order to find land where they are permitted to grow food crops, or they neglect their commercial holdings to grow rice on unused agricultural land nearby.

Conclusion

There is tremendous scope for commercial temperate vegetable farms to expand in both land area and production. The output from these farms is in great demand both locally and for export to neighbouring countries. Growth in productivity to meet this demand can be achieved by providing a package of programmes involving research, better extension services, and improvements in transportation and marketing.

The outlook for shifting cultivators on the other hand is far less promising. Here, a need exists to move these cultivators out of their long established practice of shifting cultivation. This is likely to be a long process, and the rate at which this change takes place will be the major constraint to developing new land for their resettlement. The best inducement for them to modernize is the prospect of a better way of life which can be achieved from permanent cultivation. It must be ensured that these farmers are able to fully utilize the cash earned from the sale of their farm produce, and that the effort required to obtain this income is not excessive in comparison with the reward. Thus, resettlement programmes which retain some features of their existing life style such as

the provision of a plot to allow for the cultivation of at least part of their paddy requirement are more likely to succeed than those which stress the cultivation of only one export-oriented non-food crop.

REFERENCES

Chiew, F.C. 1976. "Application of Linear Programming to Farm Planning of Vegetable Farmers in Cameron Highlands." M.A. diss., University of Malaya.

Malaysia. 1979. *Mid-term Review of the Third Malaysia Plan 1976 – 1980.* Kuala Lumpur: Government Printers.

Lee, F.C. and Panton, W.F. 1971. *Land Classification Report – West Malaysia.* Kuala Lumpur: Economic Planning Unit, Prime Minister's Department.

Lee, Y.L. 1970. *Population and Settlement in Sarawak.* Singapore: Asia Pacific Press.

Malaysia. 1981. *Monthly Statistical Bulletin.* Kuala Lumpur: Department of Statistics.

Sabah. 1976. *Kundasang Vegetable Farming Project* (Unpublished).

Tan, B.T. and Cheam, S.T. 1979. Agricultural Food Policy in Malaysia, *Readings in Agribusiness,* ed. R.A. Rahman *et al.* Serdang, Universiti Pertanian Press.

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18
Hill Farming Systems in Azad Jammu and Kashmir, Pakistan

M. ALI, H. RAHMAN, M. SAWAR and B. LOCKWOOD

Introduction

As part of the World Bank funded Hill Farming Technical Development Project in Azad Jammu and Kashmir (AJK), the Punjab Economic Research Institute, Lahore conducted a benchmark survey of hill farming system covering all areas of the state. The field survey began in May 1980, and continued through February 1981. Some preliminary results of this survey for 2 of the 9 ecological zones studied, covering the crop, livestock, fruit and forest activities for a sample of households from 2 villages in each zone are presented in this paper.

Topography, Climate and Soil

AJK is a mountainous state of 2.9 million acres with a population of 1.7 million, 90 percent of whom relies on rural occupations. Its altitude ranges from around 1,000 feet in the relatively small and flatter portions of the southern district of Mirpur to mountain peaks of well over 10,000 feet. The state is made up of a series of narrow valleys in the 2,000 to 3,000 feet range which feed into the swift-flowing Neelum and Jhelum rivers. They converge at the capital city of Muzaffarabad in the north, and feed into the Mangla Dam in the south. From the many narrow valley bottoms, the terrain generally rises sharply upwards to 5,000 feet from whereon the terrain is characterized by small rolling plateaus, steep ranges and mountain peaks. Most agricultural activity takes place up to an altitude of 6,000 feet, above which the land is given to forestry and summer grazing.

Climatic conditions are sensitive to altitude; the valley bottoms experience mild sub-tropical winters with temperatures rising to 100° – 120°F during the summer monsoon season. At the 5,000 feet level, short duration winter snows and frosts are common, followed by subtropical summer conditions. Above 5,000 feet, heavier and lasting winter snows are found with alpine summer conditions. The mountainous nature of the state gives rise to highly localized rainfall patterns, density and temperature ranges. On the whole, there is sufficient rainfall, with a reasonable spread in most areas to make improved farming systems possible. Apart from the flatter areas of the Mirpur district in the south which is characterized by sandy to clay-loam soil and small alluvial pockets in the valley bottoms, most cultivation is carried out on bench terraces cut into the hillside which have accumulated deposits of heavy clay.

Of the 2.9 million acres in AJK, about 720,000 acres are registered as farmland (including 208,000 acres of uncultivated farmland) involving 206,000 farms. Thus, the average farm holding is 3.5 acres or 2.4 acres of cultivated land. Uncultivated land, including communal hillside pasture and wood, township and houselot, wasteland, and riverbed account for 1.4 million acres. Hence, of the total area only about 17 percent

is cultivated. About 90 percent of the registered farms have less than 5 acres in cultivation, 50 percent have less than 1 acre, and only 2.6 percent record over 10 acres. Therefore, the agricultural system is characterized by many small and often fragmented farms.

Both farming and livestock management are based on very primitive technology. Cultivation is generally by hoe or wooden plough drawn by undernourished bullocks. Current planting methods in the heavy soil result in hard surface pans which limit moisture retention, and these, together with poor quality seed and low fertilizer use, result in extremely low yields. The poorness of the farming sector encourages farmers to exploit the free grazing opportunity offered by the summer alpine pasture. However, overgrazing has led to severe degradation of this pasture, a deterioration in the fodder base and animal quality, and heavy erosion.

Almost all cultivation is carried out with some kind of bench terracing. The terraces have not been constructed to conserve soil but rather to maintain crop root structure during heavy rains. They continuously collect new soil generated by soft rock weathering higher up the slope. The typical terrace measures 4 to 20 yards in width and from 18 to 70 yards in length. The terraces have a back to front slope of 1 to 5 percent and also slope along the terrace length, often in both directions. Their construction often lead to rapid rainfall runoff being channelled to a few low points in the terrace wall or earth bank, and a concentrated volume flow to the lower terrace. This in turn causes erosion and temporary flash floods which compact the heavy soil.

The World Bank technical report [World Bank, 1977] summarizes the existing situation in large parts of AJK as follows:

> The soil structure under natural conditions is not highly erodable and the rainfall density, though occasionally fairly heavy, is not excessive in relation to the soil. Nevertheless, considerable erosion occurs. The problem is largely man-made through a combination of unsuitable land cultivation practices, unsuitable grazing practices and minimal knowledge of suitable physical soil conservation techniques . . . improvement in soil conservation practices is essential both for maintaining farm production in the long-term and . . . of minimizing the siltation rate of Mangla reservoir. Three main measures will need to be tackled simultaneously; first and foremost, the need for rational grazing management; secondly, simple improved cultivation and crop planting techniques; and thirdly, improved physical measures which involve travers runoff channels into constructed (stepped) waterways and to a lesser extent, improved bench terrace designing.

Two Agro-climatic Zones

A number of farming systems have evolved in AJK in response to the variety of distinct ecological conditions of this hilly to mountainous area, but hitherto they have received little detailed study. In order for the Hill Farming Technical Development Project to develop appropriate action programmes, a better understanding of the production activities and potentials of the areas is required. The survey by the Punjab Economic Research Institute is conducted with this aim in mind. Nine agro-climatic zones are identified and in each zone, the survey included a household census and a detailed household sample survey in selected villages. As the analysis of the survey data is still going on, the tabulated data from only 2 zones (each with 2 villages) are available for discussion in this paper.

The 2 zones discussed in this paper are examples of the less and more isolated areas of the state. Zone 1 consists of the area a few miles east of Muzaffarabad (with a population of over 50,000) which has easy access by asphalt road. One village is only 4 miles from Muzaffarabad, the second is 17 miles away. Both are close to the river Jhelum. Altitude ranges from 2,000 to 4,000 feet. Both villages have some irrigated farmland on which paddy is grown in the monsoon *(Kharif)* season. Water comes from waterfalls and springs which flow only during this season. The terrain is hilly, only 6 percent of the cultivated land is flat enough not to require terracing, and 94 percent consists of terraced hillsides.

Zone 2 is at the extreme east of the Poonch district where altitude ranges from 4,000 to 6,000 feet. Access is difficult and most roads are unpaved and rough, that is, mainly jeep tracks. All crops are grown on terraces and there are no sources of irrigation water. One sample village is 8 miles west of Kahuta on the road from Kahuta to the district headquarters town of Hajira. The second village is 15 miles east of Kahuta, the last three miles being along a footpath. The jeep drive from Muzaffarabad to this area takes about 15 hours.

The average household consists of between 5 and 6 members. The villages have generally young populations with between 64 percent (Zone 1) and 55 percent (Zone 2) under 20. The adult male work force between the ages of 20 and 50 makes up only 16 percent of the population in Zone 1 and 21 percent in Zone 2. Relatively easy access to Muzaffaraba ' and other parts of Pakistan has caused about 18 percent of the adult male work force to drift away from Zone 1 villages. In Zone 2, only 6 percent is reported working away from the village. Opportunities for both full and part-time off-farm employment give rise to a farm labour shortage which is more serious in Zone 1 than in the remote villages of Zone 2. In Zone 1, 69 percent of the household reported that they have inadequate family labour for farm work, compared with only 43 percent in Zone 2. All sample households engage in farm activities, although in more than half, farm activities provide much less than 50 percent of the household cash income.

The average farm holding in Zone 1 is 3.75 acres and in Zone 2, 2.38 acres. In both zones a very large proportion of farms are under 2.5 acres (51 percent in Zone 1 and 76 percent in Zone 2), and because of the terrain this is not all cultivable land.

Although farms are smaller in Zone 2, all are fully owned by the sample household, and more farms are owned by single rather than joint families. In Zone 1, the tenure situation is much more mixed; only half of the farms are fully owned by the cultivating household, 19 percent are partly owned and partly rented, and 31 percent are fully rented. Renting is predominantly a sharecropping arrangement whereby the tenant provides all input and the owner and tenant share all output on a 50 – 50 basis. In Zone 1 about half of the sample farms are jointly owned.

Zone 2 farms contain a much higher proportion of uncultivated non-arable land (47 percent) than those in Zone 1 (23 percent), thus reducing the cultivated area to only 1.25 acres in Zone 2 and 2.88 acres in Zone 1 (Table 18.1). Zone 1 farms also have the advantage of some stream irrigation on nearly 44 percent of the terraced land and on a quarter of the very limited area of flat land; in Zone 2 where all cultivated land is terraced, only one percent is irrigated. Consequently, while Zone 2 farmers obtain only one crop a year (monsoon season), much of the Zone 1 land is also sown for winter crops. This is clear from the cropping intensity of 161 percent in Zone 1 and 93 percent in Zone 2.

TABLE 18.1
LAND USE CHARACTERISTICS OF SAMPLE HOUSEHOLD

Item	Zone 1	Zone 2
Mean farm holding (acres)	3.75	2.38
Mean cultivated area (acres)	2.88	1.25
Land use intensity (%)	80	81
Cropping intensity (%)	161	93

Not only are Zone 2 farmers single season cultivators but they are also virtually single crop (maize) farmers. In Zone 1 paddy is grown on the irrigated terraces and maize on the unirrigated terraces during the monsoon season, and wheat and fodder crops are grown in the winter season.

Zone 1 farmers keep more draught animals (bullock and buffalo) than those in Zone 2, (1.3 compared with 0.8 per farm household) but in terms of cultivated area per draught animal in the monsoon season, Zone 2, with 1.6 acres per draught animal, is better supplied with farm power than Zone 1 with 2.2 acres. Zone 1 farmers, however, also use their draught animals to cultivate during the winter — an additional 1.4 acres per animal. None of the farms in the survey owned a tractor.

The broad difference between the zones in terms of location, land resources, irrigation and household population outlined above are reflected in the levels and sources of household income (Table 18.2).

Cropping Sector

In both zones, farming is predominantly subsistence, that is, they provide food, fuel, housing and various services for household consumption but little monetary income. Market-oriented farming activities are more important to the Zone 1 household than to the isolated and resource-poor Zone 2 household.

Crops in Zone 2

Maize is the only crop grown here and its cultivation is restricted to the monsoon season. Preparation of the terrace usually begins in February and continues to the end of May. Sowing and ploughing often overlap as the timing of each depends on the snowmelt, the rains and the availability of draught animals. Households without draught animals (67 percent of the sample) depend on borrowing/hiring them from farmers who own animals. Hence the time of sowing of the maize crop varies from farm to farm and terrace to terrace, and can range over two and a half months. Ploughing is done with a traditional wooden plough pulled two or three times over by a single or a pair of bullocks. The maize seed is broadcast at an average rate of 2.2 *seers* per *kanal.*[1] Only local *(desi)* varieties are used and almost all seeds come from the previous year's crop.

[1] 1 *seer* = 0.93 kilogramme. 1 *kanal* = 0.034 hectare.

TABLE 18.2
AVERAGE ANNUAL HOUSEHOLD CASH INCOME

Source of income	Zone 1	Zone 2
Average income (Rs)		
Per household	4,695	4,818
Per capita	1,886	1,790
Main sources of income (%)		
Farm activities		
Crops	4	1
Livestock	7	8
Fruit	3	1
Total from farm	14	10
Off-farm local work	3	45
Out of village work (remittances)		
In district	55	10
Elsewhere in AJK	–	20
Elsewhere in Pakistan	–	10
Other	28	5
Total (%)	100	100

Note: In June 1981, US$1.00 = Pakistani Rs 9.90.

Most farmers apply farmyard manure at the rate of 10 *maunds*[2] per *kanal*, but only 60 percent use chemical fertilizer. This fertilizer, mainly urea, is carefully applied by the *Chundi* method, that is, by placing it by hand at the base of each plant. This method requires less fertilizer (and expenditure) per *kanal* and is regarded as less wasteful and more efficient than broadcasting.

Farmers harvest about 1.5 *maunds* of maize per *kanal*, of which 93 percent is retained for consumption and seed and 7 percent is sold. Maize stalks and leaves are also important sources of livestock feed.

Farmers spend about Rs 119 (Rs 12 per *kanal*) on input with most of it going on three items — fertilizer (42 percent), hired labour (34 percent), and hired draught power (22 percent) (Table 18.3).

[2] 1 *maund* = 37.3 kilogrammes.

TABLE 18.3
COST OF INPUT PER HOUSEHOLD

Item	Zone 1			Zone 2		
	Kharif	*Rabi*	Total	*Kharif*	*Rabi*	Total
Total cost (Rs)	368	386	754	119	1	120
Percentage spent on:						
Seed/seedling	16	33	23	1	100	1
Fertilizer	26	18	23	40	–	42
Manure	–	1	1	3	–	–
Pesticide	1	–	1	1	–	1
Hiring draught power	–	–	–	22	–	22
Hiring labour	57	48	52	33	–	34

Crops in Zone 1

The crop activities of farmers in this zone are more varied and involve both the monsoon and winter season. The main activities of the monsoon season are the raising of paddy on the irrigated terraces and maize on rainfed ones. Ploughing begins first on the paddy terraces, usually during the first week of March, and 3 or 4 ploughings are carried out. Paddy seed is planted first in nursery beds and transplanted in late April or early June. Maize terraces receive 3 or 4 ploughings between late March to early June. As the timing depends on rainfall and the availability of draught animals, ploughing and sowing (broadcasting) go on together. Sowing is usually completed by late June. These farmers broadcast about 3.2 *seers* of local *(desi)* varieties of maize seed per *kanal* (compared with 2.2 *seers* in Zone 2). The seed rate is different for each type of field, for example, with paddy the seed rate for irrigated terrace land, irrigated flat land and rainfed terrace land is 2.6, 4.0 and 5.0 *seers* per *kanal* respectively.

Farmyard manure is applied to 82 percent of the maize crop (3.2 *maunds* per *kanal*), 59 percent of the paddy (1.7 *maunds* per *kanal*) and to 38 percent of the wheat (3.1 *maunds* per *kanal*). The use of chemical fertilizer — all broadcast — is fairly common but at low doses; 63 percent of the maize crop receives chemical fertilizer (11 pounds per *kanal*), 34 percent of the paddy crop (6 pounds per *kanal*), and 70 percent of the wheat crop (13 pounds per *kanal*). While farmers use chemical fertilizer on a larger proportion of their irrigated land than on their rainfed land, the quantities applied per *kanal* vary little.

Farmers harvest an average of 2.05 *maunds* of paddy per *kanal*, 1.53 *maunds* of maize and 0.96 *maunds* of wheat. Maize yields are similar to those of Zone 2. The only grain marketed is paddy, and this is in small quantities (9 percent of the harvest). Unlike Zone 2, grain is also used as payment to labourers.

Zone 1 farmers spend about Rs 754 (Rs 30 per *kanal)* on input with most of this going on three items — labour (52 percent), fertilizer (23 percent) and seed/seedling (23 percent).

Fruit

Most households in both zones own fruit trees — apple, apricot, pear, plum and

walnut. In each zone about 40 percent of trees are in orchards (stands of 10 or more) while 60 percent are scattered. In Zone 1, 48 percent of the apple crop and 28 percent of the apricots are sold, but in Zone 2 sales are limited to only 17 percent of the apple production. The yield ranges between 0.3 and 0.6 *maunds* of fruit per tree.

Livestock Sector

When designing the survey, livestock was expected to be a very important sector in AJK villages, but this was not found to be the case in Zones 1 and 2. The household inventory of livestock shows that the number of animals of all kinds is much smaller than in most Punjab villages. The average household has one head each of buliock, cow and female buffalo. Milk is the main source of income from livestock for Zone 1 where 35 percent of the produce is sold; but apart from this, livestock is predominantly a subsistence activity (Table 18.4). Annual farm income per household from sale of livestock produce is Rs 542 in Zone 1 and Rs 33 in Zone 2.

One factor which limits livestock number in both zones is the shortage of fodder; many households are forced to purchase fodder in lean months. In Zone 1, migratory grazing in upland pasture is not practised, while in Zone 2, it is a common practice during the months of June through October.

TABLE 18.4
LIVESTOCK PRODUCTION PER FARM

Product	Zone 1			Zone 2		
	Consumption % of annual product	Sale %	Receipt (Rs)	Consumption % of annual product	Sale %	Receipt (Rs)
Milk	65	35	431	98	2	24
Ghee/butter	95	5	9	99	1	2
Wool	–	–	–	100	–	–
Skin	–	–	100	27	73	6
Egg	89	11	2	96	4	1
Manure	100	–	–	100	–	–

Forest and Fuel

No household in the sample village owns forest land but most have scattered trees on the their farmland. Upland forest is exploited mainly for cooking fuel, but not necessarily by the household directly, particularly in Zone 1 where half the wood-fuel used is purchased, and where kerosene is an important fuel for cooking. In Zone 2 wood is the main fuel for cooking and heating, and households consume about 93 *maunds* a year, almost double the average consumption in Zone 1 (Table 18.5). It appears that the forest resources, particularly in Zone 1, have been largely depleted and they no longer play a very important role in the livelihood of the present population.

TABLE 18.5
FUEL USED FOR COOKING AND HEATING

Item	Zone 1		Zone 2	
	cooking	heating	cooking	heating
Fuel type	% of respondents			
Wood-fuel	100	93	100	100
Kerosene	69	–	6	–
Dung	25	6	8	4
Electricity	–	6	–	–
Fuel-wood per household per year				
Consumed *(maund)*	48		93	
Purchased (%)	48		26	
Expenditure (Rs)	432		102	

Land Conservation

As much as 60 percent of the cultivated land in Zone 1 and 47 percent in Zone 2 suffers from flooding. Erosion affects 11 percent of the farmland in Zone 1 and 26 percent in Zone 2. Farmers try to combat this in a number of ways such as by soil bunding, levelling, tree planting and controlled grazing, but a planned and co-ordinated programme of land conservation is absent. Farmers are aware of the problems of floods and erosion but most feel unable to do more than apply temporary remedies such as soil bunding. They claim the lack of resources to reforest, the shortage of fodder prevents controls on grazing and the limited arable land (and in Zone 1, a high rate of tenancy) hampers them from making significant changes in land use.

Other Sources of Household Income

In Zone 1 where only 14 percent of the household monetary income originates from the sale of farm produce, two other sources of income are important — labouring and other employment in Muzaffarabad city and district, and a variety of business activities. Together, these activities earn 83 percent of the monetary income of the sample households. In the remote villages of Zone 2 where farm produce provides only 10 percent of the household cash income, local off-farm work earns 45 percent, and work away from the village 40 percent. The opportunity for any sort of business activity is extremely limited (5 percent).

Conclusion

The basic facts of economic life in the two zones of AJK have been outlined. The farming sector is characterized by small fragmented farms which are dependent on the monsoon which varies considerably both in timing and quantity of precipitation. Some areas have limited monsoon season irrigation (rivers, streams and springs), such as the

sample villages in Zone 1, and there is some potential for increasing the irrigated area, but most villages have no such resource and rainfed terraces are the basis of crop farming. Both farm power (bullocks) and farm labour are inadequate. The general shortage of fodder limits the number of buffalo that can be kept and the efficiency of those that are kept. Labour is drawn away in the search for cash income from non-farm activity. Cultivation is based on traditional technologies and this fact, together with poor communication with markets, restrict the crop sector to a subsistence role. A more productive technology has not yet been developed and the supply system for injecting new technology is also weak, despite a conscientious effort by the staff in the Department of Agriculture.

The fruit sector suffers from similar constraints as the crop sector — lack of markets and poor access to technology and input. The claims that there is a potential for potato and vegetable growing tend to carry little conviction because of the same set of constraints which are beyond the capacity of the farm household to overcome.

The livestock potential appears to be limited by the vagaries of rainfall and fodder production, and the inadequacy of veterinary care. It would become a more efficient sector if stocks could be reduced and the quality of animals improved. Remoteness limits the market for most of the livestock products.

The maintenance and improvement of forest areas are not the responsibility of the village household but these farmers overexploit the existing forest resources by grazing and cutting of fuel-wood. In an area where arable land is scarce, where no real alternatives to wood exist for cooking and heating, and where fodder is inadequate to maintain livestock, farmers have little choice but to exploit whatever forest land there is. This exploitation is not likely to stop until there are positive changes in the productivity of farming.

Without substantial investment in facilities and services which could reduce the isolation of most of the village communities of AJK, agriculture is likely to remain a subsistence activity. A more effective technology could raise the level of subsistence production. At the moment, most income opportunities lie outside the region where these people live, and this further degrades the local resource base by the migration of labour.

While remoteness and isolation affect most parts of AJK, and while the agricultural resource base is generally poor, there are undoubtedly areas which could and would respond to development opportunities. The purpose of the Punjab Economic Research Institute survey in AJK is to identify areas with potential for development, and those which appear to have little or no potential, so that development programmes can be designed for the first type of area and conservation projects can be emphasized in the second type.

REFERENCE

World Bank, 1977. *Hill Farming Technical Development Project.* Washington, D.C. (Report No. P-2139-AOK (2)).

19
The Royal Northern Project of Thailand

HRH PRINCE B. RAJANI

Introduction

More than two decades ago, the Revenue Department was responsible for buying opium from hill farmers. At that time, the government operated opium dens for registered addicts. In those days it was an insult to be called an "opium addict", hence, the number of registered addicts was small.

In 1959, the government enacted a law which made the selling of opium illegal. While this new law was welcomed by the international narcotic control agencies, local traders immediately replaced opium with heroin, and the production of opium was unaffected. Opium was the only cash crop known to hill farmers, and the highland of Northern Thailand remained very much a closed territory where even jeep tracks were nonexistent.

After banning the opium trade, the government established a Hill Tribes' Welfare Division, but this Division was unable to perform effectively. Although the hill tribes needed agricultural assistance, the Department of Agriculture did not know much about highland agriculture. Therefore, it was unable to recommend crops which could be grown in place of opium. At that time, it was also not the government's policy to develop highland areas because the priority of the Department of Agriculture was to devote all its resources to developing lowland agriculture.

Obviously something had to be done for the highland where the watersheds were continually being damaged by shifting opium cultivators. Even though opium was a profitable cash crop, the hill tribes remained very poor.

His Majesty the King of Thailand appreciated this serious problem about 12 years ago, and in 1969, he founded the Royal Northern Project with the following objectives:

(1) to help fellow human beings;

(2) to help preserve the security of the country by raising the standard of living of the hill people; and

(3) to preserve the natural resources of the country by preventing forest destruction and shifting opium cultivation.

His Majesty initiated this project by presenting US$15,000 to Kasetsart University for its Highland Agriculture Project to revive temperate fruit research (Appendix 19.1).

With the limited knowledge available on temperate fruit at that time, we introduced peach, arabica coffee, and kidney bean to the hill people, while at the same time carrying out research work on these crops. "We" refers to a group of volunteers from two

universities, one institute and two departments. Our work was greatly facilitated by the availability of an Air Force helicopter every Sunday.

It could be argued that the Royal Northern Project should have been actually started 20 years earlier when opium cultivation was still legal. The late start makes us feel now that we are racing against time and that we are forced to be doers rather than planners who conduct feasibility studies and evaluate proposals.

One significant element in the Royal Northern Project is the involvement of His Majesty himself. He takes a keen personal interest in what we are doing. Every year he visits the project sites and walks up the steep hills on foot. This boosts our morale and draws the attention of senior government officials to the importance of our work. It also enables Kasetsart University to obtain government funds for the research programmes of the Highland Station. We find His Majesty's comments and commands to be very important. He insisted that there must be no bureaucratic delays or red tape in carrying out his Project. Because of this ruling, we find it feasible to expand our programmes horizontally, that is, to develop more villages and link autonomous units through a co-ordinating committee. Professors and other government officials also find this ruling refreshing. It greatly facilitated their work, and many volunteers eagerly serve on this Project.

When His Majesty visits these villages, he communicates directly and intimately with his people. Those of us who witness this realize that we are not superior to the village people who are equally loved and supported by His Majesty the King.

A very significant event took place in the middle of 1973 when officials from the United States Department of Agriculture (USDA) visited Bangkok with a large budget allocation to sponsor research on crops that could replace opium cultivation in the highland. Unaware that the Thai government programmes did not include highland development, they visited several government offices to find an agency willing to undertake this work. There were no recipients until the USDA officials came into contact with us. The result was that we received funds from the USDA without any conditions. With the help of volunteers from universities and government departments, we have so far carried out 46 research projects and identified more than 20 crops that provided farmers with better returns than opium.

Two years ago, we started a new programme on village development and crop extension for 97 villages. It included road and irrigation construction, soil conservation and marketing.

To support our extension programme, we operate four agriculture research and production stations as a junior partner of Kasetsart University. We also have three canning factories.

I hope I have conveyed the impression that we who are involved in the Royal Project are merely filling gaps in agricultural development. For example, where there is a significant absence of soil conservation measures for shifting cultivation areas, we have succeeded in persuading the Land Development Department to set up soil conservation teams for the highland. This is a race against time, and we realize a lot more needs to be done.

APPENDIX 19.1

The Highland Agriculture Project, Kasetsart University

The wild montane sub-region of Northern Thailand is physiographically a southern extension of the Shan Highlands of Burma, that is, from the Daen Lao range on the

northern border where parallel ridges including the fine peaks of Doi Inthanond, Doi Chiang Dao and Doi Pui extend southwards. Four of the greater rivers feeding the Chao Phraya flow from north to south between the great ridges. They are the Ping, Wang, Yom and Nan. Along these rivers and their larger tributaries are narrow strips of river sediments, alluvial valleys and flood plains with gorges a few thousand feet deep. These provide paddy and other land for Thai farmers. Numerous dissected inter-montane plateaus and steep mountain slopes in the northern region provide a setting for the agricultural activities of the majority of hill tribes — the Miao, Yao, Karen, Akha, etc.

The total number of tribal people in the border areas of Thailand fronting on Burma and Laos has been variously estimated at between 200,000 and 500,000. They are culturally distinct from the Thais, and are also different from one another in language, dress, customs and origin. Some are akin to the Chinese while others are of Tibetan-Burmese origin. Apart from some groups of Karen, all the tribes appear to have moved into Thailand comparatively recently. They constitute the latest surge of the population movement southwards from China which brought the Thai people themselves here only seven centuries ago.

The relationship of the tribal peoples with the Thai government has always been good. This is because of the tolerance with which they have been treated. Nearly all the tribal people have come into Thailand because it has offered them better economic opportunities or refuge from foreign domination without disturbance to their social organization or tribal integrity. They have been allowed to occupy land which belong to the Crown and to migrate from place to place. Recently, welfare measures have been instituted for their benefit.

The continued happiness of these tribes depends on the degree of necessary changes which can be introduced into their way of life without disrupting their existing social harmony or lowering their standard of living. The fact that opium is the basic feature of the economy and culture of some of the largest tribes indicates the magnitude of the problem faced by the government.

In undertaking poppy cultivation and opium production, they have practised shifting cultivation which includes periodic shifting of the site of cultivation and habitation. They cut down trees from the northern wild forest mostly for timber and cultivate the land continuously until its productive capacity becomes so low that they are forced to move to other areas leaving the barren land to its fate. This type of cultivation has been detrimental to natural resources in respect of:

(1) changing forest into grassland which is of limited value even for animal grazing;

(2) causing vegetation in these areas to be in the secondary successional stages;

(3) severely affecting at least 5.5 million acres of forest with detrimental effects on the weather pattern; and

(4) exposing soil to torrential rain thereby causing severe erosion and loss in nutrient.

From the point of view of those concerned with the conservation and management of forest for purposes of timber and other production, and the preservation of soil and water resources, such a state of affairs is serious.

Only a small percentage of the hill tribes smokes opium. However, in metropolitan Thailand, the switch from opium-smoking to heroin and morphine is a problem of increasing concern. It is estimated that some 1.6 percent of the local population habitually use narcotic drugs.

Northern Thailand is known not only as the producer but also as an important centre of illicit traffic in opium from the Golden Triangle to the rest of the world. It is estimated that 1,000 tonnes of opium, sufficient to supply several million addicts come from this area annually.

The tribes within Thailand are now part of the Thai nation. Measures to eliminate opium and to advance their general welfare will require careful planning and judicious implementation. The task of providing a different economic base for the tribal groups who are at present dependent upon opium is imminent. As political and law enforcement efforts are being asserted, economic considerations assume greater urgency. The Highland Agriculture Project, which is a co-operative effort involving several government agencies, recognizes the need for solving these economic problems and aims to:

(1) reduce soil erosion problems and enhance soil and water conservation measures necessary for overall ecological preservation;

(2) reduce deforestation problems;

(3) eliminate opium poppy cultivation and drug addiction;

(4) help stabilize Thailand's hill tribes in economically and ecologically sound communities; and

(5) introduce correct watershed management and land use.

To achieve these objectives, the government agencies concerned are currently conducting research and extension work in co-operation and co-ordination with His Majesty's Hill Tribe Development Project.

Kasetsart University is conducting research on watershed management, deciduous fruit, preservation of agricultural produce, oil-seed crops, strawberry, pyrethrum, and livestock and pasture development. Most of the work is concentrated at three experiment stations, namely, the Buag Ha and Suan Songsan Stations at Doi Pui, the Ang Khang Station at Fang District, Chiang Mai, and two food processing factories at Fang and Mae Chan, Chiang Mai. In addition to government funds, the project has received grants from the United Nations, the USDA and from His Majesty's Hill Tribe Development Project.

Research work undertaken by other agencies includes afforestation, culture of legume, coffee, mushroom, mint flower and vegetable seed production and cut flower.

Although opium is not a crop which can be eliminated easily due to its widespread cultivation, it is our objective that this Project will provide a foundation for sustained success of the overall hill tribe project.

20
Use of Remote Sensing for Agricultural Planning in Upland Areas

J.P. MALINGREAU

Introduction

In formulating agricultural development policies, an appropriate combination of resource assessment, planning and management techniques must be sought to ensure that:

(1) labour and capital input are optimized;

(2) problems between conflicting land use practices are reduced; and

(3) environmental degradation is avoided.

This requires that pragmatic policies be drafted upon an accurate knowledge of the nature, extent and dynamics of the resource base. The objective is to show how a resource information system based on the analysis of images provided by airborne sensors can help in the process of improving our understanding of local agricultural conditions, and to monitor land use changes. Attempts will be made to show that it is possible to develop an "appropriate" remote sensing technology which can help to reduce the gap between planning and local realities.

While most of the discussion is based upon the author's experience in Indonesia, it is believed that some of these points are applicable to the situation found in the Hills of Nepal.

Information Needs for Agricultural Planning

In a spatial planning perspective, recommendations for resource development must be articulated in respect to specific environments. These are characterized by a unique set of spatial attributes and a given mode of resource utilization. In the case of hill agriculture, the major attributes to be considered are those related to the climate, the landform (slope), the soil, the present land cover and use. In order to assemble those attributes into a coherent and easily comprehended framework, it is useful to define, identify and map spatial units of the landscape which present some degree of homogeneity in terms of resource endowments. The stratification of an area into such land units of agricultural significance is therefore the first step in addressing the issues of spatial agricultural planning.

The criterion used for such a stratification vary with respect to the main objectives or constraints of the development plans. If production is of priority, soil fertility, water availability and access to markets will dominate the stratification scheme; if land and water conservation is the main concern, environmental parameters such as slope, soil erodibility and land cover are more suitable. In intensively cultivated areas, one will

have to pay special attention to the present cropping pattern. Often however, all of these considerations must be taken into account in an integrated perspective. This is especially so in "fragile areas" subjected to increasing pressure on resources and threatened by permanent degradation. Principles of eco-development must then be respected; they should lead to a better formulation of the use of resources to satisfy at least the basic needs of the local population and they should guide responsible considerations of the negative impacts which spontaneous or induced land use changes may have upon the environment.

The identification of a regular pattern of resource distribution and use is a major step in the evaluation of the land potential, in the assessment of the existing land use practices, and in the monitoring of the land use dynamics over extensive areas. In addition, the effective use of aerial surveillance techniques relies heavily on the understanding of such a spatial/temporal pattern of resource distribution. The two following examples summarize observations made in Indonesia.

On Java, whose agriculture is mainly rice oriented, water availability is the main determinant of land use. The following succession of forms can be recognized as one proceeds from the sea to the mountain peaks: coastal swamp – mangrove – brackish water fishpond – paddy fields with homestead gardens on levees; mix of paddy fields –settlements–upland crops in the hilly transition area; paddy fields in lower foot-slope of volcanoes, upland crops and estates – remnants of primary forest in high mountain plain.

In a rapidly changing environment such as on Kalimantan or parts of Sumatra, it is possible to identify and characterize "frontier areas". These are strips of land which contain the original land cover, that is the primary forest. Various pathways can be identified leading to temporary or permanent changes in the forest cover and each of these pathways has specific characteristics in terms of production, environmental impact, relationships with other aspects of the regional infrastructure and type of land cover.

The acquisition of an accurate and precise body of background information on the nature and mechanisms of land use patterns must be considered as an integral part of the application of remote sensing technology. Clearly, it is only after the problems at hand have been described in their multiple facets that the most beneficial use can be derived from advance information technology.

Hill agricultural systems are complex and dynamic and one should not place excessive expectations upon remote sensing if the preliminary background analysis has not been done with care. Remote sensing can be useful because it presents a unique view of the terrain. It will however not provide the final word in resource evaluation nor promote development if it is considered in isolation.

Remote Sensing and Agricultural Information Systems

Remote sensing technology can be applied to several aspects of agricultural data collection. In a sectorial approach, numerous studies have shown that the collection of relevant data on the various components of the ecosystems can be assisted by the use of airborne observation devices. Applications in geology, geomorphology, hydrology, soil, land use and forestry are common in many developing countries. There are several advantages provided by the use of air photography and satellite imagery. They are:

(1) The ability of new sensors to acquire data over large areas and to record images of a synoptic nature; whole watersheds for example can be examined

in their entirety on one Landsat image. This allows investigations of the spatial relationships between various elements of a landscape.

(2) The growing possibility to observe an area on a repetitive basis. The Landsat satellites cover the earth on a sun-synchronous orbit having an eighteen-day cycle. Cloud cover and technical constraints apart, it is thus theoretically possible to obtain a view of every spot on earth every nine days with two satellites operating in conjunction.

(3) New sensors recording the ground scenes allow an intimate look at surface features and detailed analysis of the conditions under which field events are taking place.

There are two general categories of types of information which are amenable to remote sensing observation in the context of agricultural development — those related to the crop environment and those concerned with the crops or cropping system. Because of their specific features, their analysis is based on different approaches. It is useful at this point to distinguish between inventories and monitoring. An inventory is a one-time assessment of the nature and distribution of land features such as soil, landform and general agro-ecological zones. Monitoring consists of the continuous observation of environmental parameters or land use features themselves with a frequency appropriate to the understanding of their dynamics. In this respect, land use changes will be assessed twice a year, while crop growth will be observed with a higher frequency such as monthly or bi-monthly. Information requirement for each application is different, hence the "correct" remote sensing technology will also vary.

Figure 20.1 illustrates the use of a multistage remote sensing system of crop observation which was designed for use in the specific condition of wetland rice in Java. The system combines four levels of observation — from the most general to the most detailed—with each level characterized by its own mode of operation.

Perspectives on remote sensing should, however, go beyond mere documentary purposes. Because of its synoptic nature it favours cross-sectorial combination and analysis of data, and it permits the examination of spatial relationships between various parts of a landscape. This may reveal features of significance which are not readily discovered or assessed through other means of investigation. In addition, an important aspect of the use of remote sensing images is that such images can produce an integrating effect with respect of several sources of information.

Remote Sensing as an Appropriate Technology

A major virtue of the holistic or ecosystem approach to natural resource analysis is that it directs attention to specific environments and to the communities occupying them. Using such approach, departures can be made from universal models while policies can be adapted to the resource base as well as to local socio-economic realities. At the other end of the spectrum the approach allows policies to be drawn taking into account linkages between various components of the resource utilization systems.

The concept of "appropriateness" should be applied to remote sensing technology. It is a technology that helps the user to make resource management decisions, and it should be viewed as a "decisional technology" which includes the know-how for diagnosing complex problems and formulating choice strategies for site, level and scale of technology [Goulet, 1977]. It has become a too familiar claim in remote sensing institutions that in order to validate the present effort, more and more components should

Observation system Platform and product	Function	Mode
Satellite/MSS images and digital data MSS = Multispectral Scanner	multispectral information for crop monitoring; – planted area – harvested area – events (stress, pests, etc.)	comprehensive coverage repetitive
Aircraft/small-scale air-photography (1/100,000 to 1/50,000)	identification and mapping of wetland rice areas stratification into land units	comprehensive single coverage
Aircraft/large-scale air-photography (1/5,000)	identification of varieties crop stage, growing conditions	sampling seasonal
Field work	identification of environmental relationships ground truth collection	sampling irregular observation

Source: Malingreau [1980].

Figure 20.1 Multistate system of crop observation

continuously be added to the existing system. Remote sensing professionals continue to insist that data acquisition and archiving will somehow improve the lot of humanity when the problem is lack of data utilization [Paul, 1979]. Is it not too late, one could ask, to be concerned about developing an appropriate layer to the existing complex system? This question deserves more attention than it has received so far, especially since it is of particular relevance in rural development.

Technology Transfer in Remote Sensing

The process of technology transfer has institutional and procedural aspects which determine the nature and efficiency of this transfer. Among the institutional vehicles of transfer, the major role is still played by specialized research institutions, universities, government agencies, international organizations and special development programmes.

Since we are dealing with a fast advancing technology, it is essential that there is constant interaction between remote sensing specialists and the users. The latter should in the course of training define their information needs, assess their capabilities and evaluate the possible contribution of the proposed technology to their specific problems. Because of these exigencies, it has been observed that the people who are actually working at an intermediate level of resource analysis and who are familiar with field conditions make the best and most critical recipients of the training. In turn, their professional experience allows them to contribute the most to the definition of an appropriate level of the proposed technology.

The selection of equipment supporting a training programme in an advance data gathering system is at the same time a crucial and sensitive question. Tools for remote sensing image are usually not available in decentralized locations, thereby reducing their accessibility. Very few users will ever have the opportunity to work with digital data processing equipment and although they should be made aware of its existence, a detailed study of their technique will not be of much benefit. Concentrating on self-reliance via simple visual analysis methods is thus a more realistic approach.

The following is an example of how an advanced technology, such as orbital satellite, can be adapted at low cost for developing countries. The exercise starts with an image using the most advanced transfer system of computer tape images. This image is on a small-scale but of an outstanding quality. In order to promptly reach the users, in this case Indonesian trainees leaving for a field survey, selected portions of the transparent image were photographed in indirect sunlight using a simple reflex camera with closeup attachments. The film was processed and good colour prints at a scale of approximately 1/150,000 were obtained. These prints were used as field documents on which the trainees reported their observations. They also served as medium of communication with the local people. When presented with satellite images, agricultural agents and farmers could draw upon their knowledge of the history and geography of their environment to recognize features and to point out relationships among them. The result was an up-to-date land use map with its attached resource pattern analysis. In this case use was thus made of an advanced technology designed and operated abroad (the satellite and the image processing system) whose product was adapted to the local needs (land use mapping at a given scale) and capabilities (simple reproduction facilities and visual analysis only). There is no doubt that the transfer of technology was more efficient using this simple hybrid approach than relying on hypothetical data processing systems. Obviously, requirements and capabilities will change according to places and circumstances. A national resource inventory programme must rely on different approaches

and use different operating methods. But the philosophy of self-reliance in the applications of remote sensing is justifiable and can be adopted at any level of operation.

Conclusion

The use of remote sensing images can lead to a better characterization of the cropping system environment, to an improved process of formulating recommendations for desirable changes and to the possibility of monitoring changes in the actual land use practices. Furthermore the data derived from an image based information system can be used to assess the environmental impact of the present or proposed resources management practices.

An important prerequisite for the efficient use of this technology is that field situation, problems and issues be well defined at the outset. Such an analysis can be supplemented by the information derived from air photographs or satellite images. This technology should also be considered in conjunction with progressive adjustments in current data collection exercises and planning procedures.

REFERENCES

Goulet, D. 1977. *The Uncertain Promise: Value Conflicts in Technological Transfer.* Washington: IDOC.

Malingreau, J.P. 1980. The Wetland Rice Production System and its Monitoring Using Remote Sensing in Indonesia. Ph. D. diss. University of California.

Paul, C. K. 1979. "Global Information System. Foundation for Civilized Order". *Phot. Eng. and Rem. Sens.* 14(7).

21
Towards a Strategy for Hill Agricultural Development in Nepal

W. C. BEETS[1]

Introduction

Recognizing the paramount importance of agriculture to Developing Member Countries, the Asian Development Bank (ADB) commissioned the Second Asian Agricultural Survey in 1977, which provided an analysis of the existing situation and emerging trends in the agriculture sector in the region, and identified priority areas for greater attention. The ADB's Sector Paper on Agriculture and Rural Development finalized in 1979 further explored the implications of the Survey and recommended action on several fronts. Both the documents dealt with major issues on a regional level. Soon after their completion the need to relate the general recommendations to the different countries concerned was recognized so that they would have practical relevance for both individual countries and the ADB in future programming and project selection. It was, therefore, proposed to undertake country-specific agricultural strategy studies for some countries, and Nepal was selected by the ADB for the first study.

The possibility of initiating a study in Nepal was first discussed in May 1980 with the government which expressed keen interest in collaborating with the ADB to undertake such a study. By December 1980 a technical assistance grant was approved by the ADB to carry it out.

The purpose of the agricultural strategy study is to achieve a better understanding of the constraints and opportunities for development in the crop, livestock, fishery and forestry sectors. The objective is to formulate an integrated policy framework and identify priority programmes and projects that are designed to utilize more fully the existing infrastructure facilities to derive maximum benefits from development investment. The study is being undertaken with the co-operation of the concerned government departments by ADB staff and consultants where specialized expertise is required.

This paper provides an overview of the work undertaken so far. Some of the preliminary impressions derived from the exercise are being offered in the paper to gauge their validity through the seminar discussions. The overall conclusions and recommendations will be included in the Agriculture Sector Strategy Paper which is expected to be completed later this year.

Agricultural Setting in the Hills

From an agricultural perspective, the Hills of Nepal are rather unique as the rugged topography has limited the development of transport and generated numerous micro-

[1]The views expressed are those of the author and do not necessarily reflect those of the Board or the Management of the ADB.

climates and ecological niches. Because the Hills are unique the problems faced there are also unique and so are the opportunities and challenges. In the past, agricultural development was often based, at least implicitly, on the assumption that technological solutions and innovations that had worked elsewhere would also work in the Hills of Nepal (for example "green revolution" based on the introduction of high-yielding varieties, and large-scale use of fertilizer). We now know that technology developed elsewhere is often *not* suitable to the Hills because here the farming systems are based on the utilization of a rather limited and specific resource endowment which could not be modified easily.

Historically, hill agriculture in Nepal has been characterized by farming systems which promoted a great degree of self-sufficiency and self-reliance. Farmers have traditionally relied on themselves or their neighbours for planting material. Thus, there evolved a large number of cultivars and varieties, each adapted to the particular ecological niche where they originated. It is difficult to improve or replace these varieties because of the environmental diversity and physical isolation. This means that unlike many other areas in Asia, developing a "green revolution" covering all the cultivated areas of the Hills will be extremely difficult, if not impossible.

The average hill farm size is only 0.5 hectare as compared to the norm of two hectares of arable land required for subsistence. Most farmers also keep livestock to supplement their income. Feed and fodder for the livestock are obtained not only from annual crop residue and pasture around the homestead but also from fodder trees in nearby forests. Thus, the Nepalese hill farming system is characterized by a close integration of crop cultivation, animal husbandry and forestry. A change in one of the components of the system will affect the others. In the past, these complexities were not well understood. Agricultural projects were not always well conceived and designed and quite frequently could not be implemented as initially envisaged. Also an important factor here was that several projects were conceived in isolation, particularly irrigation projects.

It would seem necessary, therefore, that future projects must take into account not only the interaction between different agricultural sub-sectors but also the effects of interplay between the agricultural sector as a whole and the overall hill economy; between the Hills and Tarai development; and the resultant impact of development on employment and incomes.

Agricultural Priorities and Strategies for the Hills

The major issues which have to be addressed in the development of the Hills can be classified as follows:

(1) food;

(2) fodder;

(3) energy and ecology; and

(4) employment and income.

Each of these aspects of agricultural development is discussed in some detail below.

Food. Virtually all the hill districts are deficient in food, as their prodution is not enough to meet the minimum basic requirements of their population. Given the rugged topography, the very limited transportation infrastructure and resultant high costs

of transport, transferring the food surpluses of the Tarai to the Hills can only be advocated as an emergency measure. Thus, making the Hills self-sufficient in food commands top priority in any strategy for hill agricultural development.

Such a strategy should be based largely on the improvement and better utilization of the local resources at the disposal of the farmers with limited reliance on external inputs such as chemical fertilizer. Production increases should be achieved primarily through improvement of the existing *subsistence* systems rather than through the introduction of *commercial* farming which could be both difficult and costly.

Although overall food self-sufficiency in the Hills is essential, self-sufficiency on each and every farm or in every hill pocket may not be feasible. In many cases, adjacent pockets endowed with varying production potentials could complement each other ensuring self-sufficiency in their basic food requirements. The strategy should emphasize the promotion of *decentralized* sub-regional marketing and distribution systems as opposed to the present *centralized* system.

Soil fertility. A prerequisite for increasing the productivity of cropping systems in the Hills is the arrest of the deterioration of soil fertility which appears to be the major cause for the decline in yield in recent years. Improving soil fertility in the Hills of Nepal can best be done through a combination of:

(1) applying increasing quantities of farmyard manure and improving the quality of the manure through better storage and handling;

(2) introducing more leguminous crops into the farming system; and

(3) applying modest quantities of chemical fertilizer containing nutrients in which the soil is still deficient after manure has been applied and legume included in the cropping pattern.

Traditionally, farmers in the Hills have been applying manure to their fields for many years. Transporting manure and its incorporation into the soil is a labour-intensive task. Nevertheless, farmers should be encouraged to continue this practice on an increased scale.

Introducing more leguminous crops, grain legume as well as some fodder legume, in pure stands as well as in associations, would help in maintaining soil fertility, especially in improving the nitrogen status of the soil. One legume crop per year has the potential to enrich the soil with about 60 kilogrammes nitrogen per hectare. Crop species which have this potential include soybean, chickpea, gram and cowpea for the summer season and broad bean and pea for the winter season.

Since cereals demanding high nutrients are the pivotal crops in the cropping pattern, application of manure and growing legume will not be sufficient to maintain soil fertility. In addition, modest, well-balanced quantities of fertilizer would have to be applied in most situations. The objective, however, should be to rely as much as possible on the use of manure and legume and as little as possible on chemical fertilizer because fertilizer is expensive due to high transport costs. If soil fertility is maintained as described, overall yield, using present crop varieties, can be expected to increase by about 0.6 tonne per hectare in the case of maize and wheat and 0.4 tonne per hectare for paddy.

The strategy described above requires that considerable quantities of appropriate legume seed and at least 50,000 tonnes of chemical fertilizer should be made available to farmers annually.

Better soil fertility management will not only increase food production but it will also result in more crop residues which can be used by livestock. Further, more vegetative growth will generally lead to better soil cover which, in turn, reduces soil erosion.

Irrigation development. The scope for irrigation development in the Hills is limited but not insignificant. During the 1980s, most of the impact from irrigation on food production is likely to come from improving the use of existing schemes, especially those of the small-scale farmer-constructed type. There is also physical potential for more gravity irrigation through diversion and large-scale pumping schemes utilizing surplus power from either the power grid or local hydroelectric schemes. However, implementing such schemes is difficult and requires considerable investment, trained manpower and involves long gestation periods. It seems, therefore, unlikely that incremental production from such schemes would have a significant impact on food availability until the end of the decade.

Most of the impact from new schemes is likely to come from the development of small-scale lift irrigation where water is lifted through the use of pumps driven by water turbines and possibly hydraulic rams. A major advantage of this form of irrigation is that the projects are multipurpose, that is, the energy that is used to lift the water can also be used to drive a small agro-processing unit and a generator which can provide the adjacent village with electricity during night time. Some projects, especially those involving hydraulic, may be more suitable for providing opportunities for improving water supply for drinking and household use.

Better on-farm water management should play a key role in irrigation development. At present it is deficient and returns from improved management are immediate and significant. However, widespread campaigns to improve water management can only take place after more research on different irrigation methods has been carried out and after training manuals on water management have been prepared.

The most important policy consideration for irrigation development would seem to be that the irrigation technology to be adopted must be appropriate to the prevailing development policies, pricing and marketing structures. Also, irrigation development must be a multidisciplinary exercise involving not only irrigation engineers but also agriculturalists, local policy-makers and most importantly, the farmers.

Fodder. The reclamation of the traditional fodder base appears to be the priority for development of the livestock sector in the Hills. This is essential, not only to sustain the existing livestock population and to increase its productivity, but also to preserve the entire agro-ecological system that is now seriously threatened by overexploitation of the hill forest land.

The approach to this problem must take into account the farmer's continuing requirement to feed his livestock. With this in mind, it would seem essential to develop a system of fodder/forest land rehabilitation that provides an immediate increase in the fodder supply, while at the same time allowing gradual reforestation through fodder trees. This could be achieved if the area to be rehabilitated is first planted to more productive annual pasture species and the replanting of fodder trees is phased to allow progressive establishment without any downturn in fodder supply.

The success of such a programme would depend on the full co-operation and participation of farmers, including controlled utilization of restored areas at the completion of the programme. The programme could be accompanied by an improvement in provision of livestock health services and establishment of market outlets for livestock products. The resulting increase in productivity of the livestock would improve not only the economic base of the hill communities but also their nutritional status.

Like irrigation development, livestock programmes should be multidisciplinary exercises involving several government agencies which have to be well co-ordinated. At present a major constraint to these types of programmes is the limited implementation capacity of the pasture/fodder development sector within the Department of Livestock and Animal Health Services. This sector should be strengthened considerably with specialist staff.

Expansion of the fodder base should be the key element in any livestock programme. Other elements could include the upgrading of production through the introduction of low level technology suited to the rural conditions of the Hills, expansion of existing cheese factories and establishment of new processing centres. In addition, other programmes such as the upgrading of wool production through introduction of better breeds of sheep and improving goat rearing for meat and milk production should be promoted. All livestock programmes should incorporate the improvement of animal health as an integral element.

Energy and ecology. Nearly all of Nepal's development endeavours are constrained by the unavailability of fossil energy, dwindling forest resources and an alarming deterioration of the ecology of the Hills. Development can only take place if the environmental deterioration is stopped and if, at least, a modest amount of energy can be made available.

Hydroelectric power. Mini hydropower plants such as water turbines and water wheels seem to be the most promising solution for pumping, agro-processing and electricity supply in the Hills. In the short-term, major hydropower schemes are unlikely to make a significant contribution to supplying electricity to the Hills due to their long gestation periods as well as difficulties of transmission.

Fuel tree plantation. About one cubic metre (725 kilogrammes) of fuel-wood are presently used per person per annum for both heat and light. This form of energy is usually termed "renewable" as opposed to "fossil". However, insufficient replanting of trees has taken place so far and this energy source has not been renewed over the past decades. Instead, rapid depletion of forest resources continues. It has been projected that, if the present trends continue, in about 10 years, the population of Nepal would have to resort to widespread burning of crop residue and dung to satisfy their cooking and lighting needs and the volume of these could rise to 8 million tonnes annually. Dung is presently used as fertilizer and its use as fuel would mean a forgone annual production of over 1 million tonnes of food grains. In addition, considerable deleterious impact on soil fertility and the environment could result if current trends are not modified.

An important component in the agricultural strategy should therefore be the protection of existing forest and replanting on as large a scale as the implementation capacity allows. Reforestation can best be based on community forestry programmes at the village level. An area of about 30,000 hectares of village wood lots would have to be planted annually to meet the demand for fuel-wood alone. In some areas, clusters of villages could co-operate in maintaining and scientifically exploiting the *Panchayat* forest. To ensure protection and good management of forest, individual and community participation is essential.

Generally, all crop production projects in the future should include a component of fuel trees; and all livestock projects a component of fodder production and possibly a biogas component.

Biogas. If properly developed, alternative sources of energy such as biogas might eventually reduce the pressure on forest resources. Biogas plants are quite attractive from an ecological point of view. The dung and organic waste used to operate them is marginally enriched in plant nutrient content and can be used as fertilizer after it has passed through the digester. Already more than 1,000 biogas plants have been built with moderate success and funds for setting up 2,000 more plants have already been made available.

It would seem that as many biogas digesters should be built as socio-economically possible and acceptable but there are still many problems. To date, wealthy, farmers have been the principal beneficiaries of the biogas programme since small subsistence farmers, who are largely outside the cash economy, cannot afford the plants. Here, credit is unlikely to solve the problem since the gas plants provide virtually no direct financial return and the beneficiaries of the credit programme would therefore be unable to repay the loans. Other problems which would have to be solved include the difficulties of operating plants at higher altitudes and shortage of field personnel for construction, supervision and financing arrangements. Future research efforts should focus on these problems.

Employment and income. While the strategies discussed above are likely to generate expanded employment opportunities and increased income, it may not be adequate to fully absorb the rapidly growing labour force. Frequently, the limited natural resource base may not be able to continue to support the increasing population and the society could no longer be able to depend on agriculture as the mainstay for its sustenance. Creation of off-farm employment would be necessary under these circumstances. The strategy of promotion of cottage and village industries catering to the basic needs of the population should receive priority in this context. Such a strategy would succeed only if strong institutional support for credit, supply of input and marketing are provided.

Presently, the extent of underemployment and unemployment in the Hills is serious (almost 60 percent) and the most common form of relief has been seasonal migration. Various options to alleviate the problem need to be examined. In those hill areas where the population pressure is severe and the resource base thin, it may be desirable to move permanently a significant proportion of the people out into accessible areas in the Hills and the Tarai where employment opportunities could be provided, thereby achieving a reasonable balance between population and the resource base in the areas from which people originated. For other areas, the existing pattern of seasonal migration may be a more viable and pragmatic approach and thus should be encouraged.

Priorities for Development of Hill Agriculture

In the short-term, the highest priority should be accorded to achieving food self-sufficiency in the Hills particularly in the remote and inaccessible hill areas. Simultaneous production of traditional high value and low weight cash crops such as cardamom and ginger could be promoted. Over the medium to long-term agricultural specialization, particularly through the expansion of horticulture in accessible hill areas should be considered. However, such specialization ought to be built on a solid base of appropriate technology and crop species suited to the environs of the Hills. These appear to be quite limited at present and adaptive research on better producing varieties and plant protection measures need to be initiated immediately on a significant scale. Thus, over the next 5 years, emphasis should be given to developing suitable technology and indentification of appropriate areas and field-testing of the new technology through pilot projects.

At the same time a few opportunities for specialization in proven areas and crops such as tea cultivation in the eastern development region should receive priority.

Programmes involving the expansion of fodder supply and improvement of animal nutrition would likely yield relatively quick returns from the livestock sub-sector in the Hills and should receive priority. In addition, more systematic and scientific management of fodder trees and forest resources should contribute not only to the immediate consumption needs but also to the improvement of the ecology of the Hills.

The harnessing of water power using water turbines for lift irrigation and agro-processing as well as water supply for domestic use should be promoted to the maximum feasible extent. Many of the project sites for water turbines may emerge as growth centres stimulating further development in their command areas.

A number of priorities for development can be identified at this stage and action can be recommended on several fronts. However, translating these general findings into clearly defined projects is more difficult, since project selection depends among other things on the implementation capacity of government agencies. During the last few years there have been signs that the implementation capacity of the government is being strained. The recommended development strategy must, therefore, first be based on implementing high priority programmes, and projects for which tested technology and staff are readily available. Only later would more difficult projects be considered.

Because of the interdependence of the different sectors, the ideal kinds of projects for the Hills would seem to be "integrated rural development projects". However, experience in Nepal and elsewhere suggests that these types of projects pose some major implementation problems since simultaneous implementation of complex packages of interrelated development measures is often quite difficult. Nevertheless, the development needs of the Hills call for an integrated approach. Consequently, the strategy should consider integrated projects in which the project components could be implemented step by step and not necessarily simultaneously from the start. Since the hill economies of Nepal are mostly agricultural, "integrated *agricultural* development projects" might be preferable to the more complicated "integrated *rural* development projects".

In conclusion, it appears that in most hill areas, there is a need for agricultural projects in which "soil fertility maintenance" is a major component. This project component should include introduction of more leguminous crops, better use of farmyard manure and modest use of chemical fertilizer.

In many of these projects there should be an irrigation component. A programme for improving on-farm water management should be a central element of this component. Further, farmer participation would be essential for ensuring the success of irrigation programmes.

There is also, in most cases, a need for animal husbandry and dairy development components. Fodder-tree planting should often be a key element of this component and in selective cases, there would also be a need for pasture improvement.

Production programmes for specialized crops appear to be generally a medium to long-term option with the exception of tea in the Eastern Hills. It would seem that there is scope for smallholder participation in tea projects.

For other specialized crops it would seem necessary to concentrate first on applied research to develop appropriate technology and on pilot projects to test the technology under farmer's conditions.

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Selected Bibliography on Hill Agriculture in Nepal

Prepared by the Agricultural Documentation Centre of the Agricultural Projects Services Centre

AOO AGRICULTURE -- GENERAL CONSIDERATIONS

1. Humphrey, C. 1980 *Report on a field study in North Sankhuwasabha* Sept. – Nov. 1979 (agriculture, livestock, trade, mountain area) Kathmandu, KHARDEP. 147p. (KHARDEP report no. 7).

   Acc. no. 1636

2. Pant, T.N. 1978 *Agricultural development in Nepal: problems and prospects.* Kathmandu, APROSC. 16p.

   Acc. no. 510

3. Rockefeller Foundation 1976 *Study of hill agriculture in Nepal.* New York. 126p. 7 annexes. maps.

   Acc. no. 201

4. Tsuboi, N. 1975 Hill agriculture in Nepal. In *Technical reports,* Janakpur, JADP. p. 83 – 105

   Acc. no. 190

5. Vreeland, C.C. 1974 Highland agriculture: when men and mountains meet. 105p. Thesis – B.A. – Goddard College

   Acc. no. R631.09143 VRE

EIO ECONOMICS

6. APROSC 1978 *Agrarian reform and rural development in Nepal: country review paper.* Kathmandu. 55p. tables.

   Acc. no. 332

7. FAO 1975 Selected papers presented at the FAO/NORD Seminar on agricultural planning for selected countries in Asia and Far East, Kathmandu 16 Nov. – 6 Dec., 1974. 182p. maps.

   Acc. no. 167

E15 FARM ORGANIZATION AND MANAGEMENT

8. Hada, K.P. 1978 A study of farm household income and resource allocation in the eastern hills of Nepal. 168p. Thesis – M.A. – Australian National University.

   Acc. no. M338.1309n HAD

9. Maharjan, B.L. 1976 An evaluation of agricultural production systems and alternatives for small farms in Nepal. 2v. Thesis – Ph. D. – University of Mossouri – Columbia.

   Acc. no. R338. 109n MAH

10. Mathema, S.B. 1977 Development of hill farming in Nepal with special reference to Tanahu District. 133p. Thesis – M.A. – Australian National University.

    Acc. no. M338. 1309n MAT

11. Rauch, E. 1954 *Report to the government of Nepal on farm enterprises.* Rome. 17p. (FAO report no. 260)

    Acc. no. 209

12. Sharma, R.P. 1979 Uncertainty and subjective degrees of belief in the adoption of modern farming techniques: a case study of Nepalese farmers 114p. Thesis – M. Econ – University of New England.

    Acc. no. R630. 71509n SHA

E30 DEVELOPMENT –– AIMS, POLICIES, PROGRAMMES

13. Banskota, M. 1979 The Nepalese hill agro-ecosystem: a simulation analysis of alternative policies for food production and environmental change. 180p. Thesis – Ph. D. – Cornell University.

    Acc. no. R338. 19n BAN

14. IHDP 1974 *Blue print IHDP; activities for the fifth plan period 2032/33 – 2037/38, 1975/76 – 1980/81.*
    Lalitpur, SATA. 6p.
    Acc. no. 101

15. Schmid, R. 1976 The Jiri Multipurpose Development Project (JMDP) a hard experience in mountain ecology and very important learning process in Nepalese/Swiss technical Co-operation. In *Mountain environment and development.* Lalitpur, SATA, p. 167 – 176.

Acc. no. 113

16. Tsubi, N. 1975 A study on the development of hill agriculture in Nepal (conditions and policy). In *technical reports,* Janakpur, JADP. p. 1 – 19

Acc. no. 190

17. Waard, J.M. de 1978 *Project proposal for Hill Area Development Project Nepal;* draft. Kathmandu, HADP. 20p.

Acc. no. 1445

18. Mcdougal, C. 1968 *Village household economy in far-western Nepal.* Kirtipur, Tribhuvan University. 140p. 53 tables.

Acc. no. 640.4209n MCD

19. Toffin, G. 1976 The phenomenon of migration in a Himalayan valley in central Nepal. In *Mountain environment and development,* Lalitpur, SATA. p. 31 – 44.

Acc. no. 113

20. Zevering, K.H. 1974 *Agricultural development and agrarian structure in Nepal;* working paper. ARTEP. ii, 126p.

Acc. no. 165

21. Whiteman, P. 1980 *Agronomy research in the hill areas of Nepal: terminal report.* Kathmandu, HADP. 36p.

Acc. no. 1677

F27 SOIL CULTIVATION AND CROPPING SYSTEMS

22. Poudel, D. 1980 The potential of cropping systems research innovations in crop-livestock based farming

systems in the hills, Kaski District, Nepal. 165p. Thesis – M. Sc. – University of the Philippines, Los Banos.

Acc. no. R338, 1609n PAU

F28 SOIL EROSION AND RECLAMATION

23. Baisyet, P.M. 1979 Land degradation and ecological condition of Bheri River watershed in western Nepal. 99p. Thesis – M. Sc. Michigan State University.

Acc. no. R631. 4509n BAI

24. Reiger, C. 1976 *Himalayan Ecosystem Research Mission; Nepal report.* Heidelberg. 161 p. illus, maps.

Acc. no. 724

K50 WOOD TECHNOLOGY AND INDUSTRIES

25. Mauch, S.P. 1976 The energy situation in the hills: imperative for development strategies? (demand for firewood). In *Mountain environment and development,* Lalitpur, SATA. p. 123 – 145.

Acc. no. 113

LOO ANIMAL PRODUCTION

26. Palmieri, R.P. 1976 Domestication and exploitation of livestock in the Nepal Himalaya and Tibet: an ecological, functional, and culture historical study of yak and yak hybrids in society, economy and culture 304p. Thesis – Ph. D. – University of California.

Acc. no. R36.29309n PAL

P05 ENERGY RESOURCES

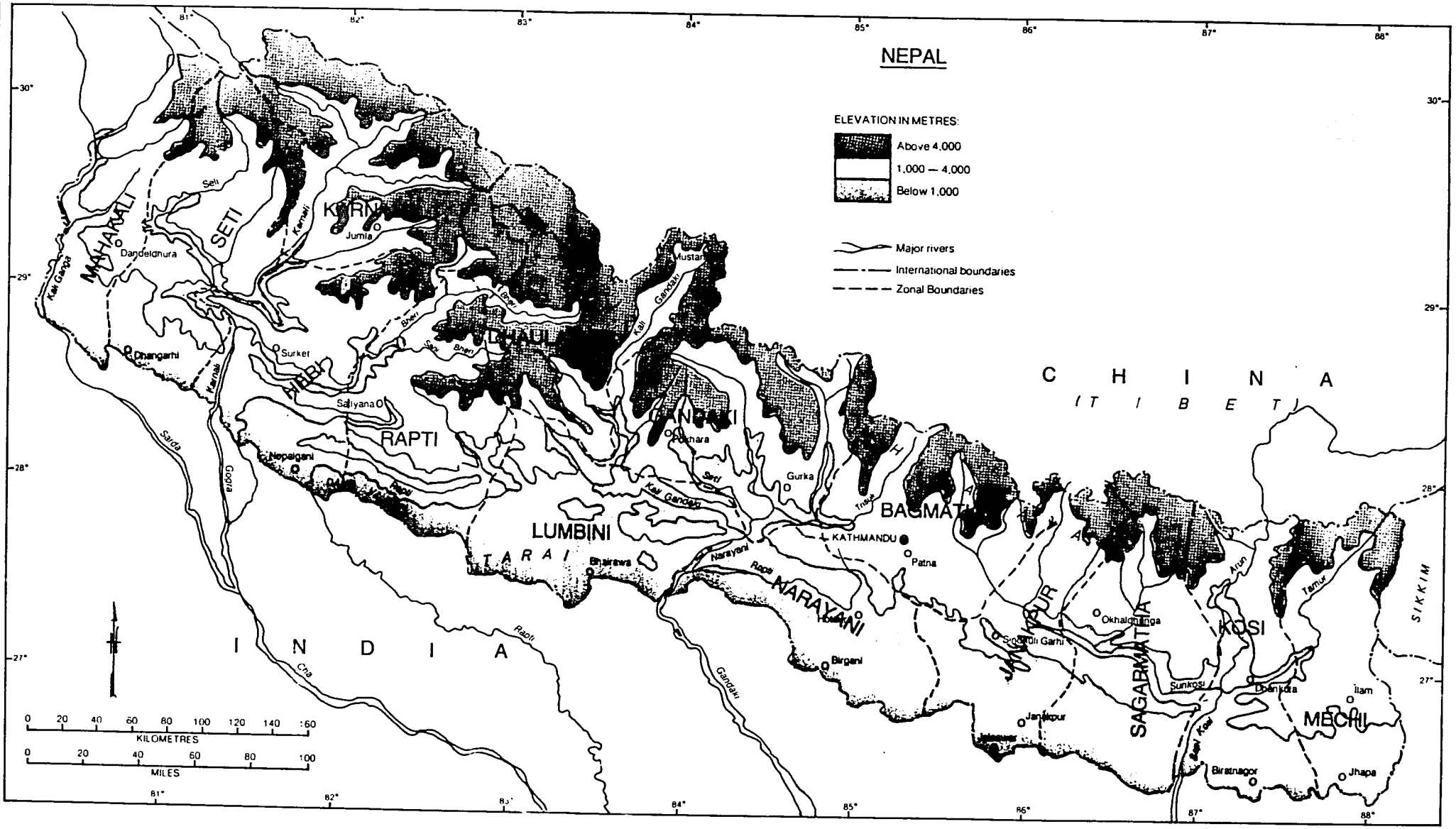
27. Howarth, S. 1978 *Energy resources and requirements in the hills of Eastern Nepal.* Dhankuta, Pakhribas Agricultural Centre. 12p.
(Technical paper no. 29)

Acc. no. 276

P10 WATER RESOURCES AND MANAGEMENT

28. Upadhyay, K.P. 1977 Contour trenching as a strategy in watershed rehabilitation: application to Nepalese condition. 134p. Thesis – M.Sc. Utah State University.

Acc. no. R631.4509n UKP


NEPAL
ELEVATION IN METRES:
Above 4,000
1,000 — 4,000
Below 1,000
Major rivers
International boundaries
Zonal Boundaries
MAHAKALI
SETI
KARNALI
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T A R A I
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Surket
Salyana
Nepalganj
Pokhara
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Bhairawa
Hetauda
Birganj
Janakpur
Okhaldhunga
Sindhuli Garhi
Sunkosi
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Ilam
Biratnagar
Jhapa
Kali Ganga
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