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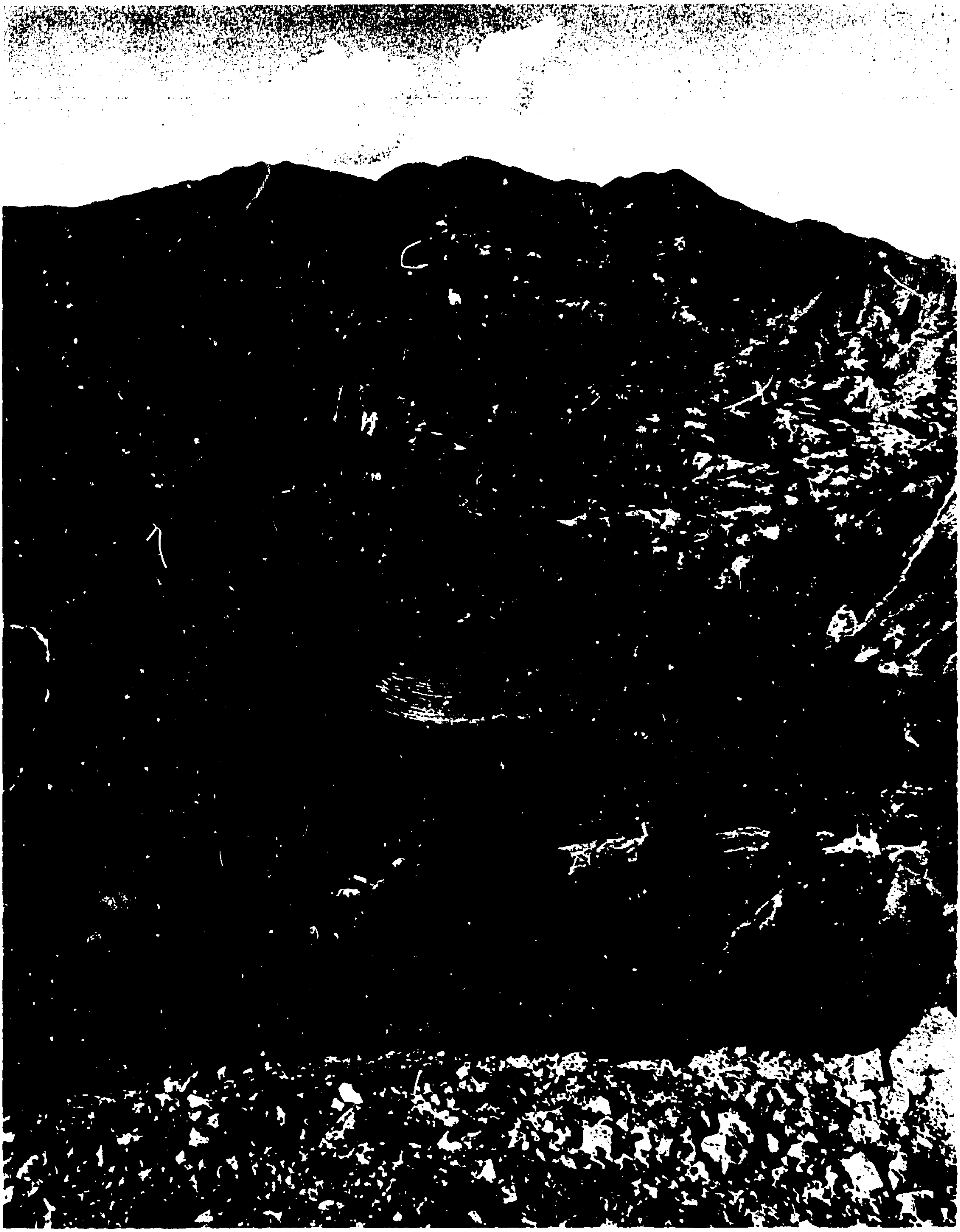
A STUDY OF HILL AGRICULTURE IN NEPAL

by

THE ROCKEFELLER FOUNDATION TEAM

April 1976



PREFACE

This study of Hill Agriculture in Nepal was undertaken at the request of the Ministry of Food, Agriculture and Irrigation of His Majesty's Government. The Members of the Team were supported by The Rockefeller Foundation, with the exception of Mr. Charles R. Bailey whose services were made available by the Ford Foundation.

The USAID/Nepal furnished travel and other support services and made available the Guest House facilities which expedited the activities of the Team. This support was given on behalf of HMG and the Team is especially grateful for the assistance of Dr. Phillip D. Smith of USAID in the preliminary planning and the carrying out of the study.

The Team received excellent cooperation from the various HMG offices and from the staff of the several technical assistance organizations concerned with agricultural and economic development in Nepal.

The Team expresses special appreciation to Secretary K. D. Adikari, Joint Secretary Dr. B. P. Dhital, Director General B. B. Khadka, Deputy Director General K. B. Rajbhandari, and Deputy Director General A. N. Rana for their guidance, and to the following officers of HMG Department of Agriculture who served most ably as counterparts to the Team members:

Mr. A. M. Pradhanang	- Chief Agricultural Botanist
Mr. M. L. Pradhan	- Chief Soil Scientist
Dr. S. N. Lohani	- Acting Chief Agronomist
Dr. B. B. Shahi	- Acting Chief Rice Coordinator
Mr. J. D. Sakya	- Acting Chief Potato Development Officer
Mr. L. P. Sharma	- Livestock Officer (Pasture)

The major focus of the study, as planned with HMG officials, was to identify opportunities for adaptive research to improve agricultural production and food availability in the Hills. The Team membership was selected to furnish specialists for those commodities and problem areas deemed to be most appropriate for the study, recognizing that other commodities including horticultural crops and livestock are also of great importance but are receiving attention from other cooperating agencies.

The Study drew upon previous reviews and on judgments of many persons who have been involved in various ways with Hill agriculture in Nepal. The Rockefeller Foundation Team, however, assumes full responsibility for the assessments and the suggestions presented in this report.

A. H. Moseman

A. H. Moseman

Team Leader

CONTENTS

SUMMARY

The conditions in the Hills -- increasing population, the lack of transport and communications, small land holdings, and a stagnation in agricultural output in spite of heavy use and increased abuse of arable lands, pastures and forest areas -- combine to render difficult the economic and social betterment of these areas of Nepal.

The development strategy of His Majesty's Government, to foster greater interaction of the labor resources of the Hills and the agricultural productivity of the Terai, and thereby achieve a greater commercial interchange and equalization of economic and social benefits, is long term.

There is an urgent need for immediate development activities to improve productivity and to minimize the further deterioration of the land and forest resource base of the Hills.

In view of the limited opportunity for expansion of arable lands in Hill areas, and the uncertainties in improving irrigation resources, the development and application of improved technology is essential to increase the output of Hill farming areas.

Farming systems in the Hills -- rotations and intercropping practices -- have evolved over many years and are intensive. They must be assessed carefully as new, improved materials and methods are developed and introduced. Special attention is needed to improvement of the farming systems as well as to the individual crop or livestock components of the systems.

The improvement of agricultural production technology should be approached as a continuum -- including critical evaluation of problems and opportunities for improvement, research to produce better materials and methods, field testing to assess and assure the suitability of innovations, and coordinated attention to seed production, sources of credit, and other inputs necessary for farmers to put new technology to work.

The Team offers some suggestions for improving operations of the Department of Agriculture in developing new technology but does not make recommendations for changing the organizational structure for research in the Department. Such recommendations should be made in the context of the total functions and responsibilities of the Department for the continuum of development and farm use of new technology as stated above. The overall organization and functions of the Department and of the four Agricultural Development Regions should be reviewed in depth, with full involvement of the MFAI officers concerned, to ensure changes that are necessary, desirable and viable.

Socio-economic factors involved in agricultural development and change are too often neglected. These should be given appropriate attention in identifying potential opportunities for improvement and in proffering innovations in the intensive farming systems of the Hill areas.

The restraints in improving Hill agriculture are complex and numerous. The sources of external support to address these restraints also are numerous, and substantial. There is both need and opportunity for HMG and the various assistance agencies to coordinate and integrate their efforts in such manner as to accelerate progress and to achieve more satisfactory returns from national and external investments in Hill agriculture development.

A STUDY OF HILL AGRICULTURE IN NEPAL

I. INTRODUCTION

Agricultural development efforts in Nepal in the past two decades have been directed primarily to the Terai and the Kathmandu Valley, with little attention to the Hills. His Majesty's Government is aware of the need to improve production and to provide for greater sharing in national development and welfare for the 60 percent of the population that lives in the Hills.

The Hills of Nepal - with their rugged terrain, their limited transport, communications and infrastructure for facilitating development, and their small-scale, intensive agriculture - present special challenges to accelerated development. The materials, practices and approaches to development in other agricultural areas around the world have limited - at least uncertain - applicability to these regions.

In July 1973 His Majesty's Government invited The Rockefeller Foundation to undertake a study of Hill agriculture, to identify opportunities for adaptive research to improve agricultural production in the Hills. HMG also requested that high priority be given to guidance for improving the organization and operation of the national agricultural research resources.

The Rockefeller Foundation Team membership, determined in consultation with HMG officials of the Ministry of Food, Agriculture and Irrigation, was selected to give attention to: 1) rice, 2) potatoes, 3) forage and fodder crops, 4) cropping systems, 5) economics, and 6) research organization and operation. Specialists were not included for crops or activities in which cooperative technical assistance projects were already under way in Nepal with support from various international or bilateral sources. The members of the Team are noted in ANNEX I.

The study was undertaken during the month of November 1974. The Team, with excellent logistical support furnished by the USAID Mission on behalf of HMG, made extensive field visits to: 1) become familiar with agricultural practices and conditions in the Hills, 2) observe the activities of selected development projects, 3) see the facilities and resources for research and field testing of new technology, and 4) assess the organization and operational procedures for agricultural development. The schedule and contacts are shown in ANNEX II and the places visited are shown in ANNEX III.

II. BACKGROUND

A. Physical and Climatic Features

Nepal has a land area of approximately 141,000 square kilometers or 14 million hectares, about the same as the state of Florida. It is approximately 800 kilometers (500 miles) in length from northwest to southeast and varies in width from around 160 kilometers (100 miles) to 240 kilometers (150 miles).

Nepal is bounded by India on the west, south and southeast, by Sikkim on the northeast, and by Tibetan China on the north. Kathmandu, the capitol city, lies at 85.3 degrees east longitude and the 27.5 degrees north latitude is similar to Ft. Pierce and Bradenton, Florida.

There are four physiographic regions in Nepal, extending in roughly parallel bands along the northwest to southeast axis of the country. The Terai, along the southern border, is an extension of the broad gangetic plain of India. The Inner Terai, to the north, lies between the Siwalik Hills and the Mahabharat Range. The Hills, which are the focus of this report, consist of the Mahabharat Range and the lower Himalayan foothills, ranging in elevation from 750 to roughly 4000 meters. The mountain regions or Himalayas to the far north, above 4000 meters, are of limited agricultural significance.

The Hills are intersected from north to south by three main river systems, the Karnali in the west, the Gandaki-Narayani in the central and the Kosi in the east. In addition, from west to east, there are other large rivers that comprise the main drainage system including the Sharada, Babai, Rapti, Bagmati, Kamla, Kankai and the Mechi.

The deep river gorges have a major influence on the agriculture of the Hills, in limiting transport and communication and in creating the numerous micro environments that are conditioned by elevation, direction and steepness of slopes, solar radiation, cloud cover, etc. Few countries have the extremes of broad plains (the Terai) and the mountain heights (Mount Everest at over 29,000 feet) that exist over the 100 to 150 miles across Nepal.

Virtually all of the arable land in the Hills is currently being used. The alluvial flood plains, the older terraces lying above the present flood levels, and the terraced hillsides on slopes as great as 45 percent or more are already intensively cultivated. The flood plain and terrace soils are generally of medium to coarse texture, with little or no profile development. The hillside soils are also mostly medium in texture and well drained. The soils of the Hills are generally low in nitrogen and organic matter and are commonly acidic in the higher rainfall areas.

The rainfall is highly seasonal, with about 85 percent falling in the June to November monsoon period. Annual rainfall decreases from around

2,000 mm in the east to less than 1,000 mm in the western part of the country. There are large local variations associated with elevation and topography and intense hail-storms, damaging to grain crops and tree fruits, are frequent in some areas.

Fertility management in the Hills is almost exclusively dependent on the recycling of organic residues from the arable land, supplemented by animal manures and composts. As the demand for fuel and animal feed continues to grow, the supply of materials for soil conditioning from uncultivated grazing lands and forests is diminishing, putting even greater pressure on the densely settled arable lands.

Irrigation, with water diverted from streams and hillside springs, has been developed in many local areas through intensive labor input. The exploitation of such water resources in the Hills should be given further attention although the extent of such added water resource and the feasibility of maintaining water delivery systems is yet to be explored.

Temperatures range from the subtropical heat of the Terai (to 46°C in June) to the extreme cold of the snow-capped Himalayas. Freezing temperatures are rare in the Kathmandu valley and in Hill areas of similar altitude but do occur from November through February in higher areas of the Hills. Temperatures are variable over short distances in the Hills, depending upon altitude and the direction and degree of slopes.

B. The Agricultural Sector

Agriculture employs about 93 percent of the labor force in Nepal, provides 67 percent of the GDP and 80 percent of the national export earnings. The per capita income of the nation's 12 million people is about U.S. $80.

The Terai, with about 40 percent of the country's population, produces approximately 62 percent of the food grains. A substantial portion of this is exported to India. The Hill regions vary in degree of self-sufficiency in food grains, with deficits in the western Hills to be expected more frequently than in the eastern Hills.

The distribution of production of food grains and of population by regions is shown in Table 1.

Table 1. Food Grain Production (1000 MT) and Population Distribution by Regions, 1972-73*

Region	Intensity of Land Use - %	Paddy	Maize	Wheat	Barley	Millet	Total	Kg. per Capita	Production % of Total	Population % of Total
E. Terai	120	956	65	104	4	10	1,139	383	34.6	25.7
W. Terai	150	473	89	74	1	6	643	630	19.4	8.8
I. Terai	145	130	109	16	1	5	261	426	7.9	5.4
E. Hills	110	207	243	53	3	39	545	193	16.5	24.4
W. Hills	145	244	316	65	16	74	715	173	21.6	35.7
									100.0	100.0

*From USAID/Nepal

The intensity of land-use reflects the number of crops harvested from the same land in one year - 100% is one crop only, 150% is a second crop from one-half of the land, etc. In some areas with year around irrigation 3 crops may be grown on the same land in one year.

Paddy is the predominant crop in the Terai, with maize and paddy the major crops in the Hills, as shown in Table 2. Wheat ranks third in the Hills, followed by millet, which is especially important in the higher Hill areas.

Table 2. Relative Importance of Major Food Grains by Region (% of Production, 1972-73)*

	Paddy	Maize	Wheat	Millet	Barley
Eastern Terai	84	6	9	0.7	0.3
Western Terai	73	14	12	0.8	0.2
Inner Terai	50	42	6	1.6	0.4
Eastern Hills	38	44	10	7.5	0.5
Western Hills	34	44	9	11.0	2.0

*From USAID/Nepal

Fully reliable data on agricultural production are difficult to obtain but available figures suggest that yields of food grains have declined in recent years, especially in the Hills. Nationally, the exportable surplus of grains has dropped by about 50 percent since 1970. A number of factors are involved in the yield declines in the Hills, including expansion of cultivation into lands of marginal productivity.

Food grain production in Nepal since the mid-1960's has grown at a rate of less than 1 percent annually, as compared with a population growth of about 2 percent. It is projected that with present trends Nepal will become deficient in food grain production by 1980.

III. THE NATIONAL AGRICULTURAL DEVELOPMENT STRATEGY

A. The Regional Growth Corridors

The Fourth Five-Year Development Plan of HMG initiated the strategy of "Corridor Development," designed to integrate the Terai with the Hills and the Mountains, to minimize disparities in the progress of development in the three main geographic zones which run roughly parallel to each other from northwest to southeast across the country. The concept considers the comparative advantages or opportunities of the Hills (surplus manpower and potential for increased production of horticultural crops and livestock) and of the Terai (surplus food grains, supplies of consumer goods and contacts with the Indian market).

The Fifth Development Plan continues the Corridor Development concept, with four Development regions, each with a major growth corridor and development center.

Development Region	Growth Axis/Corridor	Main Towns in Corridor
Eastern	Kosi	Biratnager, Dhankuta,* Chanipur
Central	Metropolitan	Birgunj, Hitaura, Kathmandu,* Dhunche
Western	Gandaki	Bhairawa, Tansen, Pokhara,* Jomosom
Far Western	Karnali	Nepalgunj, Surkhet,* Dailokh, Jumla

*Regional Development Centers or Headquarters

The geographic areas within the Regions are shown in ANNEX IV. The programs and procedures for development within the four Regions are presented and discussed in a number of recent documents and reports, so will not be elaborated here. However, the pattern of development is relevant to the study of Hill agriculture to the extent that it influences priorities and administrative or operational procedures affecting projects in the Hills.

The concept of integrated corridor or regional development, with emphasis on horticulture and livestock products in the Hills and food grains in the Terai, envisages increased trade and interdependence within each region as well as more interregional trade. Officials in HMG Ministry of Food, Agriculture and Irrigation recognize that this development strategy is long-range and that immediate and continuing attention must be given also to achieving a maximum degree of self-sufficiency in food crop and livestock products for the people in the Hills.

B. Small Area Development Projects

The National Planning Commission has proposed a concentration of effort on the Small Area Package Program, designed to accelerate economic and social advances in potentially more responsive localities. This proposal is still to be activated and it should be useful in stimulating growth and productivity in the specific areas selected. While the exact nature of the proposed Small Area Package Program is yet to be determined the approach might be expected to be similar to some of the ongoing cooperative projects concerned with improvement of agriculture in the Hills, including the following which were visited by the Team:

1. The Gandaki Agricultural Development Project (assisted by West Germany) near Pokhara.

2. The Lumle Agricultural Center for training of returned Gorkha soldiers for agricultural development (supported by the British Government) near Lumle.

3. The Pakhribas Agricultural Center with a program for Eastern Nepal similar to that at Lumle (supported by the British Government) near Pakhribas.

4. The Integrated Hill Development Project (supported by the Swiss Association for Technical Assistance) near Jiri.

5. The Hill Agricultural Development Project (supported by the UNDP) with headquarters in Kathmandu.

6. The Potato Improvement Project (supported by the Indian Cooperation Mission) at Jaubari.

The foregoing projects, described briefly in ANNEX V, are concentrating on specific approaches to agricultural development in selected localities or districts. Several of the projects have been under way for a sufficient period of time, for 5 years or more, to permit an assessment of the technics and of the priority problems requiring attention.

C. Accelerating Hill Agriculture Development

From the field reviews and discussions of the Team in Nepal, supplemented by information from the FAO "Perspective Study of Agricultural Development for Nepal" (May 1974), the IBRD "Agricultural Sector Survey" (September 1974) and other selected recent reports, certain assumptions may be made as a base for determining approaches to Hill development, including the following:

1. Population will continue to grow in the Hills over the foreseeable future, perhaps at the net 1971 rate of 1.3 percent per year. Continued migration to the Terai, prompted by organized resettlement schemes on the estimated 350,000 hectares of remaining potentially arable forest lands and by the declining opportunities in the Hills, can be expected but this will not reduce the absolute numbers of people in the Hills.

2. Pressures on land resources of the Hills will increase, with further spread of cultivation into marginal areas and further deterioration of forest and grazing lands.
With increasing numbers of people and with constant or increasing numbers of livestock the present trends in land use in the Hills - with cultivation spreading to steeper lands of marginal productivity, uncontrolled grazing of forest areas, and overcutting of forests for fuel and fodder - will continue.

3. The transportation restraint will preclude rapid exploitation of cash-intensive modernization of agriculture.
At the present time 42 of the 55 Hill districts, representing 62 percent of the land area and 41 percent of the population, are not serviced by roads. The road network will be expanded but such expansion will take place over time. Even with an accelerated program to build feeder roads, trails and foot bridges, substantial time will be required before larger quantities of fertilizers can be brought into the Hills and larger quantities of commercial crops can be carried out.

4. The Corridor Development or regional comparative advantage approach to equalizing opportunities and levels of living in the Hills and in the Terai will be long-term in making any extensive impact.
The Corridor Development efforts will progress as motorable roads are constructed and special efforts are made to encourage commercial agriculture with modern practices and inputs. This will require vigorous attention to the supporting infrastructure for supplying production inputs, credit, processing and marketing facilities and systems, etc.

5. The Small Area Package Program will have largely localized effects.
The concentration of development efforts and resources in selected areas which are potentially responsive to accelerated development will be highly locale-specific and can be expected to have limited impact nationally or throughout the Hills areas. Such projects must be replicated or repeated in-situ and will tend to have limited multiplier or "spread" effect.

6. Major and priority attention should be given to the systematic and sustained development and application of new production technology suited to the resources and restraints of the Hills.
Although there are differences in the Hills areas, in population density and in rainfall gradient from west to east, there are similarities in food grain production in the Western Hills and Eastern Hills as shown in Table 2. There is some diminishing of paddy growing in the west, with more barley and millet production, but paddy, maize, wheat, millet and barley are common across the Hills. Potatoes also are important throughout the higher Hills regions.

The Green Revolution era has created the concepts 1) that modern agricultural technology requires cash intensive inputs, and 2) that yield-boosting "breakthroughs" are to be anticipated. In fact, the impact of research in agriculturally advanced nations has been through continuous - albeit modest - changes in genetic yielding capability, disease resistance, pest control and the minimizing of yield restraining hazards or factors. "Breakthroughs" are not common.

The farming systems in the Hills are highly intensive in many areas. It should be possible, however, to increase the multiple-cropping or land use intensity in some localities through new varieties and crop sequences. This would appear feasible especially in the Eastern Hills where the land use intensity is reported as only 110 percent, Table 1, and where rainfall should be adequate for more double-cropping.

The prospects would seem especially promising to increase yields - or to reduce losses - by developing disease resistant varieties of the grain crops and of potatoes and by improving pest control practices. While no projections can be made as to the magnitude of improvement in production that may be expected over time the Team identified a number of researchable problem areas which are discussed in the following sections of this report.

IV. IMPROVING AGRICULTURAL PRODUCTION TECHNOLOGY

A. Some Basic Considerations

The development and use of improved agricultural technology is usually considered in terms of separate functions of 1) "research" to produce innovations, and 2) "extension" to carry new materials and practices to farmers. This often involves separate organizational units and frequently there is a lack of linkage or complementarity between them.

In most developing nations it has been customary to give priority to setting up extension or development organizations for maximum contact at the village or farm level - to reassure farmers that their government is interested in them and to cause government officials to believe that they are reaching out and serving the people on the land. Such well-intentioned rural development or community development schemes have usually fallen short of expectations because of the lack of new materials or technics to feed into the system that can enhance productivity or improve the quality of life for the prospective recipients.

New technology is essential for increasing the output from the present land, power and labor resources in the Hills of Nepal. This is generally recognized by those carrying out current development projects in the Hills - on selected commodities, in specific localities, or in manpower training and development. And improved technology, whether introduced from abroad or evolved in Nepal, must be fitted into farming systems suited to the Hills. Most introduced varieties and materials will have to be modified, through an indigenous adaptive research and testing program, to fit the growing season, to meet specific disease and pest hazards, and to suit local quality preferences.

In order to furnish a more effective and constant flow of improved materials and practices for use at the farm level the functions of research, field testing, demonstration and promotion should be considered as a continuum or a single, integrated effort in applied production technology.

B. The Present Status

The HMG Department of Agriculture has responsibility for research, extension and development functions, with research largely under central Department management and the extension/development activities handled by the four Regional Directorates, Figure 1. However, the functional responsibilities are not clearly defined and lines of authority and communication are still evolving. The Regional Directors are responsible to the Director General of the Department so there should be no real difficulty in establishing and maintaining fully effective working relations.

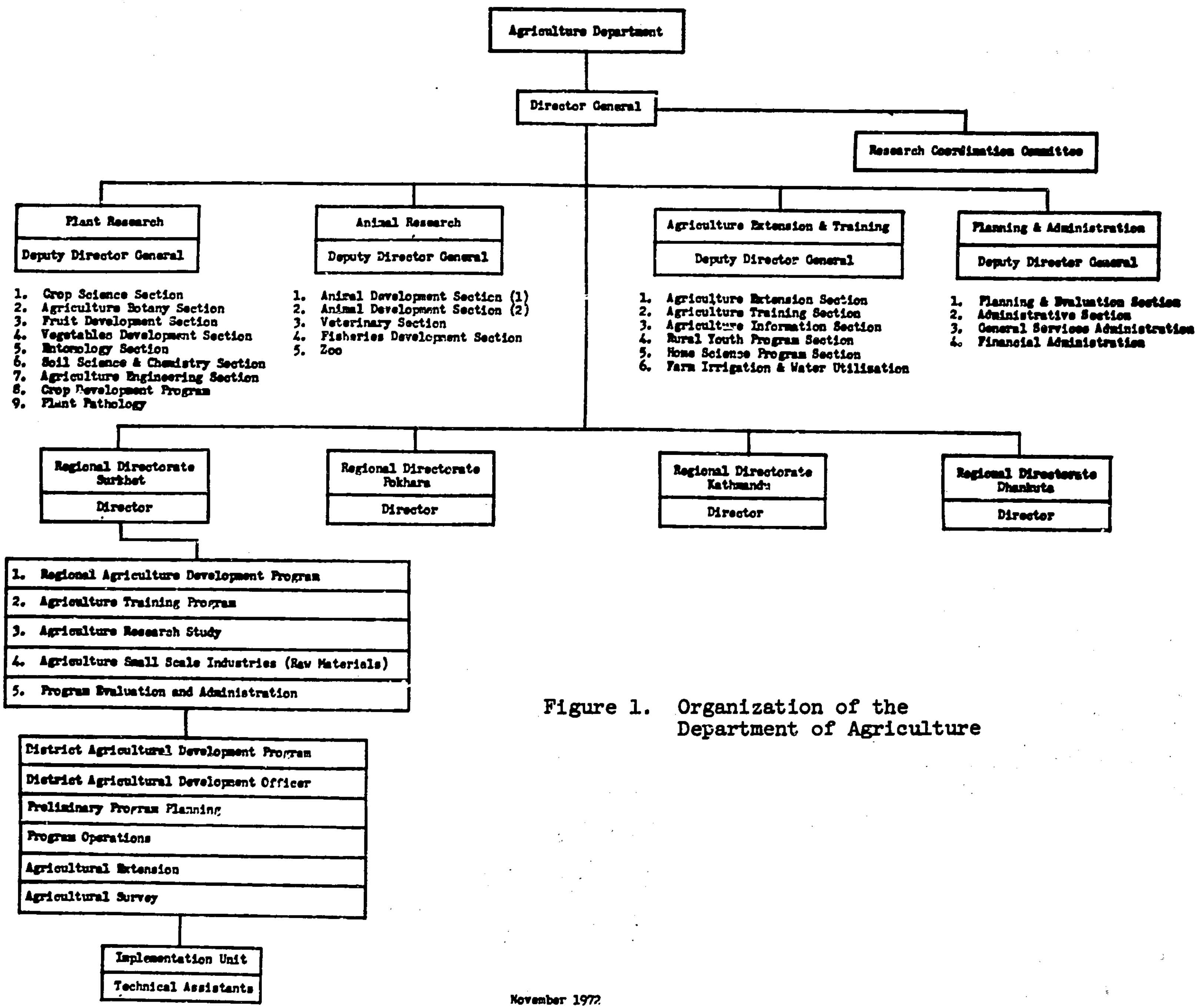


Figure 1. Organization of the Department of Agriculture

The research organization of the Department at the present time is as follows:

	Leader
PLANT RESEARCH	Deputy Director General K. B. Rajbhandary [1]
Crop Science Section	Dr. S. N. Lohani
Agricultural Botany Section	A. M. Pradhanang
Fruit Development Section	H. P. Gurung
Vegetable Development Section	D. R. Pandey
Entomology Section	P. N. Rana
Plant Pathology Section	Mohin Shaha
Soil Science & Chemistry Section	M. L. Pradhan
Agricultural Engineering Section	T. B. Basnyat
Coordinated Crop Development Programs	
Rice	Dr. B. B. Shahi
Wheat	A. N. Bhattarai
Maize	Gopal R. Rajbhandari
Citrus	P. P. Shrestha
Potato	J. D. Sakya
ANIMAL RESEARCH	Deputy Director General P. J. Rana
Animal Development Section 1	K. R. Pande
Animal Development Section 2	K. R. Keshari
Veterinary Section	Dr. S. N. Pyakural
Fisheries Development Section	S. N. Sarkar
Zoo	G. B. Basnyat

The research of the Department is set up in part on a commodity basis and in part along discipline lines. The five Coordinated Crop Development Programs have been established since 1972 and are in different stages of effectiveness in their operations.

C. Organizational Changes

The present structure of the Department of Agriculture, with substantial authority and autonomy in the Regional Directorates and with research carried out under divergent commodity/discipline units, presents some restraints. However, these are not insurmountable and modifications should be made with the recognition that organizational "form" should be adapted to fit the "substance" of the job to be done.

The Team does not propose any substantial changes in organization of the research and related activities at this time since 1) the series of recent

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[1] Replaced in 1975 by Mr. S. B. Nepali.

reorganizations of national programs in agriculture, including the Regional Corridor Development concept, should be permitted to fall into place and function before another realignment is put forth, and 2) the functions of the Department of Agriculture relative to research and new technology could not be restructured without giving attention to the total scope of activities of the Department. This broader review of total Department activities did not fall within the terms of reference for the Team.

Improvements can be made in the organization of the Department's working units, as shown in Figure 1, with staffing presented in ANNEX VI. A thorough study of the Department organization should be made, with adjustments over time and according to a design and schedule that will cause a minimum of disruption to the lines of communication and authority that are now being established.

D. Operational Changes

The national capability for developing and applying new agricultural technology can be strengthened by improving procedures within the present organization of the Department. There are a number of operational or procedural areas susceptible to improvement.

1. The research units

The initiative taken by the Department to establish Coordinated Crop Development Programs for rice, wheat, maize, citrus and potatoes recognizes the importance of approaching agricultural improvement through problem-oriented, multidisciplinary research teams concentrating attention on major commodity or problem areas. These coordinated programs are not yet functioning fully because of lack of staff and also lack of definition of operating procedures.

For a coordinated, problem-oriented research program to function effectively it is essential that the scientists in the interrelated disciplines should work within the research Team, directing their priority attention to the specific problems in their scientific field that limit productivity of the crop. It is usually not possible to maintain a well-integrated team approach to research if some members of the Team are "collaborators" - employed by and basically loyal to separate sections or units of the Department - without priority commitment to the Coordinated Program.

The Team is aware that present limitations of trained personnel in the different disciplines preclude the assignment of scientists in all of the relevant problem areas to each of the major commodity programs considered in this report, for rice, maize, wheat, potatoes, and forage and fodder crops. However, the staffing patterns proposed for these programs by the Team should be regarded as the minimum for the respective program/problem area and should be used as a guide in developing the Department's research manpower. Until such time as the additional trained personnel are available the present cooperative arrangement between the discipline-oriented Sections and the Coordinated Programs should be continued. Such relationships also should be maintained in those cases where the need for a given discipline on a commodity research Team would be less than the full-time, year-around attention of a scientist.

One operational/organizational change that should be considered by the Department is the setting up of a Coordinated Program for Improving Farming Systems. This would help to ensure more effective multidisciplinary attention to the additional crops important in the Hills, including barley, finger millet, pulses, oilseeds, and others as discussed in Chapter X.

The Team is aware that national coordinated research programs on the major crops, with headquarters stations in the Terai, may continue to give inadequate attention to the varietal characteristics and/or production practices that should be evolved for the Hills. The more specific "programmed" approach for research to improve farming systems would not only help to maintain an awareness of the requirements of the major crop components of Hill agriculture but also would furnish the mechanism for regional testing, farm evaluation, and demonstration/promotion of improved technology suited to the different farming systems in the Hills. The proposed program could be evolved from the present research and under the leadership of the Crop Science Section.

2. Program definition - Priorities

Officials of the MFAI requested that the Team should furnish recommendations for priorities in agricultural research and development for the Hills. The report presents substantial guidance in the respective chapters, in identifying limiting factors, in suggesting components for strengthened research programs, and in specifying disciplines to be included in the research teams.

It is not feasible for short-term specialists - no matter how capable they may be - to propose precise priorities for research and development under the diverse physiographic, biological, economic, social and political factors that influence the agriculture of Nepal. These factors or issues are subject to constant change in an evolving, modernizing society and cannot be assessed adequately by external reviewers.

Since agriculture employs about 93% of the labor force in Nepal, provides 67% of the Gross Domestic Product, and 80% of the national export earnings, the improvement of the agricultural sector is of concern to officials in many branches of HMG. Decisions on priorities for improving agriculture of Nepal should be reached through regular and systematic assessment by officers and staff at three levels within HMG, including:

a. A government-wide committee, to consider agricultural development within the broader context of national development;

b. A committee or council of the MFAI, to determine priorities within the agricultural sector;

c. Research and development teams, and workshops, to identify the critical problems and opportunities for specific project or program areas.

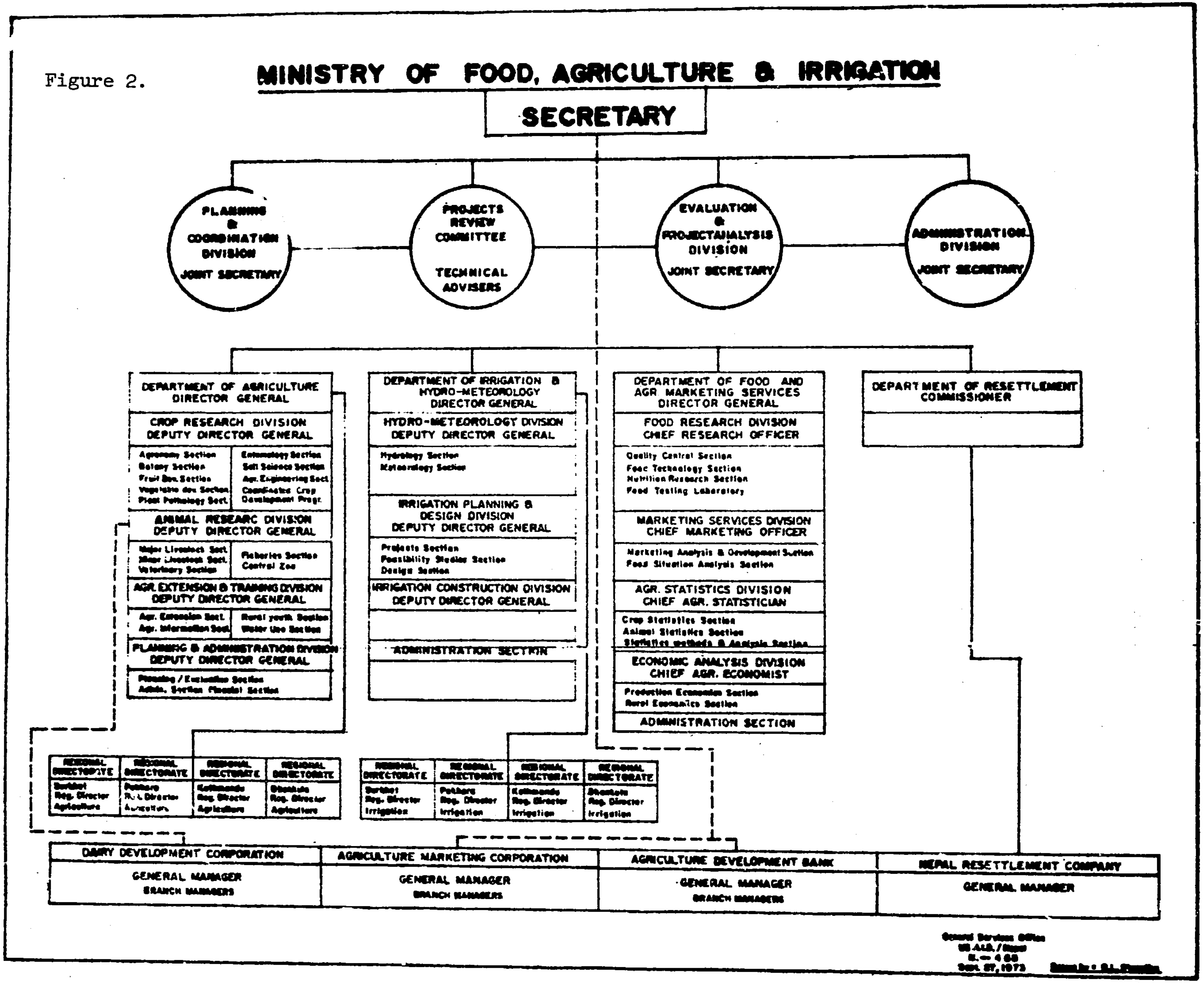
The Team was informed that a National Agricultural Development Committee, for which the Secretary of the MFAI is Chairman and a member of the Planning Commission is to serve as Vice-Chairman, has been designated but has not met. The Team was advised also that the Research Coordination Committee of the Department of Agriculture, as shown in Figure 1, has not functioned.

On the basis of experience with agricultural development elsewhere it would seem essential that systematic procedures should be established - through standing committees or councils - for setting research and development priorities, and for program planning and evaluation. The action by the Nepal Rastra Bank (subsequent to the Team review in November 1974) in establishing the Agricultural Projects Services Center supports the Team views that improved procedures should be set up at HMG and MFAI levels to guide agricultural development activities. The action to establish the Agricultural Projects Services Center reflected the awareness of the need for "a systematic and coherent approach to prepare economically sound and financially viable projects readily amenable to implementation so as to yield desired results commensurate with development priorities."

The implementation of the National Agricultural Development Committee would help to achieve a better understanding throughout HMG of the problems and potentials for agricultural development in Nepal, and also would help to ensure that priority projects would be supported adequately.

The activation of an Agricultural Research and Development Council within the MFAI, similarly, would improve cooperation among the research programs, sections and units responsible for the interrelated agricultural development activities. The membership of the Council should include those persons responsible for development of new technology and those responsible for its application and use. The Team is not suggesting specific membership since this would depend upon the scope of responsibility of the Council - whether limited to agriculture or to include irrigation and/or food. It would be desirable to limit the number of members to 12 or 14.

Figure 2.



MINISTRY OF FOOD, AGRICULTURE & IRRIGATION
SECRETARY
PLANNING & COORDINATION DIVISION
JOINT SECRETARY
PROJECTS REVIEW COMMITTEE
TECHNICAL ADVISERS
EVALUATION & PROJECT ANALYSIS DIVISION
JOINT SECRETARY
ADMINISTRATION DIVISION
JOINT SECRETARY
DEPARTMENT OF AGRICULTURE
DIRECTOR GENERAL
CROP RESEARCH DIVISION
DEPUTY DIRECTOR GENERAL
Agronomy Section
Botany Section
Fruit Dev. Section
Vegetable dev Section
Plant Pathology Sect.
Entomology Section
Soil Science Section
Agr. Engineering Sect.
Coordinated Crop Development Progr.
ANIMAL RESEARC DIVISION
DEPUTY DIRECTOR GENERAL
Major Livestock Sect.
Minor Livestock Sect.
Veterinary Section
Fisheries Section
Central Zoo
AGR. EXTENSION & TRAINING DIVISION
DEPUTY DIRECTOR GENERAL
Agr. Extension Sect.
Agr. Information Sect.
Rural youth Section
Water Use Section
PLANNING & ADMINISTRATION DIVISION
DEPUTY DIRECTOR GENERAL
Planning / Evaluation Section
Admin. Section Financial Section
DEPARTMENT OF IRRIGATION & HYDRO-METEOROLOGY
DIRECTOR GENERAL
HYDRO-METEOROLOGY DIVISION
DEPUTY DIRECTOR GENERAL
Hydrology Section
Meteorology Section
IRRIGATION PLANNING & DESIGN DIVISION
DEPUTY DIRECTOR GENERAL
Projects Section
Feasibility Studies Section
Design Section
IRRIGATION CONSTRUCTION DIVISION
DEPUTY DIRECTOR GENERAL
ADMINISTRATION SECTION
DEPARTMENT OF FOOD AND AGR MARKETING SERVICES
DIRECTOR GENERAL
FOOD RESEARCH DIVISION
CHIEF RESEARCH OFFICER
Quality Control Section
Food Technology Section
Nutrition Research Section
Food Testing Laboratory
MARKETING SERVICES DIVISION
CHIEF MARKETING OFFICER
Marketing Analysis & Development Section
Food Situation Analysis Section
AGR. STATISTICS DIVISION
CHIEF AGR. STATISTICIAN
Crop Statistics Section
Animal Statistics Section
Statistics methods & Analysis Section
ECONOMIC ANALYSIS DIVISION
CHIEF AGR. ECONOMIST
Production Economics Section
Rural Economics Section
ADMINISTRATION SECTION
DEPARTMENT OF RESETTLEMENT
COMMISSIONER
REGIONAL DIRECTORATE
Surkhet
Reg. Director
Agriculture
REGIONAL DIRECTORATE
Pokhara
Agriculture
REGIONAL DIRECTORATE
Kathmandu
Reg. Director
Agriculture
REGIONAL DIRECTORATE
Dhankuta
Reg. Director
Agriculture
REGIONAL DIRECTORATE
Surkhet
Reg. Director
Irrigation
REGIONAL DIRECTORATE
Pokhara
Reg. Director
Irrigation
REGIONAL DIRECTORATE
Kathmandu
Reg. Director
Irrigation
REGIONAL DIRECTORATE
Dhankuta
Reg. Director
Irrigation
DAIRY DEVELOPMENT CORPORATION
GENERAL MANAGER
BRANCH MANAGERS
AGRICULTURE MARKETING CORPORATION
GENERAL MANAGER
BRANCH MANAGERS
AGRICULTURE DEVELOPMENT BANK
GENERAL MANAGER
BRANCH MANAGERS
NEPAL RESETTLEMENT COMPANY
GENERAL MANAGER

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3. <u>Program planning and evaluation</u>

The leaders of the Sections and the Coordinated Programs should be responsible for developing their respective programs and for their execution and evaluation. Annual workshops involving the participating researchers and selected members of the Research and Development Council would serve for evaluation and for program direction.

The activities in research and development should be structured within programs, projects and experiments. <u>Programs</u> are the broadly scoped activities, usually multidisciplinary and long term or continuing. The Coordinated Crop Development Programs and the Sections each represent "program" areas, for which descriptive outlines should be prepared stating 1) the problems, 2) the objectives, 3) the plan of procedure and other features of the general activity.

<u>Projects</u> are more precisely defined activities within a given program. Project outlines should be prepared to identify each of these more limited activities, with the problem, objectives, plan of work, locations, collaborating agencies and key personnel noted. Projects may be long term but usually are limited to a duration of no more than 5 years to ensure periodic review and revision as required.

<u>Experiments</u>, conducted under the various projects, are specific studies carried out during a given season, at one or more locations, to pursue the objectives of the project. Work plans should be prepared and followed for each experiment, providing information on the variables or treatments to be studied, the number, size and location of the plots, the crop varieties to be grown, the seeding rates, cultural practices, etc. Care in the design of experiments is of special significance in Nepal because of the limited land areas, primarily on numerous narrow terraces, at the stations in the Hills.

The preparation of documents to define and outline programs, projects and experiments may appear to be burdensome and time consuming. Actually, it ensures a sharp focus on research objectives, furnishes the framework for program planning, execution and evaluation, and provides the base for program budgeting. The latter is especially critical for research workers - to be able to furnish details of personnel, equipment, materials and operational cost estimates - as well as to Department and Ministerial level budget and program planning officers who too often lack such information for their assessment of budget requests.

4. <u>Manpower</u>

The shortage of trained and qualified manpower is the major restraint to improvement of agricultural technology for Nepal. The present staffing of the Department of Agriculture is presented in <u>ANNEX VI</u> and summarized in Table 3.

In addition to the limitation in numbers of technical staff there is a lack of effective use of presently available personnel through 1) delay in action by the Public Service Commission in making selections to permanent posts, causing an excessive number of such posts to be filled by persons in an acting capacity, and 2) advertising and selection schedules and procedures that cause persons experienced and qualified in a given line of work (but in an acting or temporary post) to opt for an advertised position in another field of work in order to qualify for a permanent appointment. These defects are well known, not only in the MFAI but also in other high levels of HMG. It would seem prudent, and in the best interests of Nepal's economic and social development, for corrective action to be taken. This should not be difficult since the remedies are procedural - changing the bureaucratic processes.

A major positive factor in building capability for improved agricultural technology is the nucleus of well-qualified and highly dedicated young scientists in leadership or principal posts in the various Sections and in the Coordinated Programs. The Team was most favorably impressed with the HMG personnel assigned as counterparts and with other technical personnel contacted at Khumaltar and in the field stations.

Table 3. Gazetted and Non-Gazetted Manpower in the Ministry of Food Agriculture and Irrigation and Quasi-Public Corporations [1)]

Organization	Gazetted*	Non-Gazetted
Department of Agricultural Research and Education	200	851
Department of Extension (51-DADO, 6-RADO)	57	
JT level		176
JTA level		525
Department of Livestock and Veterinary	62	250
Dairy Corporation	12	75
Agricultural Development Bank	20	85
Saving Corporation	4	260
Agricultural Marketing Corporation	7	10
	362	2,232

*Gazetted staff - B.Sc. degree or higher

1) From Report by Mid-West University Consortium on Higher Education in Agriculture in Nepal (1972)

An important manpower resource is the cadre of trained young agriculturists who received their B.Sc. degrees from Indian Agricultural Universities under support from USAID, as shown in Table 4. A number of these returned participants were contacted at the various field stations visited by the Team.

This program has been reactivated, with 50 new students to be supported annually over the next four years. Nepal will have an unusually good complement of young agriculturists for carrying on programs in improving agricultural technology and for selection for advanced training to furnish leadership for such programs.

Table 4. B.Sc. Degree Holders Trained in India Under the USAID Participant Program 1)

1. Number Sent	378
2. In Training	64
3. Returned	314

Employment of Returned Participants

1. Ministry of Food Agriculture and Irrigation	158
2. Other Agriculture Related Agencies	63
3. Outside of Agriculture	37
4. Unemployed/Deceased/Whereabouts Unknown	19
5. Under One-Year Compulsory Service with Ministry of Education	37

1) FAD/USAID/NEPAL November 1974

The principal institution in Nepal set up to develop manpower for the agricultural sector is the Institute for Agricultural and Animal Sciences which is being established at Rampur. At the present time the IAAS provides limited potential for training personnel other than vocational agriculture teachers. The shifting of responsibility for training of JTA's from the IAAS to the research stations is a serious detriment to the nation's already inadequate research capability. While it is desirable to have the JTA's participate in and become familiar with the development of new technology the staff and resources at the research stations cannot take on an added, excessive training burden without further diminution of research.

The requirement that those who complete their training at the IAAS must serve for one year with the Ministry of Education is a further deterrent and/or distraction to the building of the agricultural manpower needs. An assessment of the IAAS is presented in ANNEX VII. In a nation so predominantly agricultural it would seem essential to have a critical review of this institution to reassess priorities, the direction of effort, and perhaps the restructuring to an organization that will more effectively serve the agricultural sector.

The building of the technical manpower resource for Nepal's Agricultural development should be pursued on a regular, systematic basis - with an assessment of needs and a priority schedule for meeting them. The identification of trained manpower needs can be facilitated by determining the optimum staffing for each major unit of the Department, through a charting of staff requirements as presented in Figure 3 for a Coordinated Crop Development Program.

Figure 3. <u>Staff Requirements, by Disciplines, for a Coordinated Crop Development Program</u>

	Disciplines									
Program Areas	Breeding	Pathology	Entomology	Agronomy	Soil Science	Water Specialist	Engineering	Plant Physiology	Economist	Subject Matter Specialist
Varietal Improvement	X	X	X	X	X	X		X		
Pest and Disease Control		X	X	X						
Cultural Practices				X	X	X		X	X	
Soil Management				X	X	X				
Water Management				X	X	X	X			
Harvesting and Storage				X			X			
Socioeconomics									X	
Training										X
Field Application									X	X
Seed Multiplication	X			X						

The various program areas would require different combinations of specialties and not all would require a full-time "discipline" staff member for each program. On the other hand, some program activities would require more than one person in some disciplines such as agronomy or breeding.

The number of persons needed for a given unit or activity would depend on the number of locations where the component projects or experiments are to be conducted. Also, the level of training required must be ascertained on the basis of the leadership capability or scientific competence needed in each of the disciplines, at the central station and at the field locations.

The staffing for the Sections would differ from the foregoing chart, with a more limited number of disciplines and a wider range of competence among the staff members.

The B.Sc. degree cadre will be the hard core staff for most activities of the Department and the reactivation of the participant training in Indian Agricultural Universities, under USAID support, is a positive step in strengthening this nucleus staff.

M.Sc. and Ph.D. training should be associated where possible with the International Research Institutes, to furnish a maximum of in-service work experience along with the academic training at nearby universities.

Training for technicians, JT/JTA's, station and farm managers, etc., could be handled through special workshops at the central or regional research stations.

5. Facilities and equipment

The research station network in Nepal, under the Department of Agriculture, includes the following:

1. Central Research Station at Khumaltar
2. Eastern Terai Station at Tarahara
3. Rice Research Station at Parwanipur
4. Maize Research Station at Rampur
5. Western Terai Station at Nepalgunj
6. Western Hills Station at Jumla
7. Central Hills Station at Jiri
8. Eastern Hills Station at Dankhuta

In addition, there are about 25 Agricultural Development Farms for testing, demonstrations, seed and planting stock production, and for various types of training. These are under the respective Regional Directorates.

The operations of the research stations and farms appear to be in a certain state of flux with respect to management and staffing. The facilities were placed under the Regional Directors at the time the Directorates were set up in 1972. In mid-1974 the 8 stations listed above were placed under the Central Department of Agriculture.

A number of the key personnel at the stations visited by the Team, ANNEX II, were either newly on the job or were facing near prospects for transfer. With the recent changes in operational authority and the personnel changes it was difficult to assess the suitability and capability of many of the stations and farms.

It is apparent that improvements can be made in the station/farm facilities through:

a) A critical assessment of the number and location of stations required to serve the research, testing, demonstration and seed production functions across the Terai, the Lower Hills and Upper Hills areas.

b) The development and improvement of the land areas and facilities at all stations and farms, to ensure reliability of the experiments and demonstrations.

c) Providing greater permanence and competence - through special training and workshops - for the station managers.

d) Upgrading of the professional staff, with a sufficient number of gazetted officers (with a minimum of B.Sc. level training) to permit delegating maximum responsibility for carrying out the work at the field location. This is especially critical since the leaders of programs cannot make regular field visits because of the monsoon season, topographic and transport restraints.

6. Administrative services

Administrative or supporting services and procedures are subject to improvement, especially a) the recruitment and management of personnel, b) delegation of authority and resources for maintenance, equipment and supplies, and c) arrangements for transport and communications.

Questions were raised by HMG officials about the feasibility of setting up an autonomous or semiautonomous body as a National Agricultural Research System, to permit greater freedom from usual Government procedural restraints. Such autonomous organizations have been established in a number of developing nations in recent years. However, there are limitations for a country with scarce technical manpower, and there is a disadvantage in achieving the type of continuum of research, field testing and application of new technology as proposed by the Team if the research is under a separate, semiautonomous unit.

An alternative - to furnish greater flexibility in management services - would be to establish a Governing Board within the Ministry to handle, under delegated authority from the Public Services Commission and other agencies of HMG, the responsibilities for a) personnel management, b) budget planning, c) fiscal procedures and accounting, and d) procurement. The Governing Board would establish regulations and procedures and, through subcommittees for specific action with respect to personnel, budgets, and such other activities as required, would have direct participation in the more critical functions.

The membership of the proposed Governing Board should be limited to 10 to 12 persons, with representation from those Ministries or agencies of HMG that would proffer delegated authority, and members from the MFAI. The following are suggested for membership:

Joint Secretary, MFAI Administrative Division, Chairman
Director General of Agriculture
Representative of Ministry of Finance
Representative of Public Services Commission
Representative of the National Planning Commission
The Directors of the four Development Regions
Deputy Director General for Planning and Administration, Department of Agriculture, Secretary

7. Technical support services

In addition to administrative services there are a number of technical support services that should be improved.

Experiment station improvement, operations and maintenance have been mentioned previously as an item of high priority.

Transport and communications should be improved to ensure more effective liaison between stations on both technical and management matters.

Experimental design and statistical services are especially critical in conducting experiments and demonstrations under the variable conditions found at most Hills stations and farms. An Experimental Design and Analysis Section, headed by a well-trained person, should be established at the Central Research Station at Khumaltar to serve the research and development programs of the Department.

Library services at the present time are relatively good for most Sections at Khumaltar. However, there is considerable duplication of books and references in the separate Section libraries that could be minimized by establishing a centralized library service. This should also provide "information services" for the technical personnel of the Department, including the circulation of selected materials to the main field stations.

Publications should receive more attention since there is information available from past studies of HMG and from outside technical assistance agencies that should be published and distributed to agriculturists in Nepal. This will require editorial staff as well as support for technical journals and for reports that will facilitate application of improved technology.

8. Funding

Research and the related technical development programs require a reasonable stability of funding and - equally important - the availability of funds as required to pursue seasonal activities. The preparation of budgets on a "program budgeting" basis, as mentioned previously, would facilitate both budget preparation and budget evaluation. The delegation of authority for technical program review to a Research Council and for budget review to a Governing Board, both within the MFAI, would facilitate action on the budget process.

The vesting of responsibility in the Governing Board for procedures and regulations for procurement, fiscal and accounting actions also would minimize delays and facilitate the work of the Department.

9. National and regional liaison

Some concerns were expressed by personnel at the field stations about delays in obtaining approval and support from officers in Kathmandu during recent months following the transfer of the stations to central authority from the Regional Directorate. Such problems should be minimized in future months, with better mutual understanding of authorities and responsibilities, as the recently designated Director General and some of the relatively new staff and operational procedures fall into place.

Since the four Directors for the Development Regions are under the Director General of the Department there should be no critical problem in identifying lines of authority. The major area of concern would appear to be the respective "action responsibilities" to be handled with maximum delegated authority at the Regional level.

10. Application of technology

The development, testing, demonstration and use or application of improved technology should be a continuum - from the research stations to the farmer.

The job of first priority is to produce new materials and practices that are dependably better. This requires carefully controlled experimentation and testing by Department scientists, at central and regional research stations, and then on selected farms where the design of the tests, the care in conducting them, and the competence of local supervision in interpreting the results will ensure the offering of reliably better technology to farmers.

The tests and demonstrations beyond the Department research stations would be handled largely under the administrative authority of the Regional Director. However, there should still be a prominent "technical" authority and evaluation by the Leader of the Coordinated Program or other qualified person from a Research Section to minimize errors in evaluating test results.

Subject Matter Specialists, persons trained to at least the B.Sc. degree level in agronomy or other field science, who would be responsible for putting together suitable packages of practices of improved technology for a major commodity or cropping system, should be employed as staff within the respective coordinated crop research programs. They should assist in carrying out tests/demonstrations, and in conducting training programs for JTA's, with farmers, etc. The Subject Matter Specialists would have dual responsibility, to their research program leader and to the Regional Director.

It may not be feasible to furnish a separate Subject Matter Specialist for each major crop for each region in the immediate future. An alternative would be to supply one or more such specialists in each region to cover the major annual cycle of crops. The SMS's also would assist in planning and supervising the increase and distribution of seeds and planting stocks within the Region.

11. Relations with the Agricultural Inputs Corporation, Agricultural Development Bank/Nepal, etc.

It would appear that the working relations with the Agricultural Inputs Corporation, the Agricultural Development Bank and other similar agencies concerned with inputs and support are satisfactory. The provision for Regional Coordinating Committees in each of the four Development Regions, chaired by the Regional Agricultural Development Director and with membership of the Regional Officers for Irrigation, AIC, and ADBN should ensure joint attention to most of the critical development problems within the region.

12. Relations with special development projects

There appears to be some lack of effective liaison between officials in the Department of Agriculture, the Regional Directors and the several projects supported by external assistance agencies, ANNEX V, in keeping abreast of the activities and information developed in these programs. The suggestion that adequate linkages do exist, by virtue of membership of selected HMG persons on advisory boards, is not fully reassuring or consistent with the manner in which some of the projects are operating.

It is appreciated that projects such as the Gorkha Training Center at Lumle were initiated with a clearly specified purpose of rehabilitating returned Gorkha soldiers and of providing them with specialized training so they can be more effective agents in upgrading agricultural practices in their villages. This project and the newly established similar effort in the East, at Pakhribas, are being reviewed by the U.K. staff and will undoubtedly be linked more closely with technical projects and personnel of the Department of Agriculture in the future.

In some other cases it would appear that the work of both the external support project and of the Department would benefit from a more continuous interchange of information. This is true of the Integrated Hill Development Project, supported by the Swiss Association for Technical Assistance, which should undertake a comprehensive field review of past and existing trials with selected grasses and legumes around Nepal - similar to the review Dr. L. V. Crowder had the privilege to make with Mr. L. P. Sharma.

The Hill Agriculture Development Project, newly initiated with support from the UNDP, is providing a useful service in drawing together information relevant to agricultural development programs. This, together with a greater in-depth assessment of more critical development needs and opportunities, should be most valuable in guiding priorities for future agricultural programs.

There is a mutual awareness, on the part of HMG and most of the external technical assistance agencies, of the importance of developing a more effective working liaison. This would not seem difficult and could be established with either the Central Department of Agriculture or with the respective Regional Directorates within which the projects operate. It would not seem appropriate for the Team to propose which point of contact would be most desirable but some closer working association should be developed.

The specialists on the Team have developed proposals for strengthening the applied technology resources and programs for the respective commodities or program areas they studied in Nepal. Recommendations were prepared also for maize and wheat since these crops should be improved to fit into the farming systems in the different regions in the Hills.

V. THE COORDINATED RICE DEVELOPMENT PROGRAM

A. Background

1. Economic importance

Rice occupies over 50% of the cultivated land in Nepal and accounts for 2.0 to 2.3 million tons of paddy or 60% of the total food grains in the country. In the Hills, rice is the primary monsoon crop in the valleys and lower terraces. Maize predominates at higher altitudes and where water control and rainfall are less certain. Production-wise, maize accounts for 44% of the food grains in the Hills while rice accounts for 38% in the Eastern Hills and 34% in the Western Hills.* The two crops furnish nearly 80% of the total food grains grown in the Hills. With 11 of the 18 districts in the Eastern Hills and 15 of the 35 districts in the Western Hills classed as food grain deficit areas (in 1971), intensifying production of these two crops would provide a considerable impact in alleviating this shortage.

2. Current status

Yields in the Hills are approximately 2.7 T/ha as compared with 1.6 T/ha in the Terai, 1.8 T/ha in the Inner Terai, and about 3.2 T/ha in Kathmandu Valley. Yields in the Hills may be considered near the maximum that can be achieved with existing varieties and cultural practices. Yields in the Kathmandu Valley illustrate what new varieties and fertilizers can contribute.

3. Attention to improvement

Efforts to improve production were initiated in 1966, primarily by evaluating new rice varieties. Introduced varieties recommended included China 45 (an early variety) and BR 34 for the full season crop in the Terai, and Taichung Native 1. The varieties recommended for the Hills, primarily the Kathmandu Valley, were Taichung 176, Chainung 242, Tainan 3 and Arulno.

Subsequent releases included IR 8 in 1969 and IR 20 and IR 22 in 1972. In 1973 Parwanipur 1, Jaya and Masuli were recommended for the Terai while Chainan 2 and Tainan 1 were released for the Hills. These varieties had spread to about 188,000 ha or 14.6% of the total area in 1974. In the Kathmandu Valley the new varieties cover about 70% of the area planted to rice.

In 1972 several commodity improvement programs were set up, including one for rice. A coordinator was named and the Parwanipur Research Station was designated as the principal center for rice. The structuring of the interdisciplinary research team is now under way. The research network in 1974 involved 13 centers and over 100 trials. These trials included selections from the International Rice Research Institute and

* Hagan, A. R. An Evaluation of the Agricultural Sector in Nepal, May 1974 (USAID)

from the All India Coordinated Rice Improvement Project as well as materials from Nepal's research program.

Active breeding work for development of local selections is just now getting under way, primarily with the Terai crop. Artificial screening for bacterial leaf blight has been initiated on the Nepal germplasm collection and on the entries in all the trials. Approximately 2% of the selections in the germplasm collection and a number of new selections from IRRI appear to be resistant to the indigenous strains of bacterial blight.

B. Limiting Factors

1. Transport

With topography imposing a severe limitation on transport of inputs into the Hills and transport of marketable surpluses out, production has tended to balance with local demands. The disparity of concentration of rice production in the Terai and population in the Hills, the difficulty of transport, and the low purchasing power of the Hill population, emphasize the need to increase rice production in the Hills.

2. Available technology

Since the Hill varieties of rice are "land" varieties, developed by farmer selection, their yield potential is probably fairly well exploited by present practices of the better farmers. The Hill areas could possibly influence production in three directions by change of variety, by a) maintaining the existing maturity span and introducing higher yielding varieties, b) introducing new varieties of shorter duration and maintaining existing yield levels, permitting more time in the cropping system for other crops, or c) providing irrigation in the early season to enable two short duration crops to be produced.

The most prevalent disease in the Hills is rice blast, especially at higher altitudes. Losses may not be severe at intermediate elevations but resistance should be incorporated into new varieties since the disease will be more damaging as productivity levels increase. The race pattern and the environment may be sufficiently different from other rice growing countries to require the development of resistant varieties within the country for both the Terai and Hills regions.

Pests attacking the rice crop in the Hills appear to be of much less consequence than diseases. It has been reported that in the Tansen valley (500-700 meters) some "hopper burn" has occurred and this, as well as other insect-related problems should receive more attention.

Soil fertility problems have not been clearly defined. Zinc deficiency occurs in some areas of the Terai but the extent of this problem in the Hills is not known. Observations at Khumaltar Farm indicate that zinc deficiency may limit production of some genotypes or limit levels of increase that can be achieved with the introduction of improved cultural practices. Phosphorus deficiency is reported to be widespread in Nepal. Dipping seedlings in a slurry of superphosphate and soil has been demonstrated as an effective means of applying phosphorus. Quantities 30 to 50% of normal soil applications of superphosphate are sufficient to correct the deficiency.

Cultural practices range from fairly good to poor. Factors which could have considerable bearing on yields are water management, time of sowing, seedling management, plant population, weed control, time of harvest (affecting shattering and milling quality) and the use of organic manures. Since rice is grown in rotation with a number of other crops, changes in cultural practices for rice production would have to take into account the effects on all crops in the sequence.

Altitude specificity of existing varieties is not clearly understood. This may not be as much of a constraint to the adoption of new technology as might be anticipated. Valley floors that extend up from the Terai, with an elevation below 3,000 feet, appear to provide satisfactory environments for many of the existing HYV. At the moment the choice of a new variety for these areas is rather empirical although IR 8 and IR 22 were observed to be performing reasonably well in a number of demonstrations. There is a prevailing concern that these varieties require inputs that are not available or which the farmer cannot afford. Varietal and agronomic trials and demonstrations will be necessary to identify varieties and practices which demand minimal cash inputs but maximize management inputs.

C. Strengthening the Coordinated Rice Development Program

1. Program components

The obvious need to increase yields per hectare in Nepal, in the Terai as well as in the Hills, dictates the development of a rice program that will include a) multidisciplinary, problem-oriented research to produce improved technology, b) vigorous field testing to determine the suitability or limitations of the innovations, c) seed increase to ensure availability of improved varieties, and d) demonstration and promotion activities to accelerate adoption and use of new, high-yield materials and practices.

The recently formed national Coordinated Rice Development Program provides the framework for the research component - but this will not supply the necessary new technology unless further attention is given to improving staffing, facilities, and operational support. Also, the program should give added emphasis to field testing, seed increase and the application or promotion of new technology as a unified or integrated effort.

<u>The project areas</u> and the scientific disciplines within the CRDP are shown in Table 1. Each of the project areas will involve a number of experiments in which scientists of more than one discipline will cooperate. The project area should be clearly defined, with a project outline or

Table 1. Project Areas and Disciplines Involved in the Rice Improvement Program

Project Areas	Breeding	Pathology	Entomology	Agronomy	Soil Science	Economics and Social Science	Subject Matter Specialist	Engineering	Plant Physiology
	Disciplines*								
1. Varietal Improvement	xx	x	x	x	x	x			x
2. Soil Fertility and Management				xx	xx				x
3. Water Management				xx	x			x	x
4. Cultural Practices				xx		x		x	x
5. Pest and Disease Management (excluding host-plant resistance)		x	x	x		x			
6. Harvesting and Storage			x			x		xx	x
7. Field Testing				x			xx		
8. Marketing and Socioeconomics						xx			
9. Application of Technology							xx		
10. Seed Multiplication	x			x			xx		

* The discipline with leadership responsibility is marked with xx. For pest and disease management it could be either the pathologist or entomologist.

statement setting forth the problem, the objectives, the plan of work, the personnel, locations and collaborating agencies and the length of time required. As stated earlier in this report, the project plans furnish the base for planning and budgeting - for management at all levels within the MFAI.

Technical leadership for the overall program would rest with the Coordinator but the individual multidisciplinary teams involved in a program would have technical leaders responsible for the respective project areas.

Because of the problems of communication, the Coordinator stationed at Parwanipur should be given broad administrative authority, to enable him to make decisions relative to the execution of the national coordinated program, and relative to the general operations involving Parwanipur which is a multipurpose research station as well as the national center for rice research.

Varietal improvement research should receive high priority, with attention to developing varieties for the different agroclimatic zones and agro-economic conditions of the country. Several disciplines would be involved, with several specific projects, in order to achieve the spectrum of varieties needed for the Hills and the Terai. Appendix A provides an outline of a project for the development of varieties adapted to the Hills.

Experience up to the present indicates that the dwarf types coming from the Dee Deo Woo Gen Dwarf from Taiwan are not especially suited to higher altitudes. Differences in plant type, diseases, and cold tolerance would indicate that germplasm could not be duplicated in rice improvement in the temperate and tropical zones of Nepal.

Varieties for temperate zone areas should have high yield, blast resistance, cold tolerance, acceptable grain quality and agronomic attributes which could provide production increases at the various altitudes.

Varieties for tropical zone areas should have high yield, resistance to bacterial blight, blast, helminthosporium, and, insofar as possible, resistance to insects which may become serious pests as rice production is intensified. These varieties would vary in maturity an- grain type to satisfy the domestic and foreign market demands.

Early varieties for the first season in double cropped areas would require dormancy to resist weather damage as they mature during the monsoon.

Agronomic research would provide packages of cultural practices suited to the agroclimatic zones and the various cropping sequences in which rice is grown. These packages should be built around the concept of minimal cash inputs for areas where the inputs cannot be provided. Even for areas where fertilizer can be provided, practices should maximize output per unit input rather than aspire to maximize production per unit area.

Economic studies would provide information on existing rice cultural and cropping patterns. Economists and agronomists would identify constraints in order to guide the research team in developing varieties which can perform within these constraints, or in devising means of removing them.

2. Manpower

The Parwanipur Agricultural Station, a multipurpose station which is the national center for the Coordinated Rice Development Programs, has staff for rice, horticulture, sugarcane, poultry, and fisheries, Table 3. The Rice Coordinator is the head of the research station and has administrative responsibilities for the other agricultural programs at the station. This tends to dissipate the time and attention of the rice coordinator. The Senior Officer may be able to satisfactorily handle many of the administrative details in the future so that the rice coordinator can be more effective in directing the rice research and development program.

The staffing required for a more adequate and effective Coordinated Rice Development Program, for the Parwanipur and Khumaltar Research Stations, is shown in Table 4. The 15 Assistant Agronomists and 15 JTA's would appear to be a minimum capability for handling the agronomic trials and cultural practices experiments at the 15 stations or farms other than Parwanipur and Khumaltar. The Assistant Agronomists, and other gazetted officers, would have training through the B.Sc. degree.

Training of staff at the different levels will be necessary to build a strong research team. The present staff at Parwanipur includes 5 with different levels of non-degree training abroad, with a sixth presently on study leave. The critical immediate need is for training in field plot techniques so that reliable experiments can be conducted at the various branch stations or farms. This has been provided to some of the staff trained at IRRI and a short training course should be established at Parwanipur for staff from other stations prior to the 1975 main season. Since Parwanipur has more than one crop season this could easily be achieved.

Critical to the development of a rice improvement program for the Hills will be a well-planned staff recruitment and development program for Khumaltar. This involves only 4 scientific personnel in the same number of disciplines. Priority should be given to recruitment and training of the assistant breeder and assistant pathologist. IRRI is organizing a short-term training program in early 1975, to create a team concept in varietal improvement, and this would be an excellent opportunity to develop a two-man team to initiate crossing programs for development of improved varieties for the Hills.

Development of professional staff should be pursued on a phased basis, preferably after men are assigned to the program and their potential is assessed for a period of time. They should be sent for training and degree programs with the understanding that they would return to the post for which they are undergoing training. The training of JT's or JTA's in field plot technics would ensure that the trials at the various stations would be properly conducted and more reliable data obtained during the interim period when B.Sc. Assistant Agronomists are not yet available.

Table 3. Technical Staff of the Parwanipur Agricultural Station

Post	Classification
Rice Coordinator	G.I
Senior Officer	I
Rice Agronomist	II
Sugarcane Agronomist	II
Rice Botanist	II
Training Officer	II
Soil Scientist	II
Asst. Rice Agronomist	III
Asst. Rice Botanist	III
*Asst. Rice Pathologist	III
Asst. Agronomist	III
Asst. Agronomist (Pulse)	III
Asst. Plant Pathologist	III
Asst. Soil Scientist	III
Asst. Agronomist (Sugarcane)	III
Asst. Agri. Botanist	III
Asst. Entomologist	III
Asst. Agri. Engineer	III
Asst. Horticulturist	III
Asst. Livestock Officer	III
Asst. Fisheries Officer	III

* On study leave

Table 4. Proposed Staffing for the Strengthened Coordinated Rice Development Program

Post	Research Stations and Farms		
	Parwanipur	Khumaltar	Others
Coordinator	1	-	
Sr. Agricultural Officer	1	-	
Breeder	1 + (1)*	-	
Asst. Breeder	2	1	
Asst. Breeder (Food Production)	1	-	
Sr. Agronomist	1		
Agronomist Multiple Cropping		(1)*	
Agronomist	1	1	
Asst. Agronomist	2	1	15**
Soil Scientist	1	-	
Asst. Soil Scientist	1	-	
Entomologist	1	-	
Asst. Entomologist	2	-	
Pathologist	1		
Asst. Pathologist	2	1	
Economist	1		
Asst. Economist	1		
Agri. Engineer	1		
Asst. Agric. Engineer	1		
Production Training Officers	3		
Communication Specialist	1		
Subject Matter Specialists at Regional Centers Nepalgunj, Pokhara, Kathmandu (Khumaltar), Biratnagar			4 + (4)***
JTA	10	6	15**
Librarian, NGI	1	4 + 6	
TOTAL	26 + 11 NG	4 + 6 NG	19 + 15 NG

* Proposed to be supplied by IRRI.

** One each for the 15 stations and farms where field trials would be conducted.

*** Proposed to be supplied by the U.S. Peace Corps as intermediate level production agronomists.

Training and communications personnel for rice should be available to train extension personnel in production techniques at the Institute for Agriculture and Animal Sciences (IAAS), Rampur, and to organize and conduct longer term training programs for extension personnel at Parwanipur. In anticipation of these training responsibilities a team should be sent to IRRI for training in 1975 so that a full fledged training course in rice production can be inaugurated in January 1976.

3. Facilities

Parwanipur was designated as the National Rice Station when the Coordinated Rice Development Program was set up in 1972. Since that time the only new office, laboratory, and residential facility that has been constructed is the soils laboratory which was part of an earlier developmental project.

Although the rice development program should be primarily field oriented there is a need for 1) seed storage facilities for breeding lines, which may require separate identity for several thousand progenies and collections of local varieties, 2) seed storage for breeder seed and processing facilities for breeder and foundation seed, 3) laboratories for pathology to enable the production of inoculum for disease screening and microscopic examination for disease specimens, 4) entomology laboratories and screen house facilities for evaluating resistance of selections to various insects, 5) library and office facilities for the staff, and 6) a service center for vehicles and farm machinery. These facilities are essential to accelerate productivity of the staff and to implement the seed multiplication program for which the research center is a vital unit.

Khumaltar would be a logical principal center for Hill Zone rice improvement. Kakani could serve as a center for screening for blast and cold tolerance if Khumaltar is not adequate for evaluating materials for these characteristics. There are excellent laboratory and office facilities at Khumaltar that could serve the rather limited number of research specialists to be located at this station.

The present national and regional research stations and farms serve most areas of Nepal in determining adaptability, screening for diseases and other characteristics. These stations should be improved by providing the necessary staff housing, equipment, and other facilities to effectively carry on research in rice.

The research and testing stations for the Rice Development Program are shown in Table 5.

4. Application of improved production technology

Farmers' field demonstrations are a well recognized technique for achieving a) spread of new varieties, b) evaluation for acceptance, and c) seed multiplication for those accepted. The demonstrations should not be viewed as "trials," the results of which a researcher is to use as a basis

Table 5. Research Stations and Research Farms Used in the Rice Research Program

Development/ Region /	Research Center or Farm	Area ha.	Rain-fall	Temp. Av. Ann.°C	Eleva-tion (M)	Use
Surkhet						
	Jumla*	1.66	14"		(7600')	Screening for cold tolerance varietal trials
	Doti*	8.5	45-55"		(2500)	Varietal trials Agronomic trials
	Surkhet	60**			(2400)	Varietal trials Agronomic trials
	Nepalgunj*	60	1700mm		(750)	Varietal trials, Agronomic trials Entomology trials
Pokhara						
	Pokhara (Khairinitar)				(900)	Varietal trials, Agronomic trials
	Dang		30-40"		(2200)	Varietal trials, Agronomic trials
	Bhairawa				(250)	Agronomic trials, Varietal trials
Kathmandu						
	Jiri				(1800)	Screening for cold tolerance varietal trials
	Kakani	10	2134	14.9°	(2100)	Blast screening, cold tolerance varietal trials
	Khumaltar		1302		(1300)	Blast screening hill zone breeding varietal trials agronomic trials, pathology trials
	Rampur*	200			(250)	Varietal trials, Agronomic trials
	Parwanipur*	80			(80)	Terai breeding center varietal trials BLB screening Agronomic trials, Pathology, Entomology Investigations
	Sarlahi	200	60-80"		(100)	Varietal trials, Agronomic trials
	Janakpur (Hardinath)	40			(145)	Varietal trials, Agronomic trials Farmer training Seed Multiplication
Dhankuta						
	Pakhribas					Varietal trials, Agronomic trials
	Dhankuta*				(1200)	Agronomic trials, varietal trials
	Biratnagar*				(145)	Varietal trials, Agronomic trials

* Centers of the Department of Agriculture. Other centers are presently under the control of the Regional Directors in the respective regions.

** To be established.

for his decisions. These decisions should have been made from results of research of the interdisciplinary team prior to the time the selections went to the farmer, with trials on the research stations and farms where the plantings are properly made and evaluated. In the present farm field demonstrations the number of varieties are too many and the number of centers (farmers) are too few to serve the several functions noted above. Agronomic practices suitable for the new varieties constitute a "package" which can be introduced through demonstrations of two or three such new practices to be compared with the existing farmer practice.

To provide close liaison with the development regions and to provide problem identification and feedback, Subject Matter Specialists should be stationed at a research station in each of the four regions. The Subject Matter Specialists would work closely with the extension personnel of the region in the planning, planting and observation of the trials on the research stations in the zone, the on-farm demonstrations, the AIC seed production programs, and other activities related to rice development.

The responsibility for maintenance of breeder seed of released varieties should rest with the Coordinated Program which would maintain each variety through acceptable progeny-row procedures. Seed would be multiplied in small areas of .5 to 1 ha and supplied to the AIC for further multiplication and distribution.

Seed supplies of new varieties going to on-farm tests would be multiplied on the research stations, with 1 to 5 ton lots for each region, to be available for further distribution the next season.

5. Cooperation with the four regional directorates

Many of the stations on which rice research will be conducted are under the administration of the regional directors (Table 5). Appropriate agreements should be developed whereby members of the Coordinated Rice Program staff would be posted to these stations and would have the necessary logistic support from the regional director. Experiments conducted at the regional stations would be of direct benefit to the farmers in the region and results should be channeled promptly into extension literature, radio, demonstrations, etc. The presence of a Subject Matter Specialist in the region would enable the regional director and the Subject Matter Specialist to be jointly responsible for the research trials in the region.

The Regional Coordinating Committee, chaired by the Regional Agricultural Development Officer, and including representatives of the Department of Irrigation, the Agricultural Inputs Corporation and the Agricultural Development Bank of Nepal furnishes a good mechanism for liaison of the rice development activities with these agencies.

6. Relationship to IRRI

IRRI is interested in fostering the development and strengthening of national rice production programs. Substantial assistance has been provided by IRRI through training programs for Nepal rice research and production men. Breeding materials have been provided from IRRI, and through IRRI from several other country programs. IRRI has provided stimulation to Nepalese staff through various research conferences and seminars and through visits of IRRI scientists to Nepal.

The plans that are being developed with USAID to provide technical personnel through IRRI to accelerate the rice improvement program should be of special value in building up the national program that is just getting under way.

The present leadership of the rice program has been most effective in getting the coordinated program activated. By further strengthening of this leadership and by building up presently deficient aspects of the program, especially for the Hills, it should be possible for Nepal to have a productive, self-sustaining Rice Development Program at the end of this decade.

APPENDIX A - Rice

Rice Breeding Project 1. Development of improved varieties for Hill areas.

Leadership - Breeding staff at Khumaltar.

Other disciplines - Pathology, Soil Science, Agronomy, Physiology.

Objective - To develop varieties with greater yield potential, cold tolerance and blast resistance for elevations above 3000 and up to 8000.

Experiments, teams and locations involved.

	Teams	Location
1. Germplasm evaluation		
For blast	Breeders - Pathologists	Kakani
For cold tolerance	Breeders - Physiologists	Kakani
For yield	Breeders	Khumaltar
2. Evaluation of introduced varieties		
For blast	Breeders - Pathologists	Kakani
For cold tolerance	Breeders - Physiologists	Kakani
For yield	Breeders	Khumaltar
3. Crossing local varieties with high-yielding introductions. Up to 50 crosses per season	Breeders	Khumaltar
4. F_1 cultures		Parwanipur
5. Evaluation of F_2 progenies		
For blast	Breeders - Pathologists	Kakani
For cold tolerance	Breeder - Physiologists	Kakani
6. Progeny rows from 5 above		
a. Screen for blast b. Advance to F_4	Breeders - Pathologists	Parwanipur
7. F_4 Progeny row test		
a. Screen for blast	Pathologist - Breeders	Kakani
b. Screen for cold tolerance	Breeder - Physiologists	Kakani
c. Agronomic evaluation	Breeder - Agronomists	Khumaltar

	Teams	Location
8. Multiplication of Promising F_5		Parwanipur
a. Multilocation tests of promising varieties	Agronomists - Breeders	Kakani, Doti, Jumla, Lumle, Khumaltar, Dhankuta
b. Blast screening	Pathologists	Kakani
c. Multiplication of lines for FFT the following year	Breeders	Parwanipur
9. Farmers Field Trials		
40 dist. x 10 per district	Subject matter specialists, DADO, JTA	400
10. Seed Multiplication	Breeders - Botanists - AIC Staff	10 to 5000 ha depending on variety

Annual Activities Related to Rice Varietal Improvement for the Hills

Year and season	Germplasm Evaluation	Crossing	Generation					Varietal trials					
			F1	F2	F3	F4	F5	PVT	Seed Mult.	CVT	FFT	Var. Rel.	Farm Sprd
1 Wet	x	x											
Dry			x										
2 Wet	x	x		x									
Dry			x		x								
3 Wet	x	x				x							
Dry			x				x						
4 Wet		x						x					
Dry			x						x				
5 Wet		x								x			
Dry			x						x AIC				
6 Wet		x									x		
Dry			x						x AIC			x	
7 Wet													x

VI. THE COORDINATED MAIZE DEVELOPMENT PROGRAM

A. Background

1. Economic importance

Maize is the second most important cereal grain in Nepal. The total area devoted to maize cultivation is estimated at 440,000 ha of which 256,000 ha or 58% is in the Hills. Maize accounts for about 825,000 tons or 25% of the total annual grain production in the country. Because of the somewhat lower yields than rice, maize accounts for only 44% of the food grain production in the Hills although it occupies 58% of the cultivated area. There are 43,000 ha of rice and 97,000 ha of maize in the Eastern Hills as compared to 103,000 ha of rice and 159,000 ha of maize in the Western Hills. Millets and barley are important crops in the Western Hills, reflecting the reduced rainfall of this region as compared to the Eastern Hills.

2. Current status

In the last five years yields and production of maize have declined slightly or have remained static. With no real spread of improved varieties (3% average for 1969-72) and a slight decline in area the total production has not changed appreciably.

3. Attention to improvement

Up to late 1972 maize improvement work was handled by the Agricultural Botany Section of the Khumaltar Research Station. In 1972 research and development for maize, rice, wheat, and potatoes were reorganized on commodity lines. At this time the Rampur Agricultural Station was established as the main center for maize improvement and a coordinator designated for this crop. The general activities of the initial program included 1) breeding, 2) collection of maize germplasm of Nepal, and 3) production of foundation seed. From 1973 special emphasis has been placed on the development of high lysine maize and CIMMYT (through AID) has stationed a maize breeder in Nepal to accelerate this phase of the program.

To date four varieties, Kakani Yellow, Khumaltar Yellow, Hetaura Yellow, and Rampur Yellow have been released. These have been distributed throughout the country in Farmer Field Trials and seed multiplication has been undertaken by the AIC for the past three years. About 30 tons of seed were produced for distribution in 1974. A seed processing plant is being established at Hetaura (with support from FAO/UNDP).

General criticisms of the new varieties are that they are too late to fit the farmers' cropping patterns, especially for the higher altitudes, they are tall and tend to lodge, and they lack husk coverage to protect them from insects and weather damage. The late maturity is not a critical problem in the Terai where nearly 70% of the crop is grown and since the varieties are composites which can be modified by selection pressures in future breeding cycles this limitation can be overcome.

The 302 varieties of maize collected from 50 districts of the country have been studied to determine their maturity, plant characteristics, and disease reactions.

Agronomic research has demonstrated the nitrogen responsiveness of the new varieties. In the Terai the varieties perform best when grown in the dry season, either from early September planting or February plantings. In both situations irrigation increases cropping intensity in the Terai but maize must compete with wheat for the same water resources.

The research of the Coordinated Maize Development Program includes over 70 experiments at 18 locations, with breeding work at the three stations developed for the various altitudes, as follows:

Low altitudes - Rampur (760 ft) in Chitwan Valley of the Terai.

Mid altitude - Khumaltar (4,300 ft) in Kathmandu Valley.

High altitude - Kakani (6,700 ft) in the hills north of Kathmandu.

B. Limiting Factors

As referred to earlier, the new varieties are generally unsuited to the farming systems presently used by Hill farmers because of their extended maturity. However, in trials at Kakani in 1973 the Kakani yellow composite exceeded the yield of the local by 54% while the hard endosperm opaque-2 exceeded the local by 25%. Screening of the Nepal maize collection indicated that roughly 71% of the varieties collected were earlier than the released varieties and that about 50% were white grained.

The existing varieties carry no special resistances to stalk rots, *Helminthosporium turcicum*, or rust, *Puccinia sorghi*. Screening of the germplasm collection has identified sources of resistance to rust and to some other diseases which can be introduced into the breeding program.

A number of composites carrying high lysine have been developed. The hard endosperm version appears to have farmer acceptability but it will require additional cycles of selection with appropriate chemical tests to obtain varieties suited to Hill conditions.

Setting up a seed program for an open pollinated crop like maize is extremely difficult in situations where land holdings are small. The purity of new varieties cannot be maintained without a complete "saturation" program on a village basis. This might be pursued after farmer acceptance of the new variety has been achieved.

The present trials on farmers' fields have been oriented toward maximizing yields by use of commercial fertilizers. More agronomic research needs to be addressed toward improving productivity of Hill maize with a minimum of cash inputs, including the use of organic manures, cropping sequences, plant types and plant populations for different cropping practices used by farmers.

C. Strengthening the Coordinated Maize Development Program

1. Program components

Maize contributes about 44% of the food grains produced in the Hills. National production is stagnating at about 800,000 tons. Basic to increasing this production is the improvement of varieties, particularly selections that are higher yielding with existing inputs or which can take better advantage of added inputs. The introduction of high lysine types will benefit Hill peoples by increasing food supplies and improving nutritional value.

Maize is still cultivated by traditional means in cropping sequences which fit the resources, knowledge and experience of the farmers. Agronomic research should provide packages of new technology including improved varieties and practices that will increase yields with or without mineral fertilizers or other costly inputs.

The maize development program under a national coordinator, as now conceived, provides an effective, efficient organizational structure for utilizing limited resources and manpower. In the past several statements or plans for a maize improvement program have been prepared. Some of these have addressed broad aspects of maize improvement while more recent statements have focused on a narrowly defined program of high lysine maize. High lysine is only one component of varietal improvement and the many other aspects - high yield, grain type, plant type, disease and insect resistance, and adaptation are also needed. The program must be comprehensive geographically - nationally - to improve maize production in all regions in which the crop is grown.

The maize development program, through its multidisciplinary research team of breeders, agronomists, pathologists, entomologists and economists should develop varieties with higher yield potential than existing local varieties, with low ear placement, lodging resistance, disease resistance, acceptable grain type, husk protection, prolificacy and different maturities for the various agroclimatic zones of the country.

Agronomic research for the Hills should include studies on spacing in relation to interplanted crops, improving stand establishment, increasing the efficiency of available on-farm organic manures and legumes, dates of planting in respect to other crops and achieving maximum annual production per unit area from various cropping combinations.

Plant protection research should include seed treatment to limit seedling diseases, especially when the crop is sown in cold soils and germination is slow. Disease resistance should be a factor in the breeding program. Many insects are difficult to control by means of host plant resistance so biological controls should be explored under various cropping systems.

Improved methods to control storage losses, which are reported to reduce the harvested crop by 15 to 20%, would add significantly to national food grain supplies.

Present proposals for production agronomists to work with extension personnel in the four development regions are designed to provide additional research information on variety performance at the farmer field level. This should have the broader objective of more rapid transmission of research information to extension workers and for keeping research staff abreast of farmer problems so that their research can be promptly responsive to such problems. The Farmer Field Trials also should be used to spread the outstanding varieties more widely in order to acquaint more farmers with their merits. Sixty such trials in 22 districts, as presently programmed, are not adequate to serve this function.

Seed production and distribution of new maize varieties pose problems far different from wheat or rice since maize is open pollinated. The widespread distribution through Farm Field Trials, as suggested in the previous paragraph, could lead to widespread acceptance but will not serve for seed multiplication. Isolation distances required for pure seed production cannot be achieved on small holdings so seed production must involve several farmers, or all farmers, in a village who would grow the one variety they found most acceptable. This system would also reduce transport costs and ensure greater spread of new varieties than could be achieved by production in a few key locations in the country. Key production centers can be used for production of foundation seed but "seed villages" would need to be established rather widely once the new varieties were identified.

Another procedure for seed dissemination would be repeated infusions of small quantities of seed into many villages. This would allow new cycles of composites to be introduced as improvements are made, to produce a ripple effect to upgrade the entire maize crop of an area. At the village level this would not be a "pure" seed program but an "improved" seed program.

The multidisciplinary research program can be more easily visualized by the following table which sets forth the specific projects and the disciplines involved in each. A detailed statement or outline should be developed for each project and for each experiment within the project, as discussed in the previous chapter for the rice development program.

Table 1. Project Areas and Disciplines Involved in the Maize Development Program

Project Areas	Disciplines*									
	Breeding	Pathology	Entomology	Agronomy	Soil Science	Economics and Social Sciences	Subject Matter Specialist	Engineering	Plant Physiology	Cereal Chemist
1. Varietal Improvement	xx	x	x	x	x	x				x
2. Soil Fertilizer & Management				x	xx	x		x	x	x
3. Water Management				x	x	x		xx		
4. Pest Management (excluding host-plant resistance)		xx	xx	x		x		x		
5. Cultural Practices		x	x	xx	x	x		x		
6. Harvesting and Storage			x	x		x		xx		
7. Marketing and Socioeconomics						xx				
8. Field Testing							xx			
9. Application of Technology							xx			
10. Seed Multiplication	x			x						

* Disciplines marked with "xx" have leadership responsibility for the program.

2. Manpower

The maize program is presently not functioning effectively because of lack of staff. Staffing proposals, as developed by the Coordinator and his associates, are presented in Tables 2 and 3.

Table 2. Proposed Maize Development Staff at Rampur

Discipline	Class I	Class II	Class III
Coordinator	1		
Breeding	1	3	4
Agronomy		4	3
Soil Science		1	2
Entomology		1	3
Pathology		1	3
Communications and training		1	3
Economics		1	2
Total - 34	2	12	20

Table 3. Staff Required for 10 Additional Stations in the Maize Development Program

Station	Elevation	Development Region	Agronomists II	Agronomists III	Plant Prot. III
Nepalgunj	700	Far West	1	2	1
Surkhet	2000	"	1	2	1
Jumla	7600	"	1	2	1
Kaski (Pokhara)	3000	West	1	2	1
Khumaltar	4300	Central	1	2	1
Janakpur	440	"	1	2	1
Kakani	6700	"	1	2	1
Jiri	6000	"	1	2	1
Biratnagar	440	East	1	2	1
Dhankuta	3650	"	1	2	1
Total -	40		10	20	10

This target of staffing for the end of the Fifth Plan Period would be phased over this period. It is expected that at least 70 staff members would obtain B.Sc. degrees, 8 would obtain M.Sc. degrees and 2 the Ph.D. degree. In addition, 70 B.Sc. personnel would be sent for in-service training, 35 to the Inter Asian Corn Program in Thailand and 35 to CIMMYT. Personnel would be sent for advanced degree study only after they have served in the coordinated program for a period of time after their in-service training.

Of particular importance is the upgrading of staff in the key disciplines at the main stations and the production agronomists at the regional stations. These people would be trained at CIMMYT. Also of special concern is the competence of the men conducting the different experiments at the various research stations. Intensive training in plot technics is essential to improve the reliability of the research data obtained.

The Coordinator has developed proposals for the training of JT's and JTA's in order to acquaint extension personnel with the new varieties, production technologies and plant protection measures in order to upgrade the farmer field trials and demonstrations.

Job descriptions for each of the program staff members are being developed by the Coordinator so they can fully comprehend their duties and responsibilities. These should be reviewed carefully and the proposed staffing pattern should be assessed during the five-year period to ensure that manpower development proceeds on a schedule and with priorities in keeping with the needs of the program.

3. Facilities

The network of research stations listed in Table 3 can in general provide necessary land area for research plots and for some seed multiplication.

Accommodations for staff housing, offices, laboratories, trainees, a farm service center, seed processing and storage need to be developed at Rampur. Priorities need to be established and an urgent need is for seed storage since conditions during the monsoon cause germinating ability of the seed to decline very rapidly. Seed processing and storage facilities should be developed for the breeder seed and foundation seed to be produced at the station. Considerable field equipment is available at Rampur but facilities need to be provided for servicing, maintenance, and storage.

As the staff expands office and laboratory facilities must be increased and staff housing provided as needed. Likewise training facilities need to be developed as soon as the program is more clearly defined and the role of the various stations established. There should be an orderly program for the shaping of field plots and development of the facilities at all stations involved in the maize program during the next five years.

4. Application of improved production technology

The limited spread of the new maize varieties indicates that serious consideration must be given to accelerating their use. This will require focus on a) assembling the right components of the production package, b) upgrading capability of extension personnel (already discussed), c) extensive demonstations (including feeding trials of high lysine maize), and d) improving seed production and distribution.

The maize trials on farmers'fields in 1974 included nitrogen and phosphorous fertilizers (5 treatments each), insecticides (4 treatments), and variety trials with 7 varieties. Limited observations by the Team indicate that the reliability of many such trials would be subject to question. Conducting the trials in a more accurate manner by more competent staff on the central research stations and on the regional research farms, and having extension staff and farmers involved by visiting these trials should prove more useful.

Demonstrations of a simple type in which there are four plots should include:

a) Farmers variety	Farmer's cultural practices
b) Farmers variety	Recommended cultural practices
c) Recommended variety	Farmer's cultural practices
d) Recommended variety	Recommended cultural practices

The farmer and extension personnel can observe two variables, variety and practices. Making the successful and convinced farmer a seed producer the following year offers a means of spreading the new varieties. The numbers of such trials should be intensified in districts where extension staff and progressive farmers are available. If each of the 700 JTA's presently on duty conducted only 1 or 2 demonstrations per year and moved to 1 or 2 new villages each year a substantial area of Nepal could be covered in a 5-year period.

Seed production on the research stations should carry through to multiplication to the foundation seed level. If area is available, supplies of the next generation of multiplication could also be produced.

The infusion method of providing "improved" seed in the village rather than attempting to provide "pure" seed would require smaller quantities of pure seed to be produced either by the research stations and farms or by AIC. The method to follow would be determined by a number of factors - a) rate of acceptance or demand, b) competence of the seed production staff, c) facilities for production, processing, storage, and transportation, and d) improvements in the package of technology such as yield increase, lysine, grain type, lodging resistance, etc. The pattern could vary to fit the circumstances, with different patterns for the Terai, the larger valleys, or the Hills.

5. Relationships with IACP and CIMMYT

The IACP and CIMMYT have made substantial contributions to maize improvement in Nepal through germplasm, visits by personnel, equipment, and training. It is visualized that additional support, especially for staff development, will be required for some time in the future. The continuance of external staff support in breeding and production agronomy will accelerate the development of improved technology and its dissemination to the village level.

The present working relationships enable CIMMYT and IACP to make recombinations of germplasm based on performance in Nepal. As staff develops this responsibility can be assumed within Nepal. It should be kept in mind that external assistance should be concentrated on the primary national objective of building a well organized and coordinated maize improvement, seed production, and extension program.

VII. THE COORDINATED WHEAT DEVELOPMENT PROGRAM

A. Background

1. Economic Importance

Wheat ranks third in importance as a food grain crop in Nepal. The area devoted to wheat culture was approximately 270,000 Ha. in 1973-74. The area is expanding, with an annual increase of about 10,000 Ha. Wheat is grown in the dry season and is still primarily a rainfed crop. Total production is about 315,000 T and the average yield is approximately 1.2 T/Ha. Wheat furnishes 10 percent of the total food grain in Nepal, with maize and rice contributing 25 and 60 percent respectively.

Distribution of the crop varies considerably, with 38% grown in the Hills and 62% in the Terai. Production in the Terai has increased steadily since 1965-66. The area planted to wheat in the Western Hills has remained fairly constant, with only a slight increase in production, but because of the increased area in the Terai the production of the Western Hills as a percent of total has declined from nearly 60 percent in 1965-66 to less than 40 percent in 1972-73. The Eastern Hills contributes nearly 20% of the national wheat production, with increased productivity paralleling national trends.

2. Current Status

Yields of wheat have tended to decline from about 1.157 T/Ha. in 1966-69 to 1.000 T/Ha. in 1970-1973. This may be primarily caused by the low rainfall of the last 2 years. Also, part of the decline may be due to the rapid expansion into marginal areas of production in the Terai.

3. Attention to improvement

The new Mexican wheats introduced in the mid-1960's found wide acceptance. Spread of these varieties has occurred principally in the Terai where they will constitute about 90% of the crop in 1974-75. Wheat is a new crop in the Terai which to a large measure accounts for its rapid spread in this area. For Nepal as a whole it is estimated that 66% of the total wheat area will be planted to new varieties in 1974-75, with a good spread into the traditional wheat growing areas of the Western Hills.

The rapid spread of the new varieties and the potential for increasing production, as cropping patterns change and more irrigated land is available, has focused attention on wheat as an important cereal crop in Nepal. Improvement has been primarily by varietal instruction since no wheat research on a commodity basis was officially conducted on a country wide scale until four years ago (1969-70). Further improvement in varieties and technology will be largely dependent upon the development of a more aggressive research program.

The earlier introductions included Lerma Rojo 64 and Lerma 52. The selections released to farmers more recently are Kalyan Sona (S227) from India, RR21, a selection of Sonalika (S308) and S331 (Chota Lerma) which were selected in India from materials introduced from CIMMYT. The new introductions have a wide range of adaptation suitable in the Terai and also in the Hills up to 6000 ft. elevation.

Over 100 trials are now conducted under the coordinated program at fifteen centers throughout the Terai and in the Hills. The trials include initial evaluations of varieties identified in the International screening nursery, other new foreign introductions, selections made in Nepal, etc. Advanced variety trials include entries which have performed well in the Initial Evaluation Trials and have gone through the rust nurseries.

Trials from other countries and agencies include the screening nursery of 400-500 entries from CIMMYT, a yield nursery of 49 entries from CIMMYT, materials from the All India Coordinated Wheat Improvement Project and from the GB Pant Agricultural University at Pantnagar, and trials from the Arid Lands Agricultural Development Center in Lebanon (ALAD).

The selections which have had good trial performances, especially in their reaction to leaf rust, and which may be released following the 1974-75 season include -

NL (Nepal Line) 30 - a bold grained, early variety
NL 31 - a medium grained, late maturing, high yielding variety
HD 1982 - medium grained, with good luster (from India)

With the rapid spread of the new varieties it has been recognized that germplasm collections of local varieties should be made to ensure that genetic stocks for breeding research are not lost. In 1973-74 fifty-seven such collections were evaluated at Khumaltar for yield, maturity, plant type, grain type, and reaction to brown and black rust. A number of selections were identified with high yield potential, dwarf plant type, bold grain, and a few with resistance to rust. More extensive collections need to be made so that Nepalese varieties are adequately sampled, characterized and preserved for future wheat improvement.

Over the past four years experiments under rainfed and irrigated conditions have demonstrated that varieties which are superior under irrigated conditions also are superior under rainfed conditions. Evaluations in the future will eliminate the duplicate rainfed experiments in locations where irrigation is available.

B. Limiting Factors

Wheat production in the Terai is developing with a strong dependence by the farmers for seed supplied from outside agencies rather than from local sources. It is estimated that 1800 tons of seeds were supplied to farmers in 1974-75 and this amount will increase as reliable seed sources are identified and as the area continues to expand. The major factor in the seed supply in the Terai is the difficulty in storage during the monsoon season when high humidity and insects damage seed viability and quality. It is estimated that the AIC could meet only 50% of the demand in 1974, a situation that will prevail until improved seed processing and storage facilities are available.

Wheat is exposed to a number of diseases and the disease pattern varies from one area of the country to the other, as follows:

Western Hills - stem (black) rust, yellow rust, mildew, bunt
Eastern Hills - stem (black) rust, yellow rust, leaf rust, bunt
Kathmandu - stem rust, leaf (brown) rust, bunt
Western Terai - Brown rust and yellow rust
Eastern Terai - Brown rust, yellow rust and alternaria (as far west as Bhairawa)

Fortunately the recently introduced varieties have performed fairly well when exposed to the rather wide range of disease complexes existing in Nepal. Kalyan Sona (S227) was popular with farmers until two years ago when the variety became susceptible to local races of yellow rust. Less than 10% of the area is now planted to this variety. Resistance to leaf (brown) rust is lacking in the new varieties and may be a factor in reducing their yields and acceptance.

C. Strengthening the Coordinated Wheat Development Program

1. Program Components

Wheat has been recognized as a crop of sufficient national importance to justify a "Coordinated Development Program" status and a coordinator was designed in 1972. The multidisciplinary approach to crop improvement is especially vital for wheat because the prevalence of diseases and the rapidity with which some of these disease organisms change require a well coordinated team effort of breeders, pathologists, agronomists, entomologists and others to make the best use of limited staff and resources.

The two-way tables prepared for rice and maize to relate projects and staff of the several disciplines are equally adaptable for wheat. Although the general projects and disciplines involved are similar, the outlines or plans for the projects and experiments to achieve wheat program objectives will be determined by the priorities of the constraints to production which must be overcome. The development of an effective wheat improvement program is simplified by the wide range of adaptation to seasonal conditions and elevations which exists within the available germplasm. And yet it is complex because of the wide range of diseases to which the crop is exposed and the instability of these disease organisms. The combining of multiple resistance in a few high yielding, widely adapted varieties would appear to be a priority program objective. The variability of the disease organisms will require the program to maintain a high degree of flexibility and dynamism to detect changes in disease organisms and to respond quickly with new germplasm to combat the new races. Disease screening experiments should be spread throughout the country, with the necessary sets of differential host varieties to permit prompt identification of new virulent forms. The field trials should be supported by pathological laboratory research to develop basic understandings of the epidemiologies and other characteristics of the various diseases.

The breeding material being developed should have as broad a base of resistance as it is possible to provide through appropriate multiple crosses. The segregating progenies should be grown under disease stress conditions so the best possible combinations for resistance can be identified.

If the brown rust organism changes every two to three years, as reported in Nepal, the breeding effort should be identifying new resistant varietal selections at essentially the same rate. These selections should move into the seed multiplication programs promptly so they can replace old varieties in the farmers' fields as these become susceptible. This will be fairly simple to accomplish in the Terai where farmers are accustomed to purchasing their seed.

The problem of seed distribution in the Hills is immensely more difficult and the research team should develop other means of keeping diseases in check so that varieties would not need replacement at such a rapid rate. The possibility of developing multilinear resistance should be explored for the Hill Zones.

The variations in maturity of new varieties will require agronomic studies on dates of sowing, rotations with other crops, timing of fertilization, and so on, in order to determine the package of practices necessary to attain maximum benefit and maximum production per year per unit area with the minimum of cash inputs. This is especially critical for the Hills.

The potentials of Triticales are just now being explored in Nepal. Their possibilities for food grain production deserve attention. This crop also might be grown for green feed as well as for food grain. Since the crop can fit into cropping patterns much the same as wheat, its merits could be quickly exploited.

2. Manpower

The positions for the wheat program are now limited to 5 people, all to be located at Khumaltar. Of these, one is on assignment on another crop at Biratnagar, one is on study leave, and one is at Janakpur. No pathologist is assigned to wheat diseases.

In structuring a coordinated staff representing the different disciplines, priority should be given to the breeder-pathologist team. Several aspects of wheat technology can be transplanted from countries such as India so that a full staff for a multidisciplinary team can be developed after some of the earlier priorities are satisfied.

A full complement of staff at a main wheat station would be similar in composition to the rice or maize staff at the main station.

Research stations in Nepal should be developed insofar as possible as multipurpose stations, so the full wheat research staff complement might give attention also to other crops but have primary responsibility for wheat during the wheat season.

At present a substantial amount of the time of the wheat coordinator is involved in seed production and distribution. For the immediate future this role is important. But the development of staff should very early include someone responsible for varietal maintenance and seed multiplication.

The following is a minimum staff which could effectively operate a coordinated program.

Discipline	Class		
	I	II	III
Coordinator	1	-	-
Breeding	-	1	4
Pathology	-	1	2
Seed Production	-	1	2
Later additions			
Entomology		1	2
Agronomy		1	2
Communications and Training		1	3
Total - 22	1	6	15

Production agronomists assigned to the regional centers, under the staffing projected for the rice program, also could handle maize and wheat so they would have a multipurpose role in handling research trials, on farm trials, seed production, and training.

3. <u>Facilities</u>

No research station has been identified as a principal station for wheat. This differs from rice and maize which have such centers at Parwanipur and Rampur respectively, and which have staff under the Coordinator specifically for this crop.

Considering the growing importance of wheat in Nepal, a specific center for the crop would seem to be justified. In view of the lack of irrigation facilities in Khumaltar and the predominance of the crop in the Terai, the principal wheat center might also be established at Rampur.

High priority should be given to the development of varieties resistant to the various rusts and other diseases. Screening centers should be developed where the problem is endemic and where it is possible to create artificial epidemics of the respective diseases.

The identification of a center where a reliable crop could be produced in the summer, so that two generations of breeding material could be obtained in one year, would greatly accelerate the program.

The station that is identified as the wheat center will need facilities for experiment station operations, seed processing and storage, and for laboratories and offices. The facilities at the regional stations also should be upgraded to ensure reliable experiments for wheat improvement.

4. Application of Improved Technology

Farmer field trials should be considered primarily an extension tool but also should serve to identify new or localized problems. The research personnel attached to the regional centers, together with the subject matter specialists in the regions, will facilitate problem detection such as the breakdown of a wheat variety to a new strain of rust, the appearance of nutrient deficiencies, the occurrence of insect pests not generally observed--the types of feedback that enable the research team to shift priorities or emphasis.

The primary objectives of farmer field trials are to a) determine varietal acceptance by farmers and b) accelerate spread and use of new varieties. This is similar to rice since both are self-pollinated crops. To serve both these objectives will require widespread distribution, through the extension system, of small quantities of seed of one or two new varieties which the farmer can compare with his own variety. The development of complete packages of new technology to improve yields may require other types of demonstrations which also should be conducted on a widespread basis.

The subject matter specialist posted at the regional headquarters would a) assist staff at regional research centers to conduct trials, b) work with ADO's, JT's and JTA's in the extension program, c) help organize training programs for extension and field days for farmers, and d) assist with seed production in the region. The subject matter specialists, trained as general production agronomists, also would handle maize or other crops during the monsoon season.

In the Terai the practice of farmers to purchase their wheat seed, which has been partially dictated by the loss of viability during the monsoon season, is an advantage in upgrading varietal quality. The AIC can develop a good commercial operation, with good quality seed of new varieties produced, stored and distributed for sale to farmers. The production operation would be sizable, with the wheat growing area in the Terai approaching 200,000 ha. and the seed demand approximately 20,000 T annually. Seed quantities moving in commercial channels would be sufficiently large to encourage also private seed producers in the Terai.

The pattern in the Hills is quite different and farmers and villages should be encouraged to retain their own seed stocks of new varieties. The difficulties of transport of seed and the lesser problem of loss of viability are factors in the Hills that would affect seed handling.

5. Relationships with CIMMYT

The international spread of wheat production technology demonstrates the contribution which outside agencies can make to a country program. Varietal introductions, and assistance from CIMMYT in making crosses which will provide future varietal improvements, will continue to be valuable contributions to Nepal's wheat improvement program. However, Nepal must develop its own wheat improvement program in order to produce varieties and technology more specifically suited to the highly variable agroclimatic areas and cropping systems of the country.

CIMMYT is assisting in the development of a strong viable national research program in furnishing materials and training, including the training provided for the wheat Coordinator at CIMMYT. This type of assistance is expected to continue, and the posting of CIMMYT staff to Nepal to help with breeding and production agronomy projects will be of special benefit over the next few years as the Nepalese wheat team is formed.

The Coordinated Wheat Development Program should be the avenue through which external donor agency support would be channeled. The close linkage of the program with the four development regions provides channels whereby improved wheat production technology can be spread rapidly throughout the country. The proposed Small Area Package Program would also serve for new technologies from research programs to be quickly utilized in agricultural development.

VIII. THE COORDINATED POTATO DEVELOPMENT PROGRAM

A. Background

1. Economic importance

The potato is a popular food throughout Nepal, and is grown in the Mountains, Hills, and Terai. Demand exists for a much higher per capita consumption than prevails in Nepal today. Perhaps due to the increased attention now being focused on the improvement of Hill agriculture, the potato has recently been elevated to the status of an important food crop, and a national coordinated potato development program was recently launched.

Accurate statistics are difficult to obtain, but it is estimated that 20% of the Hill population depends on the potato as a primary calorie source. This dependency increases as the upper limits of agriculture are approached in the mountains, where the potato is the basic food. In the Terai and Lower Hills the potato is still considered only an important vegetable.

Nepal produces approximately 290,000 tons of potatoes annually on 52,000 hectares of land.* The estimated average yield of 5.6 tons per hectare is very low by international standards, and has changed little in the past decade. Total potato production has risen somewhat during this time, due primarily to an increase in area planted.

Since many of the Hill districts are food deficit and the potato is important and widely cultivated there, an intensive effort to increase potato production in the Hills could do much to improve food supplies. The potato is not only a high producer of calories, but has a significant amount of protein that is well-balanced for human nutrition. In production of protein per hectare the potato outranks all of the grain crops. It is time for the potato to contribute more of its potential to food production in Nepal, and provide a higher level of nutrition to the people of the Hills.

2. Attention to improvement

The Coordinated National Potato Development Program was established in 1972, but as yet no important impact on production has been made by improved technology or materials. A coordinator has been named and the structure of the program has been submitted for the next 5-year plan beginning in 1975.

In 1974 regional variety trials were conducted at 12 locations in the 4 agricultural development regions. Testing of late blight

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* FAO Production Yearbook 1972

resistant selections from Mexico is now in its third year, and one selection was multiplied for distribution to regional centers in 1974. The Indian variety Kufri Jyoti has been multiplied in the Eastern Region, and in 1974 the first releases of improved seed were made to farmers in the region. This project at the Joubari station, conducted in collaboration with personnel of the Indian Cooperation Mission, is an example of what needs to be done in seed improvement in Nepal.

Regional potato research is now being conducted at 15 horticultural research stations. The trials are small, have little of the germplasm necessary to provide answers to the pressing production problems of the regions, and too often the plantings are badly infected with virus. The seed materials needed to conduct these trials on an adequate level can be produced only at a basic seed farm especially located for that purpose. To date that farm has not been available. Khumaltar is not at the high elevation necessary to provide freedom from insect-transmitted viruses and the subsequent degeneration of varieties.

Studies on soil fertility requirements of potatoes are fragmentary and usually conducted on research stations rather than commercial farms. The tendency is to apply whatever compost or chemical fertilizer may be available, usually without reliable research data to support its use.

Little or no potato breeding has been attempted in Nepal. It is desirable that the breeding of new varieties be delayed until currently available varieties and various resistant materials have been adequately tested in Nepal. Research and extension inputs should be concentrated on potato development projects that promise more immediate impact, such as seed production, soil fertility, and storage technology. The introduction of additional materials that promise higher yields or resistance to pathogens should be encouraged, of course. Many of these materials are now available through the International Potato Center, in Lima, Peru, and through national potato programs in various parts of the world. Specific recommendations on these introductions will be made later in this report.

B. Limiting Factors

The climate, soil, and temperature in most of the Hills and the lower mountainous areas of Nepal are favorable to potato production. The main factors that depress potato yields are:

1. Poor seed quality.
2. Inefficient use of available fertilizer supplies.
3. Disease susceptibility of the common varieties.
4. Inadequate storage facilities and procedures.

The general restraints imposed by the difficulty of access and transportation in the Hills are recognized.

Furthermore, as each of the four specific factors is examined and solutions are proposed, the limited resources of the hill farmer must be kept in mind. If research is to provide useful answers to potato production problems it must relate to the conditions and restraints faced by the farmer. Sophisticated and expensive technology is too often of academic interest only.

Improved seed production programs should follow as closely as possible the established commercial channels through which seed now flows. Fertilizer recommendations must take into account increasing scarcity and high cost of chemical fertilizer, as well as the difficulty of moving it to isolated potato fields in the Hills. Disease control must rely on resistance rather than unavailable fungicides, and on seed and cultural practices that can reduce damage without costly new inputs. Simple and practical storages that are within the economic reach of the hill potato farmer should be devised, rather than sophisticated and expensive cold storage. Such low-cost technologies are not easy to develop, but they are basic to improvement of potato production in the Hills.

1. Potato Seed

Today the Nepalese potato farmer is planting whatever seed is available, usually with little knowledge of good seed practice. Seed stocks are commonly totally infected with virus diseases that reduce yields as much as 80%. Though certain districts and panchayats have a reputation for being superior seed sources, this belief is largely traditional and only partly true, due to the higher elevation and more favorable environment of the seed production area.

Seed Size: Though seed selection practiced by farmers may vary somewhat from one district or region to another, there is a general tendency to save the smaller tubers for seed, and to eat or sell the larger ones. With no concern for the viruses that cause degeneration of seed quality, this "negative selection" will accelerate the increase in infection of seed stocks.

For purely agronomic reasons, and independent of virus content, seed tubers should be at least 35 mm. in diameter and preferably 45-50 mm. In the 1974 plantings at the Khumaltar station, a dramatic demonstration of the importance of seed size emerged from an experiment with the variety "Red Round," planted for the purpose of selecting superior clones for future propagation. The planting was begun using the largest seed available, and then with gradually decreased seed size until the smallest seed, of about 10 mm. in diameter, was planted at the end. The planting date, fertilizer application, and cultural practices were identical. The plants from the largest seed were tall and vigorous. The plants from smaller seed pieces became progressively less and less thrifty. The final group of plants, from the smallest seed, were rachitic, tiny and with little yield potential. Farmers may save or ask for tiny tubers to use as seed, believing that such small seed will go further in planting a field. It is uneconomic to do so, and the poor plants that result make further inputs unprofitable.

Seed Quality: Nepal has the environment and the farmer capability to produce excellent potato seed. The high elevations where potatoes are grown, the eagerness of the potato farmers to learn, and the recent establishment of the Coordinated National Potato Development Program, provide the essential components for a successful national potato seed multiplication program. Such a seed program, with modest additional inputs, could double potato production in Nepal on the same acreage planted today.

In the organization of this seed multiplication program, care must be taken to avoid farms or areas where brown rot, caused by *Pseudomonas solanacearum*, or wart, caused by *Synchytrium endobioticum*, are present. Other factors to consider include:

a) Seed with low virus content will give yields double or more than the seed now being widely used.

b) A well organized seed production system will facilitate the introduction of new varieties.

c) The higher yield potential of good seed will make more feasible and economic the additional modest inputs of fertilizer, special cultural practices, and storage.

2. Fertilizers

Chemical fertilizers are now very expensive and scarce in Nepal. Though experiments may show that high levels of fertilizer application give substantial increases in yield, such data will have little impact on fertilizer practices in the more remote regions where potatoes are grown in the country. The efficiency and production impact of the limited fertilizer resources available to the Nepalese potato farmer in the Hills can be increased by modified application practices.

Compost: Most farmers have some compost available, usually stable manure plus other leafy or organic matter. As a general rule, compost is applied to the potato field in advance of planting and incorporated into the soil. However, if it is applied at or near the time of planting it is probably more efficient to place the compost under or near the seed tuber, rather than broadcasting it. If the potatoes are planted in rows the compost should be placed in the bottom of the furrow and covered with a thin layer of soil. The seed tuber should then be placed in the furrow and covered with soil. If planting is done by digging holes a handful of the compost should be placed in the bottom of each hole, covered lightly with soil, and the seed tuber then planted and covered with soil. A good compost will supply nitrogen slowly, over a period of several months, and also will improve soil texture.

Chemical Fertilizer: The application of nitrogen alone, in addition to compost, is of questionable value. But P_2O_5 should give an important boost to potato yields if applied with compost and the residual P_2O_5, which usually lasts for several months, will help to improve the yield of subsequent crops such as paddy, maize, or wheat.

Even though no research data are available in Nepal to prove or disprove the hypothesis, it is suggested that any input of chemical fertilizer, limited though it may be, will have maximum impact on production if phosphate, plus available compost, is applied to the potato planting, with any available chemical nitrogen applied to the subsequent grain crop to work with the residual phosphate.

3. Diseases and Insects

The most important disease of potatoes in Nepal is late blight, caused by Phytophthora infestans. With fungicides increasingly scarce and expensive, and with the difficulty in transporting such chemicals to Hill farms, the susceptible varieties now grown are annually at the mercy of the fungus whenever the weather is favorable for disease development. Fortunately several resistant varieties are available. One of these, a Mexican selection 58-ES-5, has been subjected to field attack in Nepal for three seasons and has yet to show a lesion of late blight. The Indian variety Kufri Joti also has shown valuable resistance to this disease. The wide use of resistant varieties is the only practical way of reducing the losses caused by this pathogen. The importation of blight-resistant selections should be expanded, both from India and from the International Potato Center. There are at least 20 selections from the Mexican regional program of the IPC that merit a trial in Nepal.

Brown rot, caused by Pseudomonas solanacearum, is found occasionally in Nepal at elevations up to 7,000 feet. This disease is of particular concern to seed growers, and its presence at such locations as Daman has ruled out using the station there for seed multiplication. Though control of brown rot eventually must be achieved through tolerant varieties, losses can be minimized by using healthy seed and avoiding the cutting of seed. In areas where serious losses have occurred potato cultivation is risky and generally has been discontinued. To date, however, brown rot has not caused widespread damage in Nepal.

No commercial varieties resistant to Pseudomonas solanacearum are as yet available. However, some promising selections have been developed through a cooperative project between the International Potato Center and the University of Wisconsin. Some of these materials have been given a preliminary trial in Nepal but the results reported are variable and perhaps unreliable. This cooperative project should be continued and expanded, with the long-term objective of incorporating this resistance into an agronomically acceptable variety in Nepal through a cooperative breeding and selection program with the International Potato Center.

The wart disease, caused by Synchytrium endobioticum, is reported from several widely separated districts in Nepal. It is of great concern to a seed program since it can easily be transported with seed tubers to new areas. No effective steps have yet been taken to limit its spread in Nepal so it is probable that the wart pathogen is more widely distributed than currently reported. Fortunately, most European potato varieties are immune to potato wart. Should this disease become more widespread and serious, Nepal would be obliged to limit potato cultivation to immune varieties, as is done in many countries elsewhere in the world.

The tuber-moth (Phthorimaea operculella) is a menace to the potato particularly at harvest and in storage. Though not a very damaging pest at higher altitudes, it becomes increasingly serious at lower elevations. So far there is no known resistance to the insect, but it can be controlled by chemicals and at least partially by such cultural practices as covering the developing tubers a little more deeply in the soil. It may be necessary to use insecticides at critical periods during storage, especially at lower elevations where transport permits access to insecticides.

4. Storage

Potatoes are harvested in the hills of Nepal at several seasons in the year, and in different climates. Thus, a full treatment of potato storage procedures and problems would be complex and, in many cases, suggestions would be unsupported by the necessary research and experience. Nevertheless, there are certain principles to guide economic and simple storage systems within the reach of the small subsistence farmer.

Consumption Potatoes: The storage of consumption (table-stock) potatoes requires that they be kept in darkness to prevent greening, at a cool temperature to impede sprouting, and in an atmosphere sufficiently humid to minimize shrinkage and yet not moisten the tubers. Obviously the technology to meet these requirements is exacting, and in many places encourages dependence on refrigerated cold storage. However, such cold storage is not available to most farmers in Nepal and other, more practical procedures must be devised.

Potato farmers now store potatoes a) in pits (or clamps) in the ground or b) in darkened rooms, usually on the ground floor of the home. Both work reasonably well. Pit storage requires the placement of some straw or small branches and leaves at the bottom of the pit, filling it with potatoes, and then covering the potatoes with similar material before covering with soil. Such pit storages are simple and effective in the colder climates, and prevent losses from freezing.

Potatoes kept in the first floor of a dwelling often present more problems. To avoid their becoming too wet and more subject to decay a false floor should be constructed, using mud bricks or flat stones to support wooden planks about 5-6 inches off the dirt floor and spaced an inch or two apart. The planks might be covered with sacks to prevent crushing and bruising of the potatoes, and to prevent them from falling through the cracks. This will permit some ventilation in the potato pile, and lessen the danger from too much moisture.

Most housing and other buildings in the hills are constructed with thick walls of stone or of mud brick. These materials are excellent for insulation. Cool night temperatures can be utilized by opening doors or windows at night, and closing them in the daytime. Little or no light should be permitted to reach the tubers, which turn green if thus exposed.

If no dwelling or other structure is available to the potato grower an excellent storage can usually be constructed in the side of a hill, excavating a space with a flat floor and covering with a temporary or permanent roof and sides. A false floor and a chimney for ventilation can be easily installed.

Simple farm potato storages are as varied as the ingenuity of the farmer and the demands of the climate may permit. The basic purpose is to keep the tubers in the dark, cool, at a high humidity but not wet. If such storage is available, even temporarily, the potato farmer is freed from the necessity of selling his crop immediately at harvest time, often at much lower prices than if he were able to keep it a few weeks or even months.

The storage problem of consumption potatoes is also eased considerably by planting varieties that have a longer dormancy period before sprouting, i.e. the "deep sleepers." This is an inherited character now incorporated in many commercial varieties, and should be given some weight in making varietal recommendations.

The problem of potato storage becomes more acute in the warmer climates of the lower hills and the Terai. Occasionally potatoes can be profitably stored in refrigerated storages, but usually this depends upon wide fluctuations in the price of potatoes. For the Government of Nepal to regulate the flow of consumption potatoes to the people of the Terai, in the long run it would be most economical to construct storages in the hills near the areas of production, store them in cool but unrefrigerated storages for the few months necessary, and then market them as needed. The AIC undoubtedly would be the best agency to handle such an operation.

Seed Potatoes: The storage of seed potatoes is simpler than that of consumption potatoes because it is not necessary to keep the seed potatoes in the dark. As a matter of fact, the greening of seed tubers by exposure to light has several advantages, a) the sprouts remain shorter, thicker, and more vigorous, and b) the green tuber is less susceptible to decay, both in storage and after planting in the ground. The greening of seed potatoes is widely practiced in the world, and should be incorporated in the potato production technology of Nepal.

Every potato farmer who produces his own seed should provide a space for greening the tubers he intends to plant. There are several methods of doing this, usually in boxes or on shelves, or the tubers can be spread out on the ground if sheltered from frost, rain and direct sun. The greening of potatoes permits much higher storage temperatures than are recommended for consumption potatoes. Thus, the use of light can replace the need for low temperatures. Seed potatoes can easily be kept for 5-6 months in moderately cool climates with no refrigeration, if exposure to light is properly regulated. The greening of seed potatoes requires no important new or expensive inputs and could do much to alleviate some of the seed losses now occurring.

The problem of providing seed for the Terai plantings is a difficult one. However, the most practical and economic solution is to keep such seed after harvest in the hills for 2 to 4 months in simple seed storages and then transport the seed to the Terai a few weeks before planting. The AIC could perhaps intervene in such a marketing operation, and keep valuable seed from being precipitously sold at low prices to a merchant, only to turn up a few months later at very high prices to the potato grower in the Terai.

C. Strengthening the Coordinated Potato Development Program

1. Program components and organization

Though many details of this recently initiated program must be worked out, the basic principles and structure have been developed. Proposals have been made for further development of the program under the five-year plan beginning in 1975. (See Appendix 1 and 2.)

Fundamentally, this is a seed multiplication project. This is a sound approach, since the research and extension phases of the total program can be based at the same locations where seed is being multiplied. Production technology can be developed, tested, and extended at all stages, with the adv tage that seed production will be undertaken where the research and extension are done.

The seed multiplication plan for each variety would be as follows:

		Planted[1]	Harvested[2]
1st year	Nuclear seed farm	(1000 clones)	3 T
2nd year	Regional centers	1 Ha.	12 T
3rd year	District farms	6 Ha.	72 T
4th year	Panchayats - Coops	36 Ha.	432 T
5th year	Farmers	200 Ha.	2,400 T

Note: Seed need not go to Districts, Panchayats, and farmers each year. They will be able to maintain their own seed for several years but new seed stocks must be clean and available as needed.

Assumption: A seed multiplication rate of 6:1, planting 2 T/Ha. and a yield of 12 T/Ha.

(1) Serologically Tested.

(2) For distribution to the following multiplication center, with own seed retained.

A Regional Potato Development Center is proposed for each of the 4 agricultural development regions. Jaubari is already established as a potato center for the Eastern region, and in 1974 produced over 5 tons of superior seed of the variety Kufri Jyoti for distribution and planting in the seed multiplication program. Though a second potato development center may be desirable at some later time, for the Eastern region, for the immediate future the Jaubari station is equipped and able to make an important contribution, and so is worthy of continued support.

In the Central Region, the Khumaltar Headquarters station, and its associated nuclear seed farm, can assume the responsibilities of a regional center as well. But a geographically better regional center such as Helambu or Jiri might be established closer to the major potato growing areas.

In the Western Region, no regional center has yet been selected, but perhaps could be chosen from such locations as Thak, or Lumle. The designation of this regional potato base should be made as soon as possible.

In the Far Western Region, likely candidates for a regional center are at Jumla or Baitadi.

The Regional Potato Development centers would serve for research, seed multiplication, and an extension and training base for the dissemination of improved seeds and technology into the potato growing districts. Each regional center should be under the direction of an assistant potato development officer, preferably a scientist trained in agronomy and/or plant pathology, to guide the research, seed production and training activities, with supporting specialists and technical staff.

District Seed Multiplication Farms should be established as rapidly as seed is available and local interest and response are favorable. These farms could be organized through cooperatives by the panchayat, or by individual farmers. The farm would provide seed for all local growers interested in better quality seed and in new varieties. The supervision would be provided by personnel at the JT and JTA level. It is calculated that during the next 5-year plan ten such technical assistants should be available in each region.

The foregoing structure of regional development centers and district seed farms will require several years to establish. In the meantime effective use should be made of existing horticultural centers, some of which may serve the program for seed multiplication and simple trials on a continuing basis.

2. Manpower

The personnel now available for the Coordinated Potato Development Program and the additional staff required by 1980 is as follows:

	Current	Additional Required
Khumaltar		
Chief Potato Development Officer	1	-
Potato Development Officer	1	-
Asst. Potato Development Officer	(1)*	1
Pathologist (Virologist)	-	1
Entomologist	-	1
Soils Specialist	-	1
Physiologist (Storage)	-	1
Training Officer	-	1
JT and JTA	2	8

* Position available but not yet filled.

	Current	Additional Required
Eastern Region (Jaubari)		
Assistant Potato Development Officer	-	1
Assistant Pathologist	-	1
Assistant Agronomist	-	1
JT or JTA	5	5
Central Region		
Assistant Potato Development Officer	-	1
Pathologist (or Agronomist)	-	1
JT and JTA	-	10
Western Region		
Assistant Potato Development Officer	-	1
Assistant Plant Pathologist	-	1
Assistant Agronomist	-	1
JT and JTA	-	10
Far Western Region		
Assistant Potato Development Officer	-	1
Assistant Plant Pathologist	-	1
Assistant Agronomist	-	1
JT and JTA	-	10

As can be seen, only a small portion of the personnel needed to staff a national potato development program are now available. A training program, utilizing the scholarships and facilities that might be offered through the International Potato Center or other international institutions, should be launched as early in 1975 as is feasible. Meanwhile, a search should be made for qualified personnel now in Nepal, or among returning B.Sc. or M.Sc. students. The nuclear seed program at Khumaltar, and its proposed satellite seed farm, and the production program in the Eastern Region could be launched in 1975 with existing personnel.

3. Direction and operation of the program

The Chief Potato Development Officer will serve as Coordinator/ Leader for the national program. In collaboration with the staff of the headquarters station and the regional centers, he should prepare a clearly defined research, seed production, and extension program to be implemented on a national basis. Although over-all program leadership would be the responsibility of the Coordinator, where the work is conducted at a regional center that is under the administrative supervision of a Regional Agricultural Development Director, written agreements should be developed to ensure understandings of support and operational procedures. Such understandings and agreements also would be necessary at the level of the district multiplication stations or farms.

4. Collaboration of other agencies of HMG

The Agricultural Inputs Corporation and the Agricultural Development Bank should play an important role in the development of the potato seed production program, particularly as the volume increases at the district and local levels. Seed growers are prone to sell their product as soon after harvest as possible. If suitable on-farm storage can be provided, the financing of this storage and ultimate marketing of the seed to nearby districts or panchayats could alleviate some of the losses and profiteering that attend the marketing of a semi-perishable product. While government institutions are understandably reluctant to assume ownership of a bulky, semi-perishable product, a formula could be worked out whereby the risk would be minimal and yet the marketing of the potato seed would be smoothly accomplished.

5. Utilization of the Potato

The Hill people have many ways of preparing the potato for eating. Commonly it is boiled and eaten directly, with the skin removed. It is also boiled, and then mashed and used in the making of a gruel or bread, sometimes mixed with millet. In some regions the boiled and mashed potato tubers are dried, and the flour stored for future use. In the Namche Bazaar region potatoes are sliced and dried in the sun, and then stored. Through the personnel of the Food and Marketing Services Department, which has indicated an interest in the subject of potato utilization, it is recommended that a survey be made on the utilization of the potato by the farmers in the Hills and Mountains. If a simple, practical way can be found to dehydrate the potato, and store it for indefinite periods in the dry state, the transportation of the dried product will be vastly more feasible than carrying fresh tubers--as is now done--to the markets and villages where potatoes are needed for food.

6. Relationship with the International Potato Center

The International Potato Center (CIP) in Lima, Peru, is establishing a regional program in South Asia, and Nepal would be a logical partner in this program. CIP is interested in raising potato productivity through building strength in national programs.

This collaboration could be initiated as follows:

a. Technology:

1) Supplying CIP materials, including selections resistant to late blight and brown rot, for adaptation trials.

2) Sending new germplasm, particularly *andigenum* x *tuberosum* hybrids, for testing at high altitudes in Nepal.

3) Visits by senior CIP staff, as requested by HMG, to assist with production problems in varietal improvement, production practices, and storage.

4) Short-term visits by Nepali senior scientists and administrators to the International Potato Center to promote closer cooperation and understanding of CIP's capacity to provide technological help.

b. Training:

1) In Nepal - CIP assistance in conducting short courses for potato production specialists at the JT and JTA level.

2) In-service production training in Peru or Mexico for Nepalese technical staff.

3) Technical training of Nepalese personnel in Peru, Holland, India, or elsewhere on special subjects such as serology, physiology, etc.

4) Academic training opportunities for program leaders.

7. Potential Impact of the Coordinated Potato Development Program

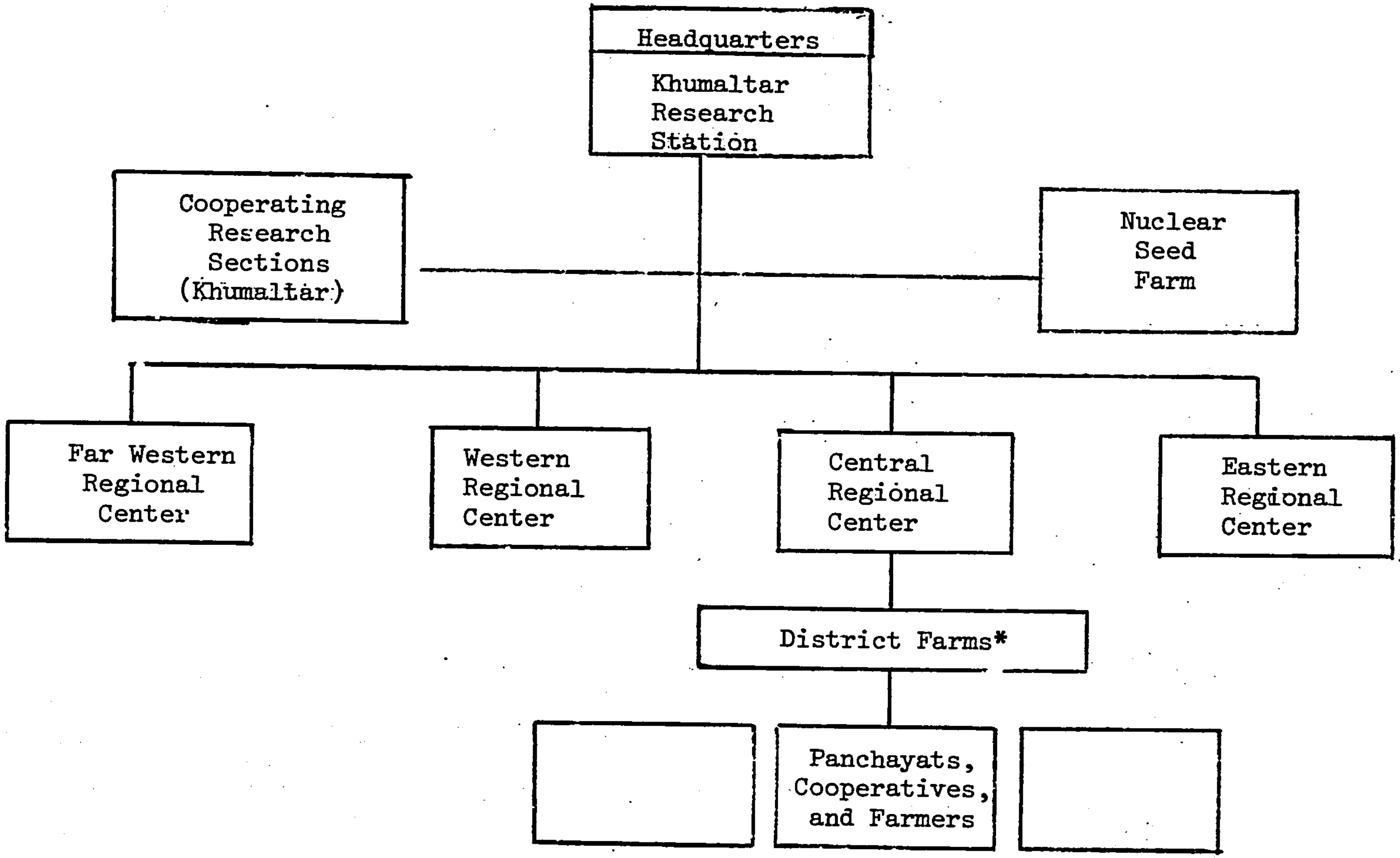
HMG is giving priority to the development of Hill agriculture and in view of the importance of the potato in the Hills and Mountains of Nepal, this crop should provide an excellent vehicle for early impact on food production in these regions.

The program for potato improvement that has been launched recently by HMG has the potential to double production wherever it is able to inject the improved seed technology, with few if any additional inputs. The concentration of technology at the source, i.e., at the central nuclear seed farm, will automatically have a beneficial effect on subsequent multiplications at regional and district levels. Given the excellent environment of the upper Hills and Mountain regions of Nepal--where the potato is so important--high quality seed can be maintained for several years, provided it is not mixed.

The potato plant has a slow rate of propagation, when compared with the grains. In order to maximize the impact of the high quality seed that will flow from the regional centers into the district plantings, it will be a primary responsibility of the regional station personnel to introduce the seed into panchayats or cooperatives through leading growers, who then in turn can be seed multipliers. The identification and organization of these growers should be the responsibility of the regional station staff, assisted by the local JT's and JTA's.

At the district and panchayat levels in the remote higher Hills and Mountain regions, seed tends to remain in small agricultural systems. Its very bulk prevents its transportation over long distances. Thus, if a quantity of improved seed is provided to a given locality, it should soon make its way into local fields and it would not be necessary to introduce improved seed each year into the same panchayat or cooperative. Broader impact will come if improved seed is provided successively to those villages where the local organization and interest favor its multiplication. And the national impact will increase each year as new districts and local growers produce their own improved seed.

Proposed Organization for the Coordinated Potato Development Program



* Each region would have several District Farms which, in turn, would each serve a number of panchayats, cooperatives, and farms within their respective Districts.

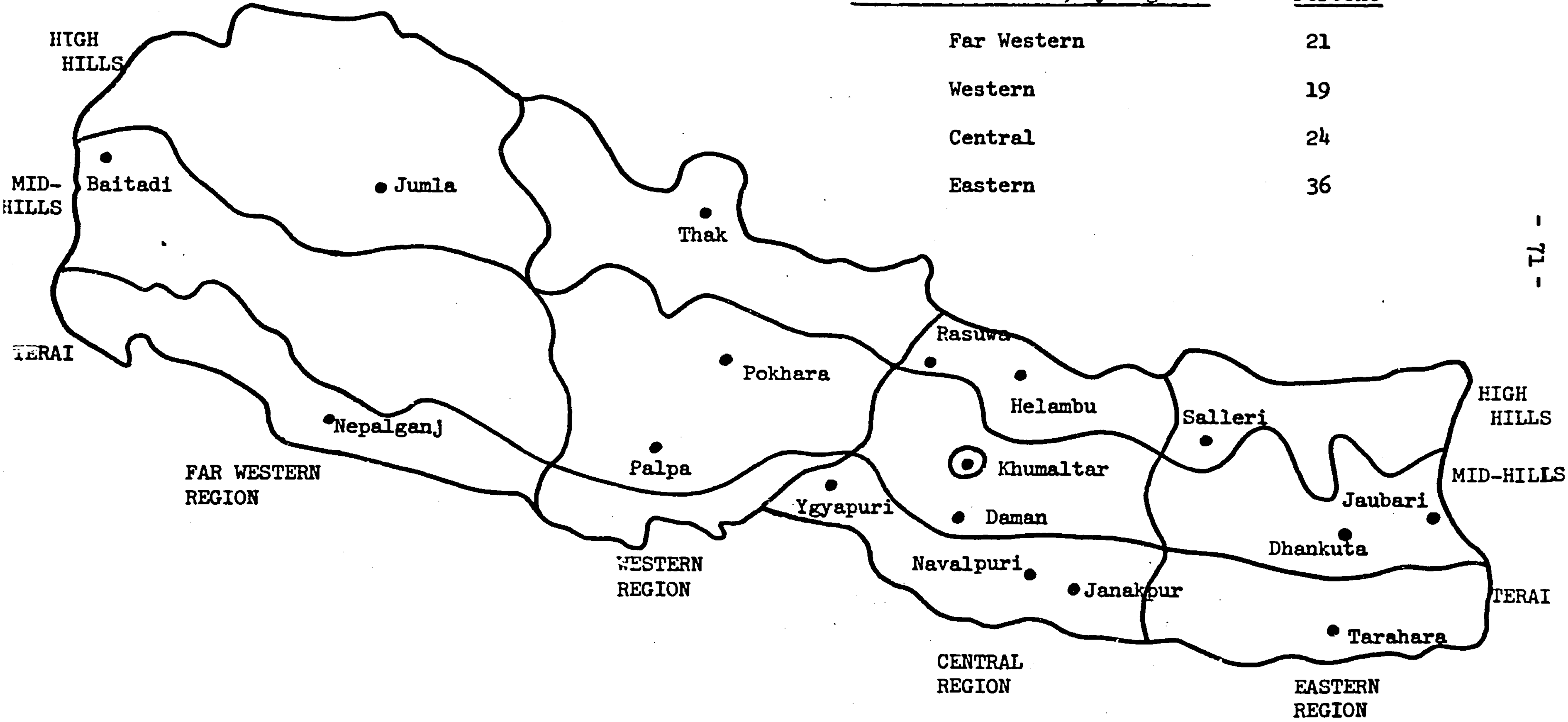
Appendix 1

Locations where potato research and development activities are under way.

• AGR.-HORTICULTURE STATIONS

⊙ NATIONAL CENTER FOR THE COORDINATED NATIONAL POTATO DEVELOPMENT PROGRAM

Potato Production, by Regions:	Percent
Far Western	21
Western	19
Central	24
Eastern	36



IX. A NATIONAL PASTURE AND FODDER DEVELOPMENT PROGRAM

A. Background

1. Economic importance

Animals are essential in farming in Nepal, providing a main source of protein for human consumption, milk or ghee, and dung for manure and fuel. Oxen are the source of draught, providing transportation in small towns and rural areas, and yaks, horses and sheep serve as pack animals across the hills and valleys. Goats are an important source of meat. Without livestock, agriculture in the Hills and Mountains--also presently in the Terai--could not exist and the production of human food would be sharply curtailed. Without pastures and fodders livestock could not exist and agriculture would not be sustained at the present level of output, let alone increased.

To set a monetary value on pasture and fodder crops would be difficult and any derived figure would not be meaningful. If one used the estimates 1969-70 figures of 9.72 millions of cattle and buffalo in Nepal[1/] and assumed a daily need for 12.5 kg. of dry matter per head, the yearly total consumption approximates 45 million metric tons. Local hay is frequently sold at one rupee per kilogram. Thus, if only hay were fed, a rough estimate could be calculated. This excludes concentrate feeds, green roughage from fodder trees and all feedstuffs for sheep, goats, pigs and poultry.

Gross development product (GDP) is measured in terms of animal output and not feed input. The livestock sector contributes about 15% of the GDP and figures are available for milk and milk products, meat and other miscellaneous animal by-products. Despite the increase in livestock numbers, about 6.0% from 1965-66 to 1969-70, Nepal is a net importer of live animals for slaughter, mainly buffalo (1).

Livestock holdings, total cattle and buffalo, average about 5.8 per household. Greater numbers per household are found in the Terai than in the Hills, being about 6.19 and 4.44, respectively. Landholdings in the Hills, however, are lower than in the Terai, approximately 0.5 and 2.6 hectares, respectively. Thus, livestock population pressures are more severe in the Hills, placing serious constraints on agricultural output in this region.

Herbage output of the national grasslands is exceptionally low since the area is grazed the year round, with no time for regeneration of additional growth, and no accumulation of nutrient reserves in the

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1/ Livestock numbers in millions estimated for 1969-70: Cows - 3.20, oxen - 3.03, female buffalo - 2.98, male buffalo - 0.51, sheep - 2.11, goats - 2.25, pigs - 3.20. Agric. Stat. of Nepal H.M.G. Min. Food and Agr., Econ. Analysis Planning Div. 1972.

roots and crowns. Thus, assessment of dry matter yields could only be made indirectly, by calculations from stocking rates. Without control of animal numbers such an estimation is impossible. An alternative method is by enclosure of an area, allowing the herbage to accumulate for subsequent cutting and weighing. Natural grasses in the Livestock Section of the Khumaltar Experiment Station, when handled in this manner, produce 5.0 tons of green material (8). Two other trials at Gatlang showed green yields of 9.4 and 39.1 metric tons, respectively, but the latter was reportedly largely composed of weeds not usually accepted by livestock (9). Without dry matter percentages it is difficult to estimate production of total digestible nutrients. Approximately 1.0 metric ton/hectare of dry herbage was harvested at Ranipauwa from a natural pasture which was protected from grazing (5). From personal observations of many grasslands in Nepal, and from discussions with Livestock Officers, it is estimated that most grazing lands would produce no more than 0.5 metric tons per hectare annually.

2. Current status

Feedstuffs supplied by pastures, forests, wasteland grazing, crop residues and fodder trees are always in short supply. Natural grazing lands exist in the Hills and alpine areas but the sward conditions are poor. Often the grasslands are overrun with weeds and brush, or serious soil erosion due to overstocking and overgrazing has scarred the hillsides with gullies. Pastures are commonly used by farmers of a particular village, even though grazing lands have now been nationalized. There is no restriction on the kinds and numbers of animals or on grazing time. During the rainy season the grasslands become green but no flush of excess herbage occurs because of the excessive stocking rate. Herbage quality is slightly improved, i.e. somewhat higher in crude protein and lower in crude fiber content; but still insufficient to satisfy the needs of the grazing animals. With the onset of the dry season plant growth is first reduced and then ceases as the grasslands become brown.

Burning of grasslands is frequently practiced during the dry season in an effort to stimulate renewed herbage growth. This is futile since so little plant residue is present. In some instances fresh growth is regenerated but at the expense of the meager root reserves. It is a devastating practice in the long run and only contributes to further deterioration of the grazing lands. Furthermore, fires frequently escape into the forests and cause further damage to an already limited vegetative cover. In some countries controlled burning is beneficial, but only where excessive herbage has accumulated. This practice is of no value for the grasslands of Nepal and should be controlled by government regulation.

It is estimated that about 2.0 million hectares occupy permanent meadows and pastures, about 14.2% of the total land area (4). In the Hills, however, the pastures are generally nothing more than loitering places for the animals from mid-morning to late afternoon (11).

In the evening the livestock are taken to the sheds or corrals and fed crop residues, straw of rice, wheat, barley, finger millet, maize stalks, etc. During the dry season fodder trees from the forests are lopped as feedstuff.

Grazing of forests is practiced in the central highlands, at altitudes of 1,000 to 3,000 meters. Here again overstocking and excessive grazing have caused severe deterioration of the growth of shrubs and trees so that ground cover is minimal or non-existent. Along many of the forested valley slopes only a few scrubby trees remain and soil erosion is severe.

Alpine pastures, above 3,000 meters elevation, are in less serious condition because of the transhumance system of yak and sheep grazing, i.e. upward movement during the warmer season and then downward grazing during the colder season (10, 11). Even here, however, the grasslands are becoming less productive each year because of the closing of the Tibetan border to the semi-nomadic herds.

In addition to the crop residues used as supplemental feedstuffs, a limited quantity of hay is sometimes preserved, taken from natural grasses and weeds growing in wastelands. This material is usually of poor quality, low in crude protein (probably less than 3 to 5% on a dry matter basis), high in crude fiber (perhaps 35% or higher), extremely high in cell wall content, and very low in digestibility.

The residues of pulse crops, such as black gram (Phaseolus mungo), soybean (Glycine max) and cowpea (Vigna unguiculata) grown after paddy or along field bunds are collected as livestock feed, usually for milking animals and working bullocks. In some regions maize is deliberately seeded thickly, to be thinned and fed to livestock after the plants reach about one meter height. At a later stage of plant growth plants which are barren, or develop small ears, are selected for removal as animal feeds.

Fodder trees are an important source of supplemental feed during the dry season. They occur naturally in the forests and are considered as a source of communal herbage. Many species, however, are established by farmers along field boundaries and around house sites as private property. Farmers are well acquainted with fodder trees and recognize their value for livestock in general, those best suited for goats, and those of particular benefit to calves. This source of feed is becoming scarce in the forests. It is frequently reported that collection of one human porter-load (30-40 kg.) of such fodder now requires a full 8-hour day or longer as compared to 3 or 4 hours 10 years ago.

Milking animals, female buffalo and cows, are frequently stall fed and given roughage as well as some form of concentrate, such as bran from maize and rice, along with mustard cake, cooked pumpkin, pulse residues, and kitchen scraps.

3. Attention to improvement

There is no officially recognized pasture and fodder development program in Nepal but one Livestock Officer posted at the Khumaltar Agricultural Experiment Station has conducted a number of species introduction and evaluation trials in several sites from 4,500 to about 13,000 feet elevation. Additional trials have been carried out at the Lumle Agricultural Center (6), at the Jiri Livestock Development Farm (3), at several sites within the Trisuli Watershed Development Project (5), and at the Pokhara Livestock Development Farm. Some of these are reviewed in Appendix 2.

Improved grasses and legumes introduced into Nepal and grown at different experimental sites have given annual fresh weight yields ranging from 20,000 to 70,000 kg. per hectare (2, 3, 6, 9). Most of these trials received inputs such as land preparation and smoothing, chemical fertilizers and/or compost, inoculum for legumes, in some instances irrigation, hand weeding, and protection from grazing. Harvests were made on a seasonal basis and represent the potential fodder yields which could be obtained under cutting conditions. Under grazing production would be reduced. Without controlled grazing it is unlikely that the improved species would become established, nor would they persist.

Improved practices for the introduced species as mentioned above were beneficial in terms of increased herbage output but may not be economical. Little benefit was derived from improved practices applied to natural grasslands except for accumulation of herbage by protection from grazing.

Many fodder trees abound in the Hills of Nepal, as well as in the Terai. Some of these have been identified and tests made of their chemical composition. Suggestions for further trials are presented in Appendix 3.

B. Limiting Factors

The lack of restrictions on grazing is the principal factor in degradation of Nepal's natural pasture and fodder resources. Lands under cultivation are continually encroaching on the grasslands and moving up the hillsides, placing heavy pressure on grazing lands and forests. This leads to continuous deterioration and serious soil erosion. In many areas the soil is bare and badly gullied and should be set aside for reforestation, with grazing prohibited. Since most grasslands are communally grazed, with no restrictions on stocking rates, there is no personal--or village--incentive for improvement. Controlled grazing must be brought about, this must be given attention by upper echelons of HMG, and it must be recognized that without controlled grazing the improvement of natural grasslands and the introduction of improved species into them cannot be achieved.

The lack of an organized and officially sanctioned national research and development program is a second major deficiency in improvement of pasture and fodder production in Nepal. The research has been limited and fragmented. One Livestock Officer at Khumaltar has received training in pasture development and has been able to instruct a limited number of junior staff. His primary attention, however, is directed toward producing livestock feed on the experimental stations rather than an intensive pasture and fodder research program.

Livestock officers at the various sheep and cattle farms have shown an interest in pasture and fodder improvement and have provided assistance in the introduction and evaluation of new materials. However, their personnel, facilities and budgets are already heavily committed to other livestock development activities.

Few reports have been prepared of the studies that have been made, information is not readily available, and external aid agencies tend to repeat introductions and evaluations. However, sufficient information is available to show that 1) natural grasslands can be improved, 2) certain species can be introduced into natural grasslands, and 3) improved grasses and legumes can be used to increase the production of supplemental feeds. None of this can be accomplished without controlled grazing--regulated by government, with support of the village chief and appreciated and understood by the farmer.

C. Establishing a National Pasture and Fodder Development Program

1. General organization and operation

It is recognized that many plant species used for livestock feed are also essential for ground cover and soil conservation purposes. However, herbage from grasses, legumes and fodder trees used as livestock feed is of no commercial value until it is transformed into animal products or animal power. It is essential, therefore, that research and training for pasture and fodder development should be closely integrated with the livestock sector.

The National Pasture and Fodder Development Program should be established in a pattern similar to the National Coordinated programs for rice, maize, wheat and potatoes. A Coordinator should be appointed to furnish national leadership and Regional Pasture and Fodder Officers should be assigned to carry out the activities in the four Agricultural Development Regions.

The National Pasture and Fodder Development Program headquarters should be in Khumaltar where there can be maximum integration with other research sections and programs. The Coordinator must have sufficient budget--and control of the budget--to make regular visitations to the regions so as to maintain close liaison with the staff and keep up-to-date with their problems. This will directly influence program planning and modifications as well as the reliability of interpretation of experiments. It will be necessary for the Coordinator and the Regional P and F Officers to work closely with the Regional Directors and keep them constantly informed as to program plans, projects, and results obtained.

The Regional Pasture and Fodder Officers should have some flexibility in development of projects, in consultation with the Coordinator, to assure that local problems are given attention.

It is highly advisable that the Regional P and F Officers meet with the Coordinator annually to review the program, discuss results and problems, and jointly plan further experiments. These seminars or workshops should be attended by other research staff of the Department and the Regional Agricultural Development Directors. They could be rotated among regions to allow familiarization of all participants with the research and developments underway.

2. Program components

National research projects should be developed for problems and with materials and treatments that may be common over the country. In addition, selected studies should be conducted at individual stations on problems of localized environments. Some of these can be conducted on the government livestock farms but studies should also be carried out on local farms with support and collaboration of the village chief. Some research will involve close collaboration of the various Sections in the Department of Agriculture, and in the case of fodder trees probably in cooperation with Forestry.

Several suggested projects are listed below, not necessarily in the order of priority, with expanded discussions in the Appendices, as indicated:

	Appendix
Introduction and Evaluation Trials	1
Management and Improvement of Natural Grasslands	2
Investigations on Fodder Trees	3
Grass - legume Mixtures	4
Supplemental Feedstuffs	5
Seed Production, Multiplication and Distribution	6
Integrating Fodder Crops with Existing Cropping Patterns	7
Nutritive Value and Feeding Trials	8
Economic Studies of Pasture and Fodder Practices and Improvements	9

3. Manpower

The proposed National Pasture and Fodder Development Program has no present base or depth of manpower resource from which to select staff. One Livestock Officer at Khumaltar has training in forages and possesses valuable experience with pastures and fodders in Nepal. Several other Livestock Officers at outlying Livestock Farms have a keen interest in improved pasture and fodder species. Thus, a potential exists within the country for developing at least a minimal staff. It is recommended that these people who have experience and interest in pasture and fodder crop improvement be given high priority when positions in the National Program are established. They would need additional training, which could be conducted within the country by the Livestock Officer (Pasture and Fodders) at Khumaltar, as well as through on-the-job experience at outlying Livestock Farms. All staff members would benefit, of course, from training outside of Nepal and this is recommended as an integral part of the program planning and development, recognizing that such periods of training must be adjusted so as not to seriously hamper ongoing research, development and on-farm testing.

During the developmental period of the Program attention should be given to on-the-job training of Junior Staff. Furthermore, regular and timely seminars and workshops should be scheduled at Khumaltar, as well as in the Regions. There should also be seminars and workshops for the Extension personnel. Such training sessions, seminars and workshops are vital to the functioning of a productive coordinated program and their cost of operation should be included and identified as a component of the overall budget.

4. Facilities

There are a number of locations where some studies are under way with forage and fodder plants, including the following:

a. Kathmandu Region (Central)

Khumaltar Livestock Development Division (4,300 ft.)

Jiri Development Farm (6,000 ft.)

Chitlang Sheep and Goat Farm (5,000 ft.)

Panchasaye Khola Sheep Farm (6,000 ft.)

Ransuwa Pasture Farm (12,300 ft.)

Rampur Development Farm (1,000 ft.)

b. Dhankuta Region (Eastern)

Tarahara Development Farm (500 ft.)

Solukhumbu Development Farm (13,000 ft.)

c. Pokhara Region (Western)

Pokhara Development Farm (2,700 ft.)

d. Surket Region (Far Western)

Karnali Sheep Farm (Tibrikot, 9,000 ft.)

One immediately notes the concentration of livestock farms in the Kathmandu Region, due largely to past and present budgeting, staffing, and the constraint of transportation and communications. It was frequently reported that maintaining staff in the more remote areas is a continuous problem because of isolation and lack of perquisites. Those who reside in these areas must be given permanent appointments and not serve for extended periods on a temporary basis, as is the situation in many instances. Furthermore, it may be necessary to provide additional benefits, commensurate with those available to some other personnel of HMG stationed in remote areas.

It would not seem desirable to propose where the Regional Pasture and Fodder Staff should be located since additional livestock farms are likely to be chosen. Some of those listed above are under the supervision of the Department of Agriculture at Kathmandu and some are under the jurisdiction of the Regional Directors. More efficient operation for the proposed program would probably occur where stations and farms are under the Deputy Director General of the Department for Livestock but cooperation with the staff of farms under the Regional Directors has been satisfactory and this close working relationship undoubtedly will continue.

5. Application of improved technology

Introduced, selected grasses and legumes and improved establishment and management practices should be tested initially in controlled experiments at the headquarters and regional stations. The most promising materials and practices should be moved promptly into field tests/observations on farms throughout Nepal as suggested in Appendix 10.

Leadership for the farm field trials should be provided by the Regional Pasture and Fodder Officers, working with the respective Regional Agricultural Development Officers. Subject Matter Specialists for pasture and fodder production should be appointed to each of the Regions, as well as at the headquarters station to give guidance to the outreach activities of farm field trials, demonstrations, and the extension of information and materials. These persons should have an appreciation of research and the development of new technology, as well as competence in extension methods. They would serve as the link between the research workers and the extension officers, would plan and assist with the field plantings, conduct workshops and meetings, and train the JT and JTA extension and development staff.

6. Production and handling of seed supplies and planting stocks

Availability of seeds of improved pasture and fodder species is one of the most serious constraints in the development of grasslands and pastures and in production of supplemental feeds in Nepal. It may also be found that certain cultivars or selections that are well suited are not commercially available, even outside of Nepal.

There has been great difficulty in obtaining seeds from outside of Nepal, even for testing and evaluation. This situation could be improved if a portion of the budget were allocated for seed import of those kinds, types, varieties and cultivars which have proved to be adapted and are commercially available. It is likely, however, that both the introduction of materials for testing and the increases of seed supplies will depend for some time on the efforts of the Coordinator and his staff. At some future date a post of Pasture and Fodder Seed Production Specialist should be added to the staff at Khumaltar.

For the near future seed production nursery plots of adapted and improved grasses and legumes, as well as fodder trees should be established at Khumaltar and at other Livestock Farms where trained personnel are located. Additional manpower would be needed, but JT's or JTA's could be trained to supervise the seed production, harvesting, cleaning and storage.

After improved types have been identified--and farmers have accepted their importance and recognize the need for controlled grazing--selected farmers could be given instruction regarding seed production, processing, and distribution in their localities. This, in fact, could now be done with Khumaltar white clover.

Some species are propagated vegetatively, e.g. Napier grass, and Kikuyu grass, and others can be propagated as such even though they produce seeds, e.g. Paspalum, ryegrass, cocksfoot, white clover, Desmodium. For these types nurseries could be established at Khumaltar and other Livestock Farms to produce materials for distribution to farmers.

7. Relations with other agencies

The proposed National Program provides for placement of staff to carry on research and development projects in the four regions. It is expected that these persons will work closely with the Regional Director and his personnel, whether they are posted to a station or farm under his jurisdiction or under the Department of Agriculture.

The Coordinator must maintain a close working relationship with the Regional Directors and with such agencies as ABB/N and AIC to keep them informed about the Pasture and Fodder Program.

External technical assistance support appears to be available for agricultural development in Nepal. While there has been relatively little attention given to pasture and fodder improvement to this time, the organization of a National Pasture and Fodder Development Program should facilitate the orderly direction of external support to problems and to the strengthening of national capabilities in pasture and fodder management.

The support of external technical assistance agencies should be solicited for training of staff for the Program, particularly for the B.Sc. degree and advanced degree training which will be necessary outside of Nepal for the foreseeable future. Provision of one or more well-qualified pasture and fodder crop specialists, to assist with the organization and establishment of the National Program also would be desirable.

8. Summary

a. Because of the present low productivity of Nepal's natural grasslands, and despite the full utilization of crop residues, weeds, herbage from fodder trees, and other cellulosic plant products, there is still a need for additional livestock feedstuffs. Grazing lands have been severely abused by overstocking so that many areas have been denuded and are badly eroded.

b. There is a critical need for controlled grazing, which may require further government intervention and regulation. The animal population should be selectively reduced by establishment of cattle sanctuaries, mass castration of inferior bulls, and prohibition of service to inferior cows. The program of genetic livestock improvement should be accelerated, to maintain an adequate population of bullocks, pack animals and milking stock.

c. The introduction and evaluation of improved pasture and fodder grasses and legumes up to this time has been fragmented and data are difficult to obtain. There is sufficient technical information now available, however, to formulate and implement projects for pasture and fodder improvement and to initiate expanded, systematic on-farm testing and demonstrations.

d. Nepal is fortunate in having many fodder trees in the forests, but these have been severely abused by over-cutting. It is evident from the large number of fodder trees which have been planted on individual farms and given attention as personal property that farmers recognize their value and benefits as supplemental feed. A good beginning has been made in their identification, collection and evaluation but this effort must be intensified and strengthened.

e. A National Pasture and Fodder Development Program should be established within the Department of Agriculture, closely integrated with the Livestock Section and organized along the lines of the Coordinated National Development Programs for rice, maize, wheat, and potatoes.

f. Several suggested projects for pasture and fodder research and on-farm testing are discussed in the appendices.

g. Pasture and fodder production and improvement must begin with proper management of the natural grasslands. Production of livestock feeds can be more rapidly increased, however, by using the improved grass and legume species which have been identified and tested in Nepal. Seed supplies are scarce and production within the country will probably be necessary. This should be given priority attention.

h. The potential for rapid progress in pasture and fodder improvement and increased production exists within Nepal. Even though the present trained manpower in this field is limited, there is an air of eagerness to get moving among those who have experience in this field.

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INTRODUCTION AND EVALUATION TRIALS

Species of grasses and legumes for livestock feed have been introduced and evaluated alone and in mixed stands in a number of locations over the past 15-20 years. Unfortunately, the trials have been fragmented; progress reports have not been centrally compiled; in some instances (especially with outside aid agencies) if reports were made, they are missing or difficult to find; and data are inconclusive or insufficient for comparative deductions. However, there is sufficient information -- frequently to be gleaned by travelling to trial sites and talking with investigators -- on many introduced species, selections, and cultivars, to proceed with on-farm testing and more intensive studies on government farms. Additional introductions also should be made of new germplasm.

It would be advisable for someone familiar with pastures and fodders to compile and assess available information and prepare reports that would be more generally accessible.

1. Introductions of improved grass and legume species

The writer visited and examined introductions at the following government stations or farms:

a. Khumaltar (4300 ft. elevation) where white clover, Napier grass and oats were performing well. Many other species have been tested and some thrive for a period of time, but production declines drastically without proper inputs. This also occurs with Napier grass but with maintenance of rows, between row cultivation for soil aeration, and use of applied chemical fertilizer or stable manure herbage yields can be maintained. Some of the Pennisetum F_1 hybrids (P. typhoides x P. purpureum) excel the Napier grass and should be evaluated.

Apparently white clover (Trifolium repens) was introduced into the Kathmandu Valley at some unknown time, as a component of a lawn mixture. It has become naturalized in the valley where it flourishes and provides valuable livestock pasture and feed. It was found to be well nodulated at a number of locations and has evolved as a well adapted ecotype. It is recommended that this clover be recognized and given the name "Khumaltar White Clover".

b. Chitlang Sheep and Goat Farm (5000 ft.) where Khumaltar white clover thrived well along with cocksfoot (Dactylis glomerata), perennial ryegrass (Lolium perenne), Dallis grass (Paspalum dilatatum), oats (as a winter feed), maize for grain and supplemental feed, and fodder trees as supplemental feed. Despite these results some hillsides used for natural grazing lands on the farm were denuded due to overstocking. Fields of paspalum and cocksfoot which had been established vegetatively were being overgrazed. At this farm a system of seasonal pasture and fodder production, using these species and others such as Kikuyu grass could be developed and evaluated. It would require controlled grazing and use of phosphate (for the clover) and compost (for the grasses).

c. Panchasye Khola Sheep Farm (6000 ft.). With more rainfall than at Chitlang, Khumaltar white clover, perennial ryegrass, cocksfoot, and tall fescue (Festuca arundinacea) performed well. The white clover established well on sites where poisonous plants had been removed, but the seedlings were constantly overgrazed because of uncontrolled stocking. Here Japanese millet (Echinochloa frumentacea, a summer annual) provided excellent supplemental feed.

d. Jiri Livestock Farm (6000 ft.). Khumaltar white clover performed well along with ryegrass, Dallis grass and oats. Kikuyu grass (Pennisetum clandestinum) flourished, providing excellent ground cover. This grass should be more widely used as noted below.

e. Khimti substation (6100 ft.). Khumaltar white clover and the above grasses are well adapted, along with Kikuyu grass which was growing well in mixture with white clover.

A brush species, Eupatorium, was severe in this hillside area. It is recommended that Kikuyu grass be established by transplanting short pieces of stolons at 50 to 100 cm. intervals after cutting the Eupatorium. The area will need to be protected for a few weeks until the grass renews growth and begins to cover the ground. It should dominate the Eupatorium and once established can be oversown with white clover.

f. Ransuwa Pasture Development Farm at Langtang (12,300 ft.). Khumaltar white clover, perennial ryegrass and cocksfoot were well established and had survived three years of abusive grazing. Down the valley at Langtang Village the Livestock Officer (Pasture and Fodder Crops) from Khumaltar had established white clover by scratching the native sod and oversowing seeds, then using soil from Khumaltar as a source of inoculum. The area was protected from grazing, allowing the plants to flourish for later haymaking. At the time of the visit in late November, new seedlings of the clover had emerged from the volunteer seed crop. Down the hillside the white clover had also grown from seeds washed over the sod surface.

g. Thodung Cheese Farm (10,000 ft.). White clover sown in 1957 by the Swiss Aid Mission has survived. Other sowings were made later so that some intermixture has occurred. Nonetheless, there has been natural selection for a cold resistant type which was well nodulated. It is recommended that an area be protected and seeds collected of this ecotype, to be designated "Thodung White Clover". This should be tested in several locations and compared with the Khumaltar selection. Nodules from the "Thodung" clover should be collected and the Rhizobium strain multiplied, as it probably has evolved as a cold-tolerant type.

h. Syangboche Livestock Farm (13,000 ft.). Khumaltar white clover sown in May, 1974, had become established and plants were healthy, despite excessive grazing.

i. Pokhara Livestock Farm (2700 ft.). At this warmer site species such as Pennisetum pedicellatum, Cenchrus ciliaris, Bothrichloa pertusa, Dichanthum annulatum, Sorghum sudanense and velvet bean (Mucuna spp., syn. Stizolobium deeringianum) were performing well. These and others need to be more widely tested at the lower hill elevations. Here small seedlings of Leucaena leucocephala (syn. L. glauca, commonly called leadtree or Ipil-Ipil) were also growing. There is a dual-purpose fodder and firewood tree that needs further evaluation, as noted in Appendix 3.

j. Lumle Agriculture Centre (hillsites varying from about 5000 to 8000 fit.). A large number of grasses and legumes have been tested (6). Those which show promise include Setaria sphacelata, Paspalum notatum (Bahia grass), Eragrostis curvula (weeping lovegrass), Festuca rubra (creeping red fescue), and Desmodium intortum (Greenleaf Desmodium). Several of the species should be given on-farm testing (See: Appendix 10).

It is difficult to determine which additional species and selections should be introduced, but the following should be considered: Lotus corniculatus (birdsfoot trefoil), sericea lespedeza (Lespedeza cuneata), cold tolerant white clovers, milkvetch (Astragalus cicer), crownvetch (Coronilla varia), perennial ryegrass, and Agropyron species for the higher elevations; lucerne (especially the creeping rooted types) should be evaluated with proper inputs. Coastal and Coastcross Bermuda grasses (Cynodon dactylon), giant Cynodon (C. nlemfuensis), guinea grass (Panicum maximum), molasses grass (Melinis minutiflora), centro (Centrosema pubescens), stylos (Stylosanthes guyanesis and S. humilis, the latter being Townsville stylo), glycine (Glycine Wightii, syn. G. javanica), kudzu (Pueraria phaseoloides), calopo (Calopogonium mucunoides), phasey bean (Macroptilium lathyroides, syn. Phaseolus lathyroides), Siratro (M. atropurpureum, syn. P. atropurpureus), and Dolichos biflorus.

MANAGEMENT AND IMPROVEMENT OF NATURAL GRASSLANDS

Controlled grazing must be practiced before natural grasslands and grazed forest pastures can be improved. This will require support of the village chief. If he is convinced of the value of a reclamation scheme, on-farm tests could be carried out in the villages. Government laws to control grazing provide legal authority for restricted grazing. Enforcement would no doubt lie at the village level.

Grazing fees are levied on a per head basis by some panchayats, but generally on livestock from other villages. A grazing fee should be levied in exchange for a grazing permit. Fees could be fixed in accordance with the economic importance of the grazing animal and the grazing intensity or amount of destruction they cause. The collected fees should be used for improvement practices.

To convince the village chiefs and farmers of controlled grazing benefits it is recommended that an organized improvement scheme such as the following be used. A portion of the grazing land should be closed for one year to allow regeneration of plant growth and accumulation of root reserves. During this period care must be taken not to excessively graze the remaining portion. At the end of the season, after seed formation and shattering, the accumulated herbage could be cut and sold for stall feeding. The next year this area could be opened up for controlled grazing and another area closed for reclamation. Once the grasslands have been reclaimed they can be continuously or rotationally grazed, but both will require controlled stocking rates.

During the reclamation period the pasture and fodder agronomist could carry out trials of introducing improved species into the natural sward. It has already been demonstrated in some areas that Khumaltar white clover can be established by scratching the soil, oversowing seeds which are inoculated (or using soil from an area where clover has grown), and then protecting the area from overgrazing. Once established, the white clover will regenerate growth from stolons or from volunteer seeds, but controlled grazing must be imposed for it to produce optimal quantities of herbage. Application of phosphates may also be needed. In addition, demonstrations to show the value of growing supplemental feedstuffs should be located on villagers' farms.

It is recommended that the management and improvement of the natural grasslands be given high priority in the proposed pasture and fodder research program. The introduction and evaluation trials have already demonstrated the success and value of some species and no scheme for pasture improvement will succeed without controlled grazing.

INVESTIGATIONS ON FODDER TREES

Nepal is one of the few countries where fodder trees are planted and protected as individual property. A large number occur naturally in the forest and are utilized as livestock feed during the dry season. These are generally abused by over- and too-frequent cutting and many die each year. This reduces the total available feedstuff and increases the manpower needed to collect the herbage from more remote areas. Those planted by farmers are systematically lopped, but there is a tendency for severe cutting when feed becomes scarce.

It is recommended that investigation of fodder trees be given high priority and a program mounted to intensify their evaluation. Many have been identified and small nurseries established at Khumaltar and Lumle. Additional nurseries should be established for increase of seedling stocks, for distribution to farmers (at a nominal charge) and for further research.

Before launching new investigations the information already available in Nepal should be compiled and the literature surveyed for information regarding other species which could be introduced.

A systematic study should be made of those which occur in Nepal, noting their range of adaptation, growth cycle, time of seeding (if flowering occurs), method of propagation, etc. It should be possible to contract with farmers to utilize their trees for certain studies, such as production, intensity of lopping, chemical composition, etc.

A dual-purpose tree is urgently needed, i.e., one which can be used as fodder and as firewood. Some are already used as such, but more rapidly growing species are needed. Leucaena leucocephala is a subtropical species highly prized in some countries, e.g., Philippines. It has already been introduced into Nepal, at the Pokhara Livestock Farm and at Khumaltar. Seeds should be collected as rapidly as possible for immediate increase and release of seedlings to farmers, as well as for intensified research. The seeds have hard coats which can be softened by bringing water to boil, immersing seeds within a cloth bag into the hot water for 3 to 5 seconds, and removing and washing them several times in cold water. It would be advisable to plant the seeds in soil in plastic bags about 6 inches in diameter and 12 inches in height, removing the plastic when the seedling is planted. Seedlings grow slowly and plants require about one year for full establishment. However, they develop rapidly, producing a nutritious herbage high in protein (up to 25% on a dry weight basis) and the trunk can be cut back to about 1.0 meter height yearly, using the wood as fuel. It should be noted that for effective and efficient nodulation of this leguminous species a specific inoculum (Rhizobium) is needed. This can be obtained from the CSIRO (Commonwealth Scientific and Industrial Research Organization) in Australia or from the University of the Philippines, College of Agriculture. A number of improved selections have been made of this South American species and seeds are available in the Philippines.

Gliricidia sepium, Abizzia falcata, and Sesbania grandiflora are other rapid growing dual-purpose species which should be introduced and tested.

GRASS - LEGUME MIXTURES

Relatively few legumes occur in the natural grasslands of the Hills. The writer observed several low-growing species which resembled Desmodiums, one which probably was a Medicago and others which were not identified. All appeared to be of low herbage production.

A number of improved legumes have been introduced and white clover appears to have prominent potential in the upper elevations. It was observed in mixture with ryegrass, cocksfoot, Bermuda grass (Cynodon dactylon), Dallis grass, Kikuyu, Napier grass, and several naturalized grass species. Desmodium intortum was seen growing well at Lumle in mixture with the common grasses.

Research on grass-legume mixtures was noted in reports, but no combinations have been grown for sufficient time to permit valid conclusions regarding their persistence. Performance was always improved with application of phosphate and nitrogen fertilizers. Certain mixtures are compatible and productive under some conditions and could be used for production of supplemental feed. For example, excellent ryegrass - Khumaltar white clover hay was seen at the Tibrikot Sheep Farm. Grass-legume mixtures must be grazed in a judicious manner since they will not persist under the practices of heavy stocking rates and over-grazing which are common in Nepal. Other grass-legume mixtures should be evaluated in the proposed National Pasture and Fodder Development Program.

SUPPLEMENTAL FEEDSTUFFS

Many kinds of crop residues, weeds, grasses cut from bunds, terraces and waste places, fodder from trees, excess foodstuffs such as the potato, radish and turnip, vines of pumpkin, squash, cowpeas, etc. are being used as supplemental livestock feed. But such materials are inadequate and demands will be greater in the future. It has been suggested that some Brassica species (especially root types) could be used, but it is doubtful whether farmers will utilize scarce land resources for growing livestock feed instead of other crops.

Silage making has been attempted, but this requires land needed for production of human food and is demanding of manpower and bullock power. It was reported that 6 weeks were needed to fill a 55-ton capacity silo on the Jiri Multipurpose Livestock Farm. To make good silage requires a quality product, timely cutting, fine chopping of the material, rapid silo filling, heavy packing and exclusion of air. Silage making would not seem promising in Nepal in the foreseeable future.

Hay is frequently made from certain natural grasses and from the vines of pulses such as gram, cowpeas, and soybeans. During the monsoon season haymaking is difficult, but generally a few sunny days occur and wilting can be done on elevated platforms. The use of improved grasses and legumes for hay appears to have some potential for increasing the supplemental feedstuffs.

Oversowing paddies with leguminous species also should be explored.

Appendix 6

SEED PRODUCTION, MULTIPLICATION AND DISTRIBUTION

Seed supplies of improved pasture and fodder grasses and legumes are difficult to obtain, even for experimental testing. Commercial production within the country will come very slowly because seed growing and processing is a specialized enterprise. Yet, in order to increase livestock feed through the use of improved pasture and fodder species, increased supplies of seeds (or vegetative material) must be made available.

High priority should be given to production of seeds on the government farms. A Pasture and Fodder Seed Specialist should be positioned in the proposed national program and given ample budget and personnel to operate effectively.

INTEGRATING FODDER CROPS WITH EXISTING CROPPING PATTERNS

Integrating fodder crops into existing cropping patterns becomes feasible only when the profit margin is favorable and marketing support is available. Intercropping of maize with soybeans and other pulses is already practiced and cowpeas, gram, and soybeans are sown in finger millet.

For early planted rice crops, especially where shorter-season varieties can be used, there exists the possibility of oversowing with a leguminous crop near the end of the growing season. This would be of particular value where the soil moisture is marginal for a second foodgrain crop (either paddy or wheat). Foodgrain legumes such as lentils, cowpeas, gram and mung bean might be used. Even if they do not yield bountiful grain harvests the herbage would be valuable as livestock feed. Instead of foodgrains, fodder legumes such as Phasey bean, calopo, Siratro, Lablab purpureus (syn. Dolichos lablab), Dolichos biflorus, rice bean (Phaseolus calcaratus, syn. Vigna radiata), Mucuna, etc. could be oversown.

Appendix 8

NUTRITIVE VALUE AND FEEDING TRIALS

Chemical analyses of pasture and fodder species provide a rough measure of their nutritive value. Information on crude protein and crude fiber furnishes a rough index of quality, but data on dry matter and cell wall content are of more value. Chemical analyses of some of the natural grasses and of fodder trees is important, and of special significance would be the phosphorous content as it is related to reproduction.

In vitro dry matter digestible studies are generally well correlated with *in vivo* digestibility but require special equipment and trained personnel.

Simple feeding trials should be conducted, such as comparing the milk production of female buffalo or cows fed hay from improved grasses as compared to common feedstuffs, or measuring the growth weight of lambs when provided improved fodders. These trials should be conducted in collaboration with the Livestock Officers concerned with nutritional studies.

ECONOMIC STUDIES OF PASTURE AND FODDER PRACTICES AND IMPROVEMENTS

Whether special projects can be devised in the near future to obtain economic analyses of improved pasture and fodder practices would depend on the availability of a collaborating economist. Economists should be consulted in planning experiments as well as in data interpretation. This consultation is of special value in studies of management and improvement of natural grasslands and in village pasture and fodder demonstrations.

Appendix 10

VILLAGE PASTURE AND FODDER DEMONSTRATIONS

A substantial base of technical knowledge exists for the implementation of on-farm testing of improved grasses and legumes, with initial attention to the following:

1. The research on the *Setaria sphacelata*, *Paspalum notatum*, and *Desmodium intortum* at the Lumle Agricultural Centre is ready to be moved to farm demonstrations in villages where the panchayat is cooperative and where the village chief would assume responsibility for controlled grazing. *Setaria* and *Desmodium* can be vegetatively propagated or established from seeds which can be harvested at Lumle and undoubtedly in other comparable climatic regions. *Paspalum* can be vegetatively propagated. All three species would grow well along field boundaries, on bunds and faces of terraces, and in field plots. Such a program would require the close supervision of a JT or JTA who has been trained in the establishment and maintenance of these pasture and fodder species. Visits from the Pasture and Fodder Officer would also be desirable.

2. The Napier grass - white clover combinations seen at the Khumaltar Livestock Section could also be used for on-farm testing.

3. Results of trials with white clover, ryegrass, cocksfoot, and Dallis grass have shown that these species could be placed in farm demonstration tests.

4. Kikuyu grass should be extended to the farmer testing phase. This grass should perform well on steep slopes, even those which are partially denuded, thus serving the dual purpose of providing pasture or hay as well as protecting the soil from erosion. Once established the grass could be over-sown with white clover. A light dressing of phosphate would benefit the establishment of the clover.

X. FARMING SYSTEMS IN HILL AGRICULTURE

A. The Farming Systems Concept

The farming system includes those enterprises which combine natural, social, and economic resources to produce agricultural commodities, and the farm activities which interact with the off-farm social and economic environment. Improvement of farming systems requires attention to the operations as a whole rather than concentrating only on the component parts. The significance of the more comprehensive approach depends on the degree to which the component parts (for example, crops and livestock) are interrelated. There are generally two conditions under which these interrelationships are strong:

1) Where the production system has so intensified that resources (physical, socio-economic) become limiting.

2) Where the farming system provides for the majority of the needs of the farm family for food and shelter (a largely non-market system).

Hill agriculture is characterized by both conditions existing simultaneously. The first condition has been extensively described in several reports which refer to the "tightness" of the production system. The shortage of grazing land and animal feed, the scarcity of firewood, the limitation of compost, the lack of animal power, the "tightness" of the cropping pattern, the seasonal shortages of labor and the shortage as well as uncertainty of water, all reflect resource limitations. The second characteristic, that of a largely non-market economy, is illustrated in Figure 1. Without ready access to markets most farms are almost entirely subsistence-oriented. The few that do market a larger proportion of their produce are involved in production of high-value crops. Even with access roads, however, few farms market more than half of what they produce, largely because of small farm size and the tendency to produce their own staple foods for home consumption. Small farmers will continue to produce their own food, remaining largely non-market oriented, until alternative production enterprises are sufficiently attractive and until the assurance of a stable external food supply becomes a reality.

1. Resource Interactions

Hill farms are characterized by closely interdependent production enterprises. The understanding of such systems thus requires consideration of the whole as well as of the component parts and their interactions.

A very generalized model of Hill farming systems, Figure 2, shows a few of the major interactions between forests, grazing lands, livestock and crop area. The systems change, both within and across physical environments, depending on the resources available to the farmer and the needs of his family. A complete understanding, therefore, requires more specific definition of the interacting resources, as follows:

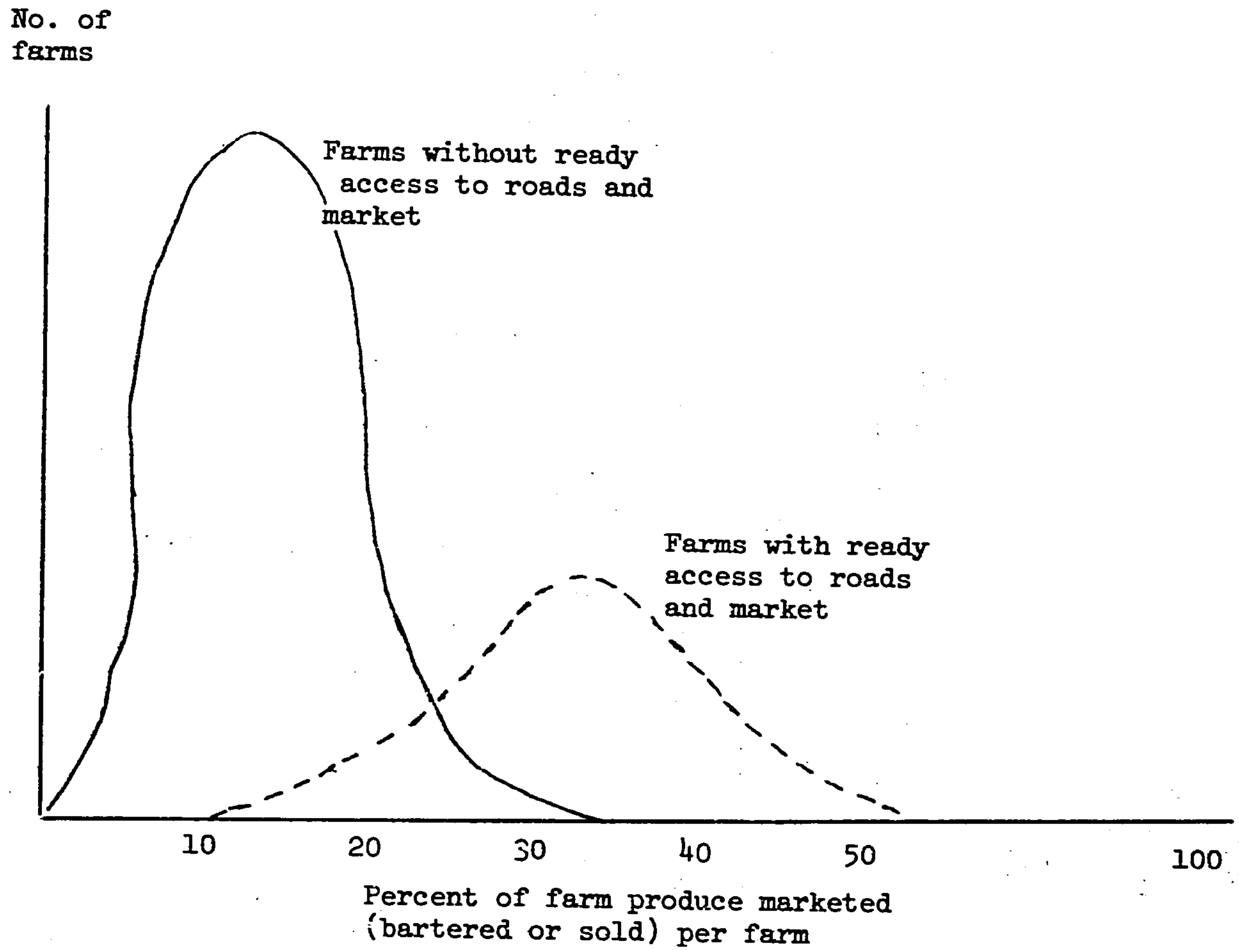

Figure 1. Conceptual model of degree of participation in a market economy for Hill farms

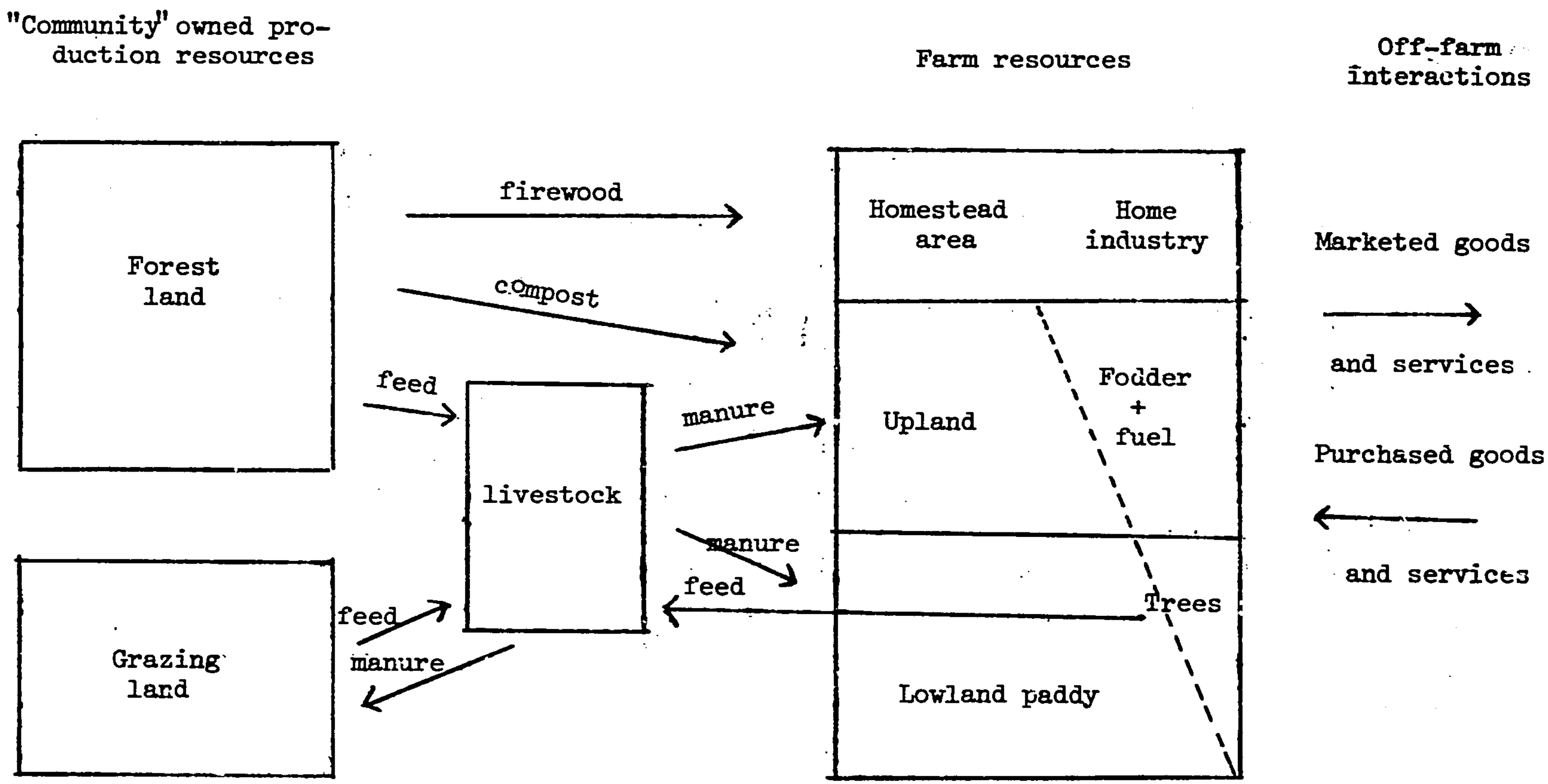

Figure 2. Conceptual model of a Nepal hill farm production system

1) Forest land

   a. Provides fuel

   b. " compost for direct use on crops

   c. " feed and bedding for animals

   d. " food and cash crops (herbs, etc.)

   e. " construction materials

   f. " medicinal herbs, resins

   g. Gets little return from the farm operation

2) Grazing land

   a. Provides feed for animals

   b. Receives nutrients from animal waste (urine and uncollected dung)

3) Livestock

   a. Receive feed from forest, grazing land, fodder trees and crop residues

   b. Provide compost to the farm area (primarily homestead and upland areas)

   c. Provide power

   d. Provide hides and food products

   e. Add stability to the production systems (animal numbers vary little with short-term climatic fluctuations)

   f. Require considerable labor for care

4) Homestead area

   a. Trees provide comfort, shade, privacy, fodder and fuel

   b. Diversity of crop species adds to income, family nutrition and general family pleasure and welfare

5) Fodder and fuel trees

   a. Contribute to stability of the land area

b. Remove pressure from forest and grazing area by providing fuel and feed

6. Crop area

a. Receives nutrients from leguminous crops or from the grassland or forest area, either through animals or directly by means of plant residues

b. Provides for the family staple food and oil needs

2. <u>Modifications and Variations in Farming Systems</u>

The degree to which cropping can be intensified is limited by soil fertility and the physical resources of temperature, water, etc. Fertility, in turn, depends on the amount of animal manures, compost or plant residues available, as well as on the crop components of the system. Cropping intensity also depends on available power for tillage. Therefore, for a given level of technology, cropping intensity and productivity depend ultimately on the number of animals and the amount of grazing and forest land available -- in a traditional subsistence system.

In areas where population growth has caused expansion of crop area as well as intensity, more and more pressure has been put on grazing areas. The greatest ratio of grazing land/livestock to crop area is found at the highest elevations and in the dry regions. Large numbers of animals are grazed over wide areas, with manure being carried sometimes more than a day's trek back to the home village for use in growing staple food. In these regions slow plant growth limits both the carrying capacity of grazing areas and the numbers of plant species which can be used as food crops. At Namchebazzar, for instance, no more than a dozen plant species are used for food. Sharp gradients of land productivity exist, in response to minor changes in slope or soil type.

In contrast, at lower elevations in the mid-hills of eastern Nepal, it is not uncommon to find 40 to 50 plant species used on a single farm for food purposes. This compares with 50 to 60 species commonly used on farms in the high rainfall areas of southeast Asia. The higher rainfall mid-hills have far less of a gradient of land capability corresponding to slope or soil type. Here plant growth is much more luxuriant and rapid, and relatively small forest and grazing areas support a larger animal population and relatively larger farms with intensive cropping. At lower elevations crop durations are shorter and cropping patterns are more complex, with more crops being grown.

No attempt will be made to characterize the numerous farming systems over the wide range of Hill region environments. It would be possible, however, for an interdisciplinary team to catalogue the majority of Hill farming systems, with perhaps as few as a dozen carefully selected representative models, each with a range of possible crop combinations and sequences. The system in a given environment does not seem to change much in basic makeup. A few models would furnish a clear understanding of systems across physical environments and would provide a framework within which improvements in the systems could be made. Such models, if simply described, would be extremely useful to the commodity-oriented scientist charged with improving a specific crop in the system, by giving him a more precise picture of the many factors which have a bearing on the crop.

The socio-economic matrix adds additional diversity to that of the physical environment. Its effect on farming systems is difficult to assess and should probably be treated as uncontrolled variation except for the factor of market availability.

The farmer's needs for an assured food supply, for construction materials, clothing, fuel, cash income and social recognition -- together with the physical and economic environment -- all influence the choice of farming system. Some argue that a Hill farmer might better grow high-value, low-bulk crops and then purchase his food needs. With small farm size, however, he will never achieve more than low-income status. If, in addition to concern about future uncertainty of food supplies, the farmer must bear the significant cost of marketing and transport services for both his produce and his consumed goods, the income advantage of cash crops in place of food crops must be substantial. Until such time as inexpensive transportation and efficient marketing channels are available, maintaining self-sufficiency in food production in Hill areas would seem to be a high priority national goal.

In subsistence farming systems most changes can be made only after sufficient pressure has built up within the system. A farmer will not plant fodder-fuel trees if alternative sources of feed are available close by. Likewise, he would be unwise to reduce his animal numbers as long as adequate feed is available from nearby "common" areas and his animals effectively harvest nutrients from those areas for recycling onto his crop lands. A relevant and acceptable change in one locality may thus be premature in terms of farmer acceptance in the next.

B. Increasing Productivity of Hill Farming Systems

1. Diversification and Cropping Sequences

In farming systems where large-scale mechanization and processing are not relevant, diversification not only spreads risks and increases overall stability, but also ensures more efficient use of resources. A farm which includes both upland and lowland fields has the potential for considerable diversity, with more uniform demands for labor and power. A single major crop on the entire farm creates extremely uneven, heavy labor demands at planting and harvest time. Also, a single crop may not be best suited for all land classes and seasons on a given farm. Millets or oilseeds are not as productive as rice, but they will grow in dry fields or in the late season when rainfall is lower and highly uncertain.

Hill farms generally have 2 to 4 staple food crops -- maize, wheat, rice, millet or potato -- and as many as 40 to 50 other food crops, depending on location. This large number of non-staple crops is highly desired by all Hill farmers, for purposes of trade or simply to improve and add variety to their diet. The staff of the Lumle Agricultural Center reported that of the improved technology and materials offered by that program, peach trees were probably the item in biggest demand. Farmers everywhere also want winter vegetables (for which they have not been able to produce their own seed). Crop diversity in Nepal is closely associated with the physiography, with the higher elevations and drier areas being far less endowed.

Efficiency of a crop is a major factor in changing cropping patterns or adding new crops. Paddy rice, for instance, requires relatively low power inputs, so the return per unit of power is high. There is no exacting requirement for organic matter or soil structure, so there are minimum demands on compost resources. The anaerobic conditions of the paddy make phosphorus and potassium more readily available so that lower soil concentrations can be maintained. These characteristics and their importance in non-market oriented systems have been described at length by Geertz.[1] An additional feature, in rice -- wheat or rice -- other upland crop rotations, is the excellent weed control obtained. Paddy cultivation followed by upland crops gives reduced weed control problems, since few weed species survive well under both upland and lowland conditions. This is perhaps one of the best examples of efficient weed management through traditional cropping systems. It is restricted, of course, to soils which can be readily converted from puddled to upland, as can many of the Nepal hills soils.

Legumes are efficient in not requiring high levels of compost. Many, such as mung bean, are good competitors with weeds and require little weeding.

The rice-wheat rotation is highly efficient in the Hills. At lower elevations rice-rice-wheat is used where early maturing varieties are available. This three-crop system probably requires about the same fertilizer inputs as the common maize-millet pattern of upland areas. In areas where farmers grow rice-wheat on the paddy land and corn-millet on the upland, the bulk of available compost goes on the maize-millet, simply because it requires more inputs.

Intercropping (the growing of more than one crop in the field at the same time) and relay cropping (the short overlap of growing seasons) are widely practiced. Many writers pass these methods off as simply "providing insurance" that something will be harvested. This may be the primary reason for the use of intercropping in primitive shifting cultivation systems, but recent intercropping studies give little, if any, indication that it is important in intensive agriculture. The major intercropping systems in Nepal, shown in Appendix 1, are used primarily for time-saving and greater efficiency. Maize-millet, for example, are delayed to permit the harvest of two crops at high elevations where long maturities would not permit sequencing. Maize-radish follow the same pattern.

1/ Geertz, C. <u>Agricultural Involution: The Process of Ecological Change in Indonesia</u>. University of California Press, Berkeley, 1963.

In some instances crop combinations may reduce disease or insect infestation. The wide row-spacing of maize when intercropped with peanut or soybean reduces both downy mildew infestation and corn borer damage in the maize.

In some cases a slow-growing crop like pigeon pea will be intercropped with a short-season crop at the start of the growing season.

In most instances the efficiency of the labor or power-use is higher in intercrop patterns. Many intercrop combinations in Nepal provide a continuous crop season of 7-9 months, requiring primary tillage only once a year, thus reducing power inputs. The additional labor required is not a heavy "hoe type", but rather a "tending" kind of labor that is readily available in the farm family. Returns on labor and power are higher in these systems. Maize-soybean-field bean, maize-radish and paddy-pea or lentil are examples of such systems.

2. Improving Cropping Systems

a. Extending Use of Superior Indigenous Practices

The improvement of cropping systems should be approached by (a) developing a better understanding of cropping sequences and combinations now used in the Hills of Nepal and (b) testing those apparently superior combinations in the different regions of the country.

Little information is available from other areas of the world that would be applicable to specific conditions in Nepal. Experience in the Kumaun Hills of India, to the west of Nepal, will have some comparability and possible transferability. Methods, timing, labor and power use, and productivity should be recorded in the survey of present practices in the Hills. The better practices should be tested at regional locations in the areas where they would appear to be suited, to ensure maximum use of those materials and methods already proved suitable in the country. For some time to come the use of these practices will continue to be more of an art than a science because of their biological complexity as well as their economic interactions. Trying them in areas similar to those in which they are now found would permit most rapid progress in their evaluation and possible spread. Farmer participation in this evaluation is extremely useful. For a discussion of methods that may be used in a farmer-oriented testing of systems see the report of the Cropping Systems Workshop, International Rice Research Institute, March 1975.

Some of the simpler techniques such as relay planting to permit more crops being grown in a limited growing season can be readily adapted. Simple time-of-overlap trials should be conducted to learn the length of overlap possible for different crops.

The systems of particular importance which should be given priority in testing are:

<u>relay</u>

maize - millet

maize - radish

paddy - pulse

maize or paddy - forage legume

<u>intercropping</u>

maize - soybean

millet - mung

wheat or barley - mustard

Complex multi-crop mixtures and new combinations not already in use in Nepal should not be tried or introduced until indigenous practices have been evaluated. When testing crop combinations the crop type or variety and time of maturity are important.

b. <u>Increasing Productivity of Components of Cropping Systems</u>

A wide range of crops is grown in Nepal, some in larger scale and as major food crops, and many in family gardens, as listed in Appendix 2. Productivity of Hill farming systems can be increased by improvement of the inherent or genetic yielding capability of the respective crop variety, improving the disease resistance and pest control practices, and then assembling new combinations of the various higher yielding materials and methods. The major crops -- rice, wheat, maize, and potato -- have properly received the focus of development attention in Nepal, with coordinated national programs, and have been treated separately in this report.

The importance of the remaining "minor" crops to welfare of hill people far outweighs their relative production and area statistics. While the major crops cover the bulk of arable land during the main growing season, the minor crops are planted before, during or after the main season or on marginal land to increase both stability and productivity of cropping systems. Nepal cannot afford major research and development programs in each of these crops, but much can be done without heavy investments.

Where a crop has been grown for many years in isolated valleys, as is the case with most of Nepal's minor crops, considerable genetic variation has evolved. Likewise, if a crop has received major improvement work in research centers elsewhere in the world, a great deal of genetic material is usually available for that crop. In such cases the first step in improvement is the collection and testing of both indigenous and exotic varieties. This is a relatively straightforward and inexpensive process, especially when the crop is seed-propagated and self-pollinated. Expected gains from such efforts are substantial. An increase in average yield of "land" or existing varieties of 50% would not be unusual. Initial efforts in breeding might add another 25% over a 5-10 year period, with slower progress afterward from a continued breeding effort, Figure 3. The resources needed for the more intensive breeding phase, however, are several times those of the initial collection and screening work.

A collection and screening program has been initiated with finger millet (Eleusine corcana) by Dr. S. N. Lohani, Acting Chief Agronomist. After two years of collection and testing, with minimum expenditure of resources, it appears that gains of the order of magnitude of the 50% suggested above are a distinct possibility. The selection of higher yielding varieties which have greater disease and insect resistance and prompt distribution of these varieties across the Hills regions where they are adapted should be most effective in utilizing the best material available from both indigenous and exotic sources.

The crops most easily collected, tested, and increased are those that are self-pollinated. The cross-pollinated crops, such as buckwheat, require isolation or controlled pollination to maintain purity. Fortunately, most of the minor crops (pulses, oilseeds, cereals) fall into the former category. A number of these crops have received major attention in agricultural research centers elsewhere, they have been widely collected and so there is a large supply of readily available germplasm. The most readily improved species in each crop are as follows:

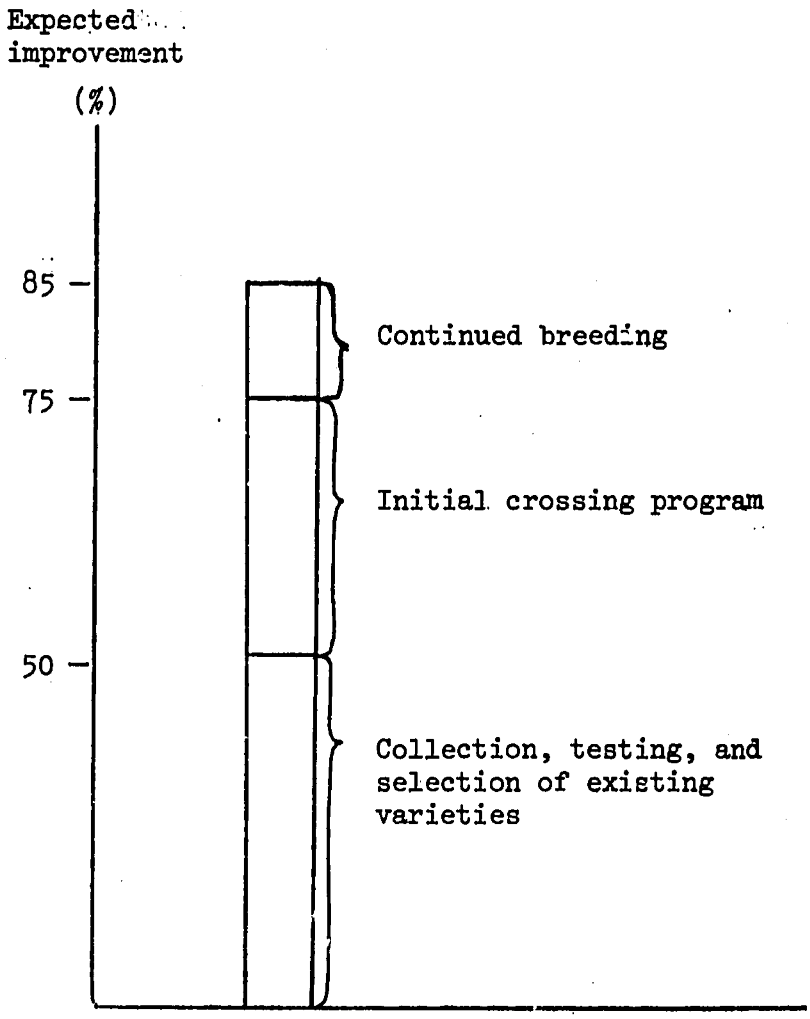

Figure 3. Crop improvement expected with increased expenditures

Crop	Source of germplasm
Cereals	
barley (2 species)	US Department of Agriculture (USDA)
	Canadian Department of Agriculture
	European (Scandinavian) countries
	CIMMYT (Mexico)
finger millet	ICRISAT (Hyderabad, India)
sorghum	ICRISAT
	CIMMYT (for high-altitude) sorghum
buckwheat	Canadian Department of Agriculture
Oilseeds	
mustard (3 species)	India
niger	India
sesame	India
groundnut	ICRISAT
castor bean	USDA
sunflower	Canadian Department of Agriculture
Pulses (15 species)	
pidgeon pea	ICRISAT
chick pea	ICRISAT
mung	AVRDC (Taiwan)
black gram	AVRDC

soybean	AVRDC
	INTSOY (USA)
	USDA
cowpea	AVRDC
	Philippines
	USDA
	IITA (Nigeria)

Root crops

sweet potato	AVRDC
	Pacific collection (New Zealand)
taro	IITA
yam	IITA
	Institute for Tropical Agriculture (Trinidad, W. I.)

Since Nepal is extremely rich in crop species there would seem to be little need for introduction of many new species, but rather to concentrate on improved varieties or cultivars of the above. Triticale should be looked at within the wheat program. Adzuki bean in the pulses, safflower in the oilseeds and cassava as a root crop may have promise.

As suggested in Chapter IV, it would be highly desirable to set up a National Coordinated Program for Improving Farming Systems, for attention to the many minor crops that are of special significance in the Hills. Until this is done, substantial progress can be made by a more intensive, systematic effort that can be strengthened within the present organizational structure.

Collection and maintenance of germplasm is the responsibility of the Department of Agriculture, Botany Section. This activity should be increased to meet the needs of improvement programs for the many minor crops. The Section should have a first class seed storage facility for this purpose, and a junior scientist should be assigned to the maintenance of each group of crops, under the supervision of the Chief Botanist. Collections would be carried out jointly with the crop improvement specialists.

Testing and selection should be carried out in several stages. The first generation of screening should be done at a single main station where facilities and competent staff are available. This could be at Khumaltar or one of the Regional Stations. For the initial season of screening, 1000 to 2000 varieties, both indigenous and exotic, might be handled. This would be reduced to 100 lines or less for the second-season evaluation. The 100 lines should be yield-tested across the appropriate range of elevations and micro environments, depending on species adaptability. From this 100 lines, perhaps twenty to thirty would go into yield trials across zones and elevations. Two or three seasons of such testing should be adequate for final recommendations to be made. A concentrated 5-year program should be adequate in each crop, to exploit most of the available germplasm.

Farmer evaluation, extension, and seed production would be organized as for the major crops, with subject matter specialists at the headquarters and in each of the four regions.

Horticultural crops -- the wide range of vegetables, fruits, and tree crops now in the country -- should be spread. There is ready acceptance by farmers for this diversity of crops and prompt use should be made of the information and experience of the several projects working with these crops. The Gurkha retraining center at Lumle and the Gandaki Project have considerable experience with temperate fruit trees. The Japanese-supported vegetable enterprise near Namchebazaar has developed substantial information on vegetable species, on varieties and production methods. In making these crops and varieties available to farmers first priority should be given to those that can be maintained by farmers themselves without continual introduction of new seeds.

Staff support should be strengthened for the Coordinated Program for Improving Farming Systems as follows:

Plant Introduction, Seed Increase and Maintenance

Plant Breeder/Agronomist (M.Sc.)	1
Assistant Breeder/Agronomist (B.Sc.)	2

Field Trials of Varieties and Production Practices

Agronomist (M. Sc.)	1

Assistant Agronomist (B. Sc.)	4
<u>Crop Protection</u>	
Assistant Pathologist (B. Sc.)	1
Assistant Entomologist (B. Sc.)	1
<u>Subject Matter Specialists</u>	
Assistant Agronomist (Main Station) (B. Sc.)	1
Assistant Agronomist (Regional) (B. Sc.)	4

The above staff would serve under the general guidance and technical supervision of the Leader of the Coordinated Program, but might be located with the respective research sections at Khumaltar.

The facilities at Khumaltar, the various regional multi-purpose stations and horticultural farms should be improved as required to serve the scope of research and testing for the different crops. No new or separate stations would be necessary. Specific attention should be given to:

a) A first class air-conditioned storage facility for maintaining seed supplies of all the crops.

b) Field facilities at one or more locations as required for increase of germplasm materials.

c) Field facilities at the main and regional stations for initial trials and evaluations.

d) Field facilities at the horicultural farms in the different elevations or environments in which the varieties and practices undergo further field testing.

3. Animals in Hill Agriculture

The pressures on intensive farming systems in the Hills, as well as the degradation of forest areas and the increase of erosion because of overgrazing can be reduced only through better management of animals in Nepal. This may be achieved in part through reduction in numbers -- action that must eventually be taken. Some improvement may be achieved by giving more attention to (a) increasing efficiency of nutrient cycling, and (b) increasing feed supplies within the farm units.

Detailed comparative studies should be undertaken of the organic matter/nutrients produced by animals and the nutrients produced from various types of crops and forest residues -- with special attention to the points of loss in each source.

A second phase of the study would involve methods for inserting chemical fertilizers into the system. Most past studies of isolated N P K trials tend to disregard the existing nutrient flow patterns and are concerned primarily with maximizing yields. This is relevant where agriculture has shifted over to a cash-intensive, market-oriented form, but is not suitable for Hill situations. In the traditional cycling pattern it is likely that small amounts of specific limiting elements, including phosphorous, would greatly improve crop yields and add efficiency to the system.

Another specific area for improvement would be more precise use of compost at the opportune time. In the rice-wheat pattern, for instance, most compost is properly used on the wheat. The shortage of labor during the time of rice harvest and during land preparation and planting of wheat encourages the use of compost as a top-dressing in wheat. The nutrient use efficiency of this method should be compared with plowing in the compost before planting wheat. If advantageous, the compost could be piled along the bunds during the labor-slack period preceding rice harvest.

The improvement of animal feed sources on the farm would appear to have large scope for nationwide application in Nepal. The improvement of pasture areas and fodder trees is covered separately in this report and this discussion is limited to increasing the feed output of the farm unit itself through adjusting cropping patterns.

It is recognized that the growing of hay or forage crops to increase feed availability in already established systems will only be acceptable if (a) food or cash crops are not adversely affected, (b) off-farm feed is limiting, (c) little additional labor or power is required, and (d) they do not add to the compost (nutrient) demands of the system.

There may be some scope for additional intercropping of maize or other crops with food legumes such as soybeans, which might reduce maize yields slightly, but which would reduce the nutrient demand of the system substantially and would provide a high quality hay for mixing with straw.

Maize-soybean intercropping on bari land during the rice growing season, for instance, would greatly increase the feed value of the main-season crop stover as a whole.

In areas where a single crop of rice is grown per year (50% of the rice land in the Khanbari district) either a cash crop or forage legume could be over-seeded (relay planted) before harvesting the rice. Farmers to whom this was proposed in interviews seemed eager to try it -- if they knew what to plant. The species selected would have to be fast-growing, set seed easily, and tolerate low soil PH. A few suggested species are:

cowpea	*Vigna sinensis*
berseem clover	*Trifolium alexandrinum*
rice bean	*Phaseolus calcaratus*
lentil	*Lens esculenta*
sunhemp	*Crotalaria juncea*
forage rape	*Brassica napus*
hairy vetch	*Vicia villosa*
horse bean	*Vicia faba*
phasey bean	*Phaseolus lathyroides*
Perennial lespedeza	*Lespedeza cuneata*
Korean lespedeza	*L. stipulacea*
common lespedeza	*L. striata*
desmodium	*Desmodium sp.*
kudzu	*Pueraria thunbergiana*
Tropical kudzu	*P. phaseoloides*

The effectiveness of this practice, to furnish additional and improved feeds following the rice crop, will depend upon the extent to which animals are controlled and kept from the harvested rice lands for a sufficient time for the legume plantings to become established and productive.

The transfer of fuel production to the farm units through fodder/fuel trees also should be encouraged. The species should be fast growing legumes which provide high quality fodder and good firewood. They would add to the nitrogen balance on the farm. Some southeast Asian species used for this purpose are:

Sesbania grandiflora

Leucaena glauca

Gliricidia sp.

Hibiscus species (in dry areas of Sri Lanka)

These species supply the entire fuel needs of Indonesian farms in Java. They should grow equally well in the low and mid-hills of Nepal.

4. The Application of Innovations in Farming Systems

The creation, dissemination, and adoption of new technology is a continuum, starting in the laboratories or research stations and proceeding to the farm. Intermediate steps include (1) testing on regional government stations or farms, (2) trials in farmers' fields, and (3) demonstration plots. There is no clear dividing line between research and extension. The design and development work in laboratories and experiment stations is clearly research, and the demonstration and application of innovations by farmers is the extension function.

The job of the researcher is unfinished until the new technology has been tested on farmers' fields and has performed satisfactorily. If it has not, it is the job of the scientist to carry on the adaptive research -- to make the necessary modifications in the material or the practice -- that will ensure suitability and acceptance. At this point it is still a research function, not an extension activity, even though the researcher may get the extension workers involved, or at least aware of what is being done.

The importance of central research facilities, regional facilities for testing, and farmers' field trials in research, as well as the role of extension in Hill agricultural development in general, are covered in other sections of this report. In considering the development and introduction of innovations into farming systems -- where a number of commodities or new practices may be involved -- some special emphasis might be placed on procedures for continuous assessment or evaluation of new technology as it becomes available for use. This involves what has been termed "Agro-Economics" studies in some countries, but what might more properly be called "Agro-Economic-Social Studies."

The studies would be concerned with:

a. Testing *in situ* each "improved" component separately, i.e., each crop variety or animal species, to see how it performs in that location.

b. Testing the farming system with the new or improved component in place.

c. Measuring the impact on the system of the changed component.

d. Identifying constraints which prevent the full potential of the component from being expressed.

e. Determining the likely adoption level and rate.

f. Developing methods to facilitate dissemination.

Overlying all of these functions is feed-back to the research team and feed-forward to the extension operations. These evaluative functions furnish the bridge in the research-extension continuum.

Carrying out the functions listed above will require different types of investigations at several points in time. Testing the component alone and testing the system with the component in place will involve trials on fields of cooperating farmers. Technical guidance and direction should be furnished by a Subject Matter Specialist in each of the four development regions. This should be an agronomist with B. Sc. degree-level training, with an economist of equal training fully involved in the studies and responsible for the assessment of social and economic factors related to the innovations.

The research workers concerned with the specific new component -- variety or practices -- should be tied into the field studies, through the on-farm evaluations. Also, JTA's should participate in order to ensure their understanding of the new technology.

The mutual involvement in the evaluative work makes the research worker more aware of farm problems and gives the extension worker a better understanding of the potentials and limitations of research.

COMMON INTERCROPPING PATTERNS IN NEPAL 1/

A. Maize patterns

Maize + fingermillet

March*- April — maize — Sept. 1-30
July*-August — fingermillet — Nov.

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* earlier in higher altitudes

Maize + soybean + beans. Maize often intercropped with soybean and beans. Soybean and beans are mostly dibbled at random. In Kathamandu Valley farmers run soybean rows between two maize rows, or maize and soybean in alternate rows.

March-April — maize — Sept. 1-30
soybean — Oct.
June — Field beans — Oct.-Nov.*

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* some types are sown along with maize and harvested in July-Sept.

Maize + potato

March-April — maize — Sept. 1-30
Feb. 15* — potato — July 1-15

----
* From 7000'-9000' altitude (will be planted earlier than Feb. 15 at even higher altitudes). At lower altitudes maize and potato are often planted together: potato is dibbled at random between maize plants.

Maize + radish

March — maize — Sept.
early August — radish — Oct.-Nov.

* A popular practice in Kakani and adjoining villages. Maize is sown on ridges about a meter wide. Radish seeds are broadcasted and thinned later.

B. Fingermillet patterns

Fingermillet + Phaseolus mungo (blackgram) + Phaseolus calcaratus + Dolichos sp.

```
    July 7-Aug. 7                              Oct.-Nov.
      /-------------- fingermillet ---------------/
 June 7-July 15*                                    Nov. (end)
   /----------------- Phaseolus ----------------------/
```

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* Phaseolus sp. and Dolichos often broadcast in the maize field and fingermillet transplanted later (see maize + fingermillet system).

Fingermillet + other crops*

```
      July 7-Aug. 7                    Oct.-Nov.
        /---------- fingermillet ---------/
       July                          Oct.
       /------------ sesamum ----------/
          Aug.                         Nov.
          /--------- buckwheat ---------/
 June 15-July 15          sweet potato                April
   /--------------------------------------------------/
          Aug.                        [illegible]
          /--------- mustard ------------
```

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* Fingermillet is not often mixed with the crops shown here. However, there are always some farmers who like to grow one or each of the crops in some segment of fingermillet plot.

C. Wheat or barley patterns

Wheat + Black mustard*

```
  Nov.                                                  May
   /---------------------- wheat -------------------------/
   /------- Black mustard (B. nigra) -------/ March-April
```

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* Fairly common in hill regions.

Barley + linseed or mustard or lentil*

```
Nov.                                               March
/____________________barley______________________/
/____________________linseed and lentil_______/February
/____________________mustard_______/
```

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* Fairly common in Tarai. Quite often linseed and lentil are mixed together with barley. Lentil and linseed are also grown together (without barley).

D. Paddy and Relay crops* (rainfed paddy)

```
June 21-July 21                            Nov. 15-Nov. 30
/____________________rice_____________________/
                       Oct. 21-Nov. 21                    Mar. 21-Apr. 7
                       /__________________________________/
                        peas or lentil or linseed or lathyrus
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* Mostly common in Tarai and Inner Tarai (Chitwan, Dang)

Upland paddy + maize

```
/__maize_________
/__paddy_________________
```

1/ Dr. S. N. Lohani, Acting Chief Agronomist, Department of Agriculture

CROPS GROWN IN NEPAL

English Name	Botanical Name	Local name
	Cereals	
Rice	*Oryza sativa*	dhan
Maize	*Zea mays*	makai
Wheat	*Triticum vulgare*	gahun
Barley	*Hordeum vulgare*	jau
Naked barley		uwa
Fingermillet	*Eleusine coracana*	kodo
Sorghum	*Sorghum bicolor*	junello
Buckwheat	*Fagopyrum esculentum*	phaphar (mitha)
Buckwheat	*F. tataricum*	(tits)
	Oil Seeds	
Mustard	*Brassica juncea*	tori
Mustard	*Brassica campestris*	rayo
Niger	*Guizotia abyssinica*	philingay (jhusa til)
Sesame	*Sesamum indicum*	til
Groundnut	*Arachis hypogaea*	badam
Castor bean	*Ricinus communis*	
Black mustard	*Brassica nigra*	cab tori
Sunflower	*Helianthus annuus*	

Pulses

Indian bean	*Dolichos lablab*	
Broad bean	*Vicia faba*	keraiya
Chickling vetch	*Lathyrus sativus*	khesari
Mung bean	*Phaseolus aureus*	mugi
Pigeon pea	*Cajanus cajan*	rahar
Black gram	*Phaseolus mungo*	mas
Soybean	*Glycine max*	bhatmas
Horse bean (horsegram)	*Dolichos biflorus*	gahut
Cowpea	*Vigna sinensis*	
Cowpea	*Vigna catjang*	bodi
Kidney bean	*Phaseolus calcaratus*	mashyang
Lentil	*Lens esculenta*	
Lentil	*Lens culinaris*	
Chick pea	*Cicer aurietinum*	
Field pea	*Pisum arvense*	
Potato	*Solanum tuberosum*	alu
Sweet potato	*Ipomoea batatas*	suthani
Jerusalem artichoke	*Helianthus tuberosus*	kachu
Yam (vine)	*Dioscorea alata*	tarul
Taro	*Colocasia esculenta*	pedalo
Arum	*Amoraphalus sp.*	ol

Vegetables

Turnip	*Brassica rapa*	salgum
Choyote	*Sechium edule*	
Radish	*Raphamus sativu*	mula

Mustard (broad leaf)	Brassica juncea	sayo
Tomato	Lycopersico esculentum	lolkeda
Cauliflower	Brassica oleracea var. botrytis	kauli
Cabbage	Brassica oleracea var. capitata	bandakopi
Eggplant	Solanum melongena	bhanta
Cucumber	Cucumis melo	kankro
Field pea	Lathyrus odoratus	
Green beans	Phaseolus vulgaris	
Pea	Pisum sativum	thulo karao
Okra (lady finger)	Abelmoschus esculentus	ramtoria
Pumpkin	Cucurbita maxima	farsi
Onion	Allium cepa	pyaj
Garlic	Allium sativum	lasoon
Carrot	Daucus carota	jajar
Spinach	Spinacia oleracea	polungo
Lettuce	Lactuca sativa	jirisag
Spinach	Trifolium felmungracum	mitha
Cress	Lepidium sativum	chanbur
Chillie	Capsicum annuum	corsani
Amaranthus	Amaranthus sp.	batti

Sugar

Sugar cane	Saccharum officinalis	ookhoo

Spices

Ginger	Zingiber officinale	aduwa
Cardamon	Elettaria cardamomum	alainchi
Coriander	Coriandrum sativum	dhania

Fruit (temperate)

Apple	Pyrus malus	syau
Pear	Pyrus communis	naspati
Peach	Amygdalus persica	aru
Plum	P. domestica	alu boukhara
Apricot	Armeniaca vulgaris	khurpani
Raspberries		
- yellow	Rubus ellipticus	ainsalu
- red	R. easiocoupus	rato ainsalu
Grape	Vitis vinifera	angoor
Strawberry	Fragaria vesca	
Walnut	Juglans regia	okhan
Litchi	Litchi chinensis	lichi
Papaya	Carica papaya	mewa
Pineapple	Ananas comosus	bhui katahar
Guava	Psidium guajava	amba
Mango	Mangifera indica	amp
Banana	Musa sapientum	kera
Custard apple	Anona squamosa	sasita
Jackfruit	Artocarpus heterophyllus	rukkatahar
Lime	Citrus aurantifolia	kagati
Pomello/Shuddock	C. maxima	bhogate

Tangerine/mandarine	*C. nobilis*	suntula
Orange	*C. chryacarpa*	suntula
Sweet lime	*C. limettioides*	chaksi
Citron	*C. medica*	bîmuri
Rough lemon	*C. jambhire*	kath jamir
Melon	*Citrullus vulgaris*	karbuja
	Others	
Tobacco	*Nicotiana tabacum*	surti
Nicotine tobacco	*N. rustica*	
Cotton	*Gossypium sp.*	kopas
Jute	*Corchorus capsularis*	tita, sada
Jute	*C. olitorius capsularis*	tossa

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XI. THE SOCIO-ECONOMIC CONTEXT OF HILL DEVELOPMENT

The conclusions and recommendations of this study are based on the assumptions as noted in Section III. Of these, two are of special significance. First, the Hill population will continue to grow over at least the next five to ten years, net of migration. Declining levels of soil fertility, yields, and consumption, and sharp, sudden environmental stresses, such as droughts landslides, and floods, will push some of the population to migrate. Historical attractions of the plains, and some organized resettlement schemes on the estimated 325,000 hectares of remaining arable Terai forest lands, will pull people to India and the Terai. These forces may reduce some of the population increment, but will not relieve or reduce absolute numbers of people in the Hills.

A second major assumption is that present Hill land use practices, specifically over-cutting of forests for fuel and fodder; uncontrolled grazing of pastures, wastelands, and forests; and spread of cultivation to marginal lands, are destructive of the Hill resource base. These land use practices are a consequence of larger numbers of people trying to eke out livings practicing a now necessarily out-grown style of subsistance agriculture.

A. Approach and Strategy for Development

These assumptions, and a generalized understanding of the socio-economic activities and the bio-physical processes operating in Hill areas, furnish guidance for an approach to Hill development. Such an approach would aim at progressive improvement of the standards of living of Hill people, primarily through catalyzing increases in agricultural production despite the paucity of resources, as follows:

1. His Majesty's Government should support the generation and application of a variety of plausible new technologies and implementation strategies for the varied conditions found throughout the Hills. Furthermore, a sequence or progressive series of such activities needs to be devised, one to succeed the next in a given Hill environment as the sophistication and absorptive capacity of the local society and economy increases. Economic tools and socio-cultural insights have a critical role in this process.

2. While redress of inter-regional (and to some extent, intra-Hill) imbalances is an important HMG policy goal, this should not always force a uniformly even doling out of government manpower and financial resources. Priorities will inevitably be set, by default if by nothing else, and it seems in the better interests of the nation to consciously analyze and strike a balance between economic efficiency and equity. Some concentration of effort and attention on more responsive Hill areas, as represented, for example, by the National Planning Commission's proposed Small Area Package Program, or by the various foreign donor supported Hill development projects, may be a useful part of a development approach which, on the other hand, does not neglect the remaining Hill areas.

3. Access to motorable roads is a critical factor in assigning research priorities and designing implementation strategy. Specifically, the degree of access will largely determine what real possibilities farmers face for a modernizing agriculture, and specialization in a variety of commercial crops. Access may be improved by construction or repair of feeder roads, trails, and footbridges. On the other hand, roads by themselves are not a sufficient stimulus for significant Hill development.

4. The usual model of a cash-intensive modernizing agriculture based on increasing specialization and articulation of exchange networks among the farm, the village, and the rest of the world will not be applicable in most parts of the Hills for the foreseeable future, largely because of the transportation constraint. At the present time 42 out of 55 Hill districts -- two-thirds of the total land area and over half of the Nepalese -- are unserviced by roads. The road network will expand its effective coverage only slowly, which suggests:

   a) Technology should be developed for farmers with limited production resources which makes better use of those resources, or resources that could realistically become available to them; that is, such farmers should be able to achieve some "intermediate position" where they are partly self-sufficient and partly participating in the cash economy.

   b) Regional comparative advantages between Mountains, Hills, and Terai will not be realizable for some time. However, the existing comparative advantages and trade between adjacent areas of the Hills can be further developed and encouraged.

Taking the four headings above as defining an approach to Hill economic development, the following strategy emerges:

1. Seek to improve the largely self-sufficient production of food crops (especially foodgrains), livestock, fodder, fuelwood, and fruit in Hill communities to obtain more food from the same resources with minimum harm to the resource base.

2. Where possibilities for commercial exchange exist, adjacent to motorable roads and population centers, introduce elements of a modernizing agriculture, such as cash inputs, credit, and marketing of a surplus. These areas may also permit the development of specialized commercial crops, generally with a high value to weight/bulk ratio. The specific crops or products would have to be determined by critical studies to ensure agronomic and economic potentials.

B. Catalyzing Development

Much of the literature on development concerns itself with categorizing in a general way the constraints and facilitating conditions to "development", and how these factors can be adjusted in a favorable direction by means of public policy, public administration, and public planning and investment. In Nepal it would appear that critical factors are the implementation of government policies and programs, and catalyzing the people of a locality to undertake effective development activities. The latter involves time and culture-specific issues of great complexity. While the present study has concentrated on the possibilities for improving technology for the Hill regions, it is not restricting attention only to research, but embraces the continuum of development of new technology through its use or application by farmers.

Catalyzation of Hill development depends first on a continuous and progressive process of finding solutions to problems which prevent greater advantage being derived from the human and natural resources of a particular Hill area. Since agriculture is the most important socio-economic activity, appropriate agricultural technologies as defined earlier should provide in most instances the initial catalyst for development change. There are presently available few improved technologies which are widely adaptable and offer dramatic increases in Hill subsistence agricultural production, and the development and spread of new knowledge and practices will not be easy, rapid, or "automatic". The analogy of the "irrigated wheat revolution" does not apply to Hill agriculture production possibilities. Nevertheless, Hill development will have to be Hill-agriculture-led, and will have to be heavily dependent upon a strengthened HMG agricultural research system. Government development agencies will be called on for local sensitivity, flexibility, and credibility in fitting improved technology to Hill environments.

Catalyzation of Hill development secondly, therefore, must look to local community leadership, a sense of social consciousness and community cooperation, and government and quasi-government institutions and agents in the locality. Many stimuli for local change, of course, do not come from HMG. Returned migrants and ex-servicemen, children sent outside the community for schooling, and radio have a pervasive influence on community knowledge and attitudes. Indian price and trade policies also have an important impact on the local economy. Nevertheless, it is the government which must take responsibility for purposeful policies and program for Hill development. The question is how to implement, and how to strike the right balance between simple response to local felt needs articulated through the village and district political structures, and the introduction from the outside of new opportunities, knowledge, production inputs, and practices which may, or may not, have local appeal.

There are a limited number of government and quasi-government institutions, agents, and organizations with development mandates operating locally in Hill communities: Panchayats; class organizations of peasants, ex-servicemen, graduates, youth, and women; the "Back Village" National

Campaign; the Local Development Department; the Health Department with health posts and health workers; cadets of the National Development Service; the Agricultural Extension System with the District Development Officers (DDO's) and Junior Technical Assistants (JTA's); farmer leaders; and the primary and secondary school system. Of these, the extension system has been most directly concerned with promoting agricultural development, with the DDO/JTA furnishing the principal channel from the Department of Agriculture to the farmer. The use of farmer leaders for promoting agricultural innovation is just beginning. With the vocationalization of education under the National Education System Plan, agriculture is also to get extensive attention in the schools. All three of these channels connecting government with hill communities and back require further attention and improvement.

At present JTA's have ten years of education plus one year of general agricultural training. They are young, generally without direct experience of running a farm themselves, and usually posted in areas distant from their home community. As yet, there are only a small number in the Hills, and overall turnover is high as young men move on to higher studies or to higher paying, more prestigious jobs. JTA's are a new idea in Hill communities, and it is not yet clear to most Hill farmers (as well as to many JTA's) how their contacts actually contribute to agricultural advance. Nor is it clear that just more training and larger numbers of JTA's, however well supported by the agricultural research system, will be able to adequately catalyze agriculture-based Hill development. JTA's can be effective in situations where they are able to (1) deliver something the farmer wants, such as an improved variety of seed, (2) suggest a solution to a farming problem that already exists, or (3) be a willing instrument for farmers in obtaining goods and services they want from the government (a sprayer for the panchayat, credit from a bank-managed cooperative). The JTA can thus respond to felt needs, but at the present time he appears less suited for flexible, sensitive, and credible introduction of genuine agricultural innovation.

Farmer leaders, if they can be recruited, trained, and supported, have some advantages the JTA's do not. Farmer leaders would be older people with farming experience in Hill communities, but not necessarily possessing a SLC Pass. The emphasis would be on selecting people already acquainted with agricultural practices in the Hills, and who have demonstrated some ability in adopting improvements. Training could then supplement and give force and direction to their expanded efforts. The Lumle Agricultural Centre is already experimenting with this idea, using ex-servicemen. Farmer leaders have the potential of being flexible. They are sensitive to the local situation, and they are locally credible, so they can be effective conduits between the agricultural research stations and Hill farmers.

The training and posting of vocational agriculture teachers to Hill schools can potentially complement the JTA's as a second, although somewhat different reciprocal channel between government development policies and programs, and Hill communities. The vo-ag teachers emerging from the Institute of Agriculture and Animal Sciences will have ten years of education plus four years up to the Diploma level in agricultural education. While they too will probably not have had direct experience of running a farm, they will find themselves occupying an already established role of teacher within an established local institution, the school. People of the locality will already have expectations about the school -- as a place for their children to go for purposive activity with an expected result. The vo-ag teacher should be encouraged to use his position to reach out into farming households through his students or through direct contact with farmers. He should be able to use his position and prestige, and his greater knowledge of agriculture to draw farmers to the school to learn new skills. He may also be able to adapt and introduce agricultural innovation in the farming community. Unlike the JTA, the vo-ag teacher will not be tied to target achievements and to the systematic processes for field tests and farm demonstrations of new technology to be guided by the proposed subject matter specialists. Important questions of how to motivate and encourage vo-ag teachers to become agricultural activists, and how to involve them in the agricultural research/extension system while leaving them in the educational system, have to be explored further.

Suggestions for improving administrative structures and research systems are easy to make. It is much more difficult to determine how government Hill development policies and programs can actually be implemented to the greater benefit of Hill people at particular times and in particular situations. This task, after all, involves responsibilities of many HMG officers. There is the danger of trying to manage too much, but the opposite danger is to do, or be able to do, too little.

TEAM MEMBERS

1. Charles Bailey grew up on a farm in southeastern Michigan, and graduated from Swarthmore College in 1967 with a B.A. (Honors) in history and political science. First coming to Nepal with the Peace Corps, Mr. Bailey underwent training and received a certificate in agricultural education from the National Vocational Training Centre, Sano Thimi. He worked from 1967 to 1969 as a high school teacher of vocational agriculture and extension worker in Mulpani Athrai, Terhathum District. From 1969 to 1970, he worked in Kathmandu as a curriculum developer for agricultural topics in the Ministry of Education's Science Teaching Enrichment Programme. He was then admitted to the Woodrow Wilson School of Public and International Affairs at Princeton University, receiving in 1972 the degree of Master of Public Affairs in modernization and economic development. Mr. Bailey joined the New Delhi staff of the Ford Foundation in August 1972. He is particularly associated with the Kumaun Hills Rural Area Planning, Research, and Action Project of the G.B. Pant University, Pantnagar.

2. Loy V. Crowder was born February 5, 1920. He received the M.Sc. degree from the University of Georgia and the Ph.D. from Cornell University. He served as pasture agronomist at the Georgia Experiment Station in 1947-55 and as Head of the National Pasture and Fodder Project of the cooperative Rockefeller Foundation program in Colombia in 1955-63. Since 1963 he has been a professor of plant breeding at Cornell University.

Dr. Crowder assisted in planning the pasture and forage program of the International Center of Tropical Agriculture (CIAT) in Colombia in 1967 and was an adviser in agronomy (pastures and forages) at the University of the Philippines, College of Agriculture in 1967 and 1969. He served with the Ford Foundation on a pasture and fodder survey in Pakistan in 1969. In 1970 he was a member of the World Bank Team that reviewed agriculture in Spain and planned the project for strengthening the national agricultural research organization.

Dr. Crowder served as Visiting Scientist in Pasture and Fodder Crops at the International Institute of Tropical Agriculture (IITA) and the University of Ibadan, Nigeria in 1971-73. He was a member of the team that reviewed the Livestock and Pasture Program of CIAT in 1973.

3. Wayne H. Freeman was born November 21, 1915 and reared on a general crop and livestock farm in Kansas. He graduated from high school in Kirwin, Kansas and received the B.S. degree in Agronomy in 1938 from the Kansas State University. He received his M.Sc. in Agronomy from the University of Illinois in 1940 and his Ph.D. at the same institution in 1945.

In 1941 he joined the staff of Mississippi State University as Assistant Maize Breeder, which post he held until joining the U.S. Department of Agriculture in 1943. He served as Associate Agronomist and Agronomist for ten years with the USDA, stationed at the Georgia Coastal Plains Experiment Station at Tifton, Georgia. During this period he was in charge of the maize breeding program for the Georgia Coastal Plains station and developed the hybrid Dixie 18 which was to become one of the first widely grown yellow maize hybrids in the Southeastern U.S.

In 1953 he joined the Greenwood Seed Company, Thomasville, Georgia, as maize breeder in which capacity he served until he joined the Rockefeller Foundation in 1961. He was posted in India to work with the Indian Government in the development of a seed industry through the newly formed National Seeds Corporation.

From 1966 to the present he has served as Joint Coordinator of the All India Coordinated Rice Improvement Project. This project involved central government and state research staff and stations in a multidisciplinary, multi-location network to accelerate rice research and production. The rice program has been one of the more successful of several coordinated projects in India.

During his professional career he has served on consultancies in Egypt on maize seed production; in Indonesia for the World Bank on upland crops research, and for USAID for rice research; and in Bangladesh for the IRRI on rice research.

4. Michael R. Harwood was born September 18, 1937 in Manchester, New Hampshire. He graduated from high school in Nashua, New Hampshire in 1955, then served for four years with the U.S. Air Force as meterologist and flight weather forecaster from 1957 to 1961. He graduated from Cornell University with a B.S.in vegetable crops in 1964. His M.S. and Ph.D. were from Michigan State University in plant breeding and genetics in 1967. From 1967 until 1971 he worked with the Rockefeller Foundation in Thailand as associate sorghum breeder attached to Kasetsart University. This program included sorghum breeding and agronomy, and experiment station development and management. From 1971 until the present he has been assigned by the Rockefeller Foundation to IRRI as agronomist and head of the cropping systems program. This involves multidisciplinary studies of cropping systems in the high rainfall rice-growing areas of Southeast Asia, and their improvement through extension and production programs.

5. John S. Niederhauser was born on September 27, 1916, in Seattle, Washington and graduated from high school at Palo Alto, California. He received the B.S. degree (1939) and Ph.D. (1943) from Cornell University, majoring in plant pathology with minors in plant breeding and botany. He served as plant pathologist with the USDA in 1944-45, and as Assistant Professor in Plant Pathology at Cornell University from 1945-47.

In 1947 Dr. Niederhauser joined the staff of the Mexican Agricultural Program of the Rockefeller Foundation, where he was stationed until his retirement in July, 1973. He carried out research and development work in the phytopathology of maize, wheat and potatoes during the first 15 years of his career in Mexico, gradually increasing his emphasis on the development of potato production programs, first in Latin America, then throughout the world. From 1962 to 1973 he was Director of the International Potato Program of the Rockefeller Foundation. With the establishment of the International Potato Center in Peru in 1972, the International Potato Program was incorporated into the new Center. In 1973, Dr. Niederhauser joined the staff of the Center to work in the outreach program.

6. M.B. Russell was born April 11, 1914 on a farm in Southern Michigan. He received the B.S. in agriculture from Michigan State University in 1936 and the M.Sc. and Ph.D. degrees in Soil Physics from Iowa State University in 1937 and 1939,

respectively. He taught physics and soil physics and conducted research on soil water, clay mineralogy and soil structure as a member of the faculty of Iowa State University from 1939 to 1945. As Professor of soil physics at Cornell University in 1946 to 1951 he developed and taught courses in soil physics and physical edaphology. From 1951 to his retirement in 1974 he served on the faculty of the University of Illinois first as Head of the Agronomy Department (1951-1962), then as Director of the Illinois Agricultural Experiment Station (1962-1969) and finally as Leader of University development teams at two new agricultural universities in India. Professor Russell has served as President of the Soil Science Society of America, the American Society of Agronomy and of Commission I of the International Society of Soil Sciences. He has been a member of the Agricultural Board of the NAS-NRC, the Science Advisory Committee to the Secretary of Agriculture, the Advisory Committee to the Division of Biology and Medicine of the Atomic Energy Commission, the Board of Directors of the Agricultural Development Council and the Research Advisory Board for Cities Service Company. He has served in several countries of south and southeast Asia as consultant to the Ford and Rockefeller Foundations and USAID on water management and on agricultural research planning and evaluation.

7. Delane E. Welsch was born in Milford, Nebraska on June 1, 1934. He received the B.Sc. in general agriculture in 1959 and the M.Sc. in agricultural economics in 1962 from the University of Nebraska, and the Ph.D. in agricultural economics in 1964 from Michigan State University. His areas of specialization include farm management and production economics, marketing and agribusiness, and agricultural policy. His work experience includes research in Nigeria (1963-64), teaching and research in Texas A.M. University (1964-67), an IBRD/FAO irrigation review mission in Sri Lanka, and teaching, research and university development activities in Thailand (1967 to present). He currently holds positions of Visiting Professor in Agricultural Economics at Kasetsart and Thammasat Universities in Bangkok, Professor of Agricultural and Applied Economics at the University of Minnesota, and Agricultural Economist of the Rockefeller Foundation, posted in Bangkok. His commodity experience includes rice, maize, sorghum, food legumes, cassava and livestock.

8. Albert H. Moseman was born January 27, 1914 on a farm in Northeast Nebraska. He received the B.S. degree in 1938 and M.Sc. in 1940 from the University of Nebraska, and the Ph.D. from the University of Minnesota in 1944 with a major in plant breeding and genetics. He served with the U.S. Department of Agriculture in the regional hard red winter wheat improvement program in 1936-40 and then assisted in organizing the coordinated national seed flax investigation program in 1940-44. From 1944-1956 he was involved in research administration in the USDA, including service as Chief of Bureau of Plant Industry, Soils and Agricultural Engineering from 1951 to 1953 and as Director of Crops Research in 1953-56. He joined the Rockefeller Foundation in 1956 to give initial attention to development of the cooperative agriculture program in India. He served as Director of the Rockefeller Foundation Agricultural Sciences program in 1960-65. Dr. Moseman was Assistant Administrator for Technical Cooperation and Research USAID, from 1965-67 and then joined the staff of the Agricultural Development Council. During his time with the ADC he was involved in planning the Malaysian Agricultural Research and Development Institute (MARDI) and served as the initial director of this national agricultural research organization from 1969 through 1971. Dr. Moseman has served as a consultant-adviser in the review and planning of national agricultural research organizations in India, Pakistan, Bangladesh, Malaysia, the Philippines, Thailand, Indonesia and Afghanistan, and in review of selected research activities in Korea, Iran, Sri Lanka and Taiwan during the past 20 years.

SCHEDULE AND CONTACTS

November

2-3	Arrival of Team Members	
4 (M)	10:00 A.M.	Meeting with Team Associates - Khumaltar Farm Dr. K.B. Rajbhandary, Deputy Director General, Plant Research Mr. A.M. Pradhanang, Chief Agricultural Botanist Mr. M.L. Pradhan, Chief Soil Scientist Dr. B.B. Shahi, Acting Chief Rice Coordinator Mr. R.B. Shrestha, Agronomist, Cropping Systems Mr. L.P. Sharma, Livestock Officer, Pasture Mr. S.K. Shrestra, Plant Pathologist, Potatoes Mr. L. Khairgoli, Potato Development Officer
	2:00 P.M.	Meeting with Secretary of Agriculture, Mr. Karna Dhoj Adhikari
5 (Tu)	7:00 A.M.	Drive to Pokhara Visit Gandaki Project enroute (West German assisted) Mr. H.B. Shrestha, Project Director Mr. Jens Von Barben, German Technical Officer Mr. Moti RamLautt, Horticulturist Mr. S.E. MadhiKarmy, Assistant Plant Protection Officer
6 (W)	9:30 A.M.	Trek to Lumle, British Hill Agriculture Project for Gorkha training (6 hour walk -- 16 miles) Col. Alistair Langlykke Mr. Thomas Wormald, Forestry Mr. Ramkrishna Raux, Horticulture Mr. Prem Dutt, Pastures Mr. Mike Roper, Agronomy Mr. Panday, Agronomy Dr. Peter Robinson, Animal Health Mr. Richard Odell, Sheep Investigation (Note: Mr. Bill Evely, Manager, was enroute from Kathmandu)
7 (Th)	9:30 A.M.	Return Trek to Pokhara
8 (F)	8:00 A.M.	Drive from Pokhara toward Tansen, to Naudande village, Thulodhunga, Walling Village, Bhumre and Galyambhyang Pass. Visit Gandaki Project horticulture and livestock centers and Regional Agricultural Development Activities. Mr. H.B. Shrestha, Gandaki Project Director Mr. B.P. Sinha, Director of Pokhara Agricultural Development Region Mr. Tapha, Livestock Officer, Syangja
9 (Sa)	8:00 A.M.	Drive, Pokhara to Kathmandu Mr. Govind Shah, Livestock Officer and Livestock Farm Manager, Pokhara Mr. T.K. Lama, Assistant Plant Pathologist, Horticultural Research Station, Pokhara.

10 (Su) 8:00 A.M. Team meeting to schedule travels

10:00 A.M. Khumaltar Farm, briefings by Department of Agriculture

Mr. K.B. Rajbhandari, DDG Plant Research
Mr. A.M. Pradhanang, Chief Agricultural Botanist
Mr. M.L. Pradhan, Chief Soil Scientist
Dr. S.N. Lohani, Acting Chief Agronomist
Mr. L.P. Sharma, Livestock Officer
Mr. P.N. Rana, Entomology Section
Mr. M. Shah, Plant Pathology Section
Dr. B.B. Shahi, Acting Chief Rice Coordinator
Mr. J.D. Sakya, Acting Chief Potato Development Officer
Mr. G.P. Rajbhandary, Acting Chief Maize Coordinator
Mr. S.B. Nepali, Chief Of Janakpur Ag. Dev. Project
Mr. T.B. Basnyat, Chief Agricultural Engineer

4:00 P.M. Dinner, Dr. and Mrs. Melvin Splitter
Dr. and Mrs. Phillip D. Smith, Chief, FAO/USAID
Mr. Don Wilder, Peace Corps Training Officer
Mr. Peter Calkin, Cornell University

11 (M) 8:30 A.M. UNDP/FAO
Mr. Jacob Joury, UNDP Representative
Mr. John Glistrup, FAO Representative

10:30 A.M. Department of Agriculture

Mr. B.B. Khadka, Director General of Agriculture
Mr. S.K. Upadhaya, Deputy General Manager, Agricultural Development Bank of Nepal
Mr. A.N. Rana, Chairman and General Manager, Agricultural Marketing Corporation
Dr. I.H. Khan, Acting Director General, Department of Food and Marketing Services
Mr. Peter Myers, Director, UNDP Hill Agriculture Development Project

2:30 P.M. IBRD

Mr. David Thomas, Resident Representative

12 (Tu) Schedule for A.H. Moseman and M.B. Russell

10:00 A.M. Department of Agriculture

Mr. B.B. Khadka, Director General
Mr. S.B. Nepali, Chief of Janakpur Agricultural Development Project

2:00 P.M. Swiss Association for Technical Assistance (SATA) Integrated Hill Agricultural Development Project

Mr. Kurt Voegele
Mr. Paul Egger

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13 (W) 2:30 P.M. Meeting with USAID

Dr. Charles Greader, Director USAID/N
Dr. Phillip D. Smith, FAD
Mr. Jacob Crane, Program
Miss Carol Peasley, Program

14 (Th) Preparation of report outlines and future schedules

Schedule for J.S. Neiderhauser, J.D. Sakya, L.V. Crowder and L.P. Sharma

12 (Tu) 8:00 A.M. Depart Kathmandu to Namchebazaar (Syangboche) STOL
Salukhumbu Yak Farm

Dr. P.M.S. Pradhan, Farm Manager
Mr. Madhav Upadhya, Assistant Manager

14 (Th) 8:30 A.M. Pick up at Syangboche to return to Kathmandu STOL

Schedule for R.R. Harwood and S.N. Lohani

12 (Tu) 8:00 A.M. Depart Kathmandu to Namchebazaar and Tumlingtar STOL

Mr. Khana, Chief District Officer, Tumlingtar
Mr. Pokhrel, JTA, Khanbari
Mr. Karka, JTA, Khanbari

14 (Th) 9:00 A.M. Pick up Tumlingtar to return to Kathmandu STOL

Schedule for W.H. Freeman, B.B. Shahi and D.E. Welsch

12 (Tu) 8:00 A.M. Depart by Carryall for Parwanipur, National Rice Research Center

13 (W) Rapti Agricultural Station, National Maize Research Center

Mr. Gopal Rajbhandary, Maize Coordinator
Dr. Melvin Splitter, CIMMYT/USAID

Institute of Agriculture and Animal Science

Mr. Rajbhandary, Dean of IAAS
Mr. Merrill Asay USAID, Adviser

14 (Th) 4:00 P.M. Pickup at Rampur to return Kathmandu STOL

Contacts by C.R. Bailey, November 12-14

Dr. Govind Agarwal, Director, Center for Economic Development and Administration (CEDA)
Mr. Mahesh Banskota, Research Associate, CEDA
Mr. Durga Prasad Ojha, Research Associate, CEDA
Mr. Tek Raj Joshi, Chief, Extension and Training Division, Department of Agriculture

15 (F) Team conference and individual conferences with counterparts

16 (S) M.B. Russell and R.R. Harwood depart to ICRISAT Conference, Hyderabad, India

Schedule for A.H. Moseman, J.S. Neiderhauser and J.B. Sakya

7:00 A.M. Depart for Biratnagar via helicopter. Pick up Regional Director, R.C. Gupta

10:30 P.M. Joubari Potato Research Farm

Mr. J.K. Garg, Indian Cooperation Mission
Mr. S.P. Yadav, Farm Manager
Mr. S.K. Thapa

1:30 P.M. District Agricultural Development Office, Ilam

2:30 P.M. Gurkha Training Center, Pakribhas (UK supported)

Mr. Adrian Gordon
Mr. R. Sen, Extension Agronomist

3:30 P.M. Pari Patle Research Station, Dhankuta

Mr. R.D. Shahi, Farm Manager
Mr. B.R. Kaini, Assistant Vegetable Officer
Mr. B.R. Khadje, Assistant Plant Pathologist

17 (Su) 8:00 A.M. To Biratnagar

9:00 A.M. Tarhara Agricultural Research Station, Biratnagar

Mr. N. Giri, Station Manager
Mr. D.N. Chaudhary, Assistant Agronomist
Mr. T.N. Misra, Assistant Horticulturist
Mr. S. Jha, Fisheries Officer
Mr. S.D. Adhikari, Poultry Officer
Mr. Yonjon, Agricultural Officer, JRC
Mr. Madhav Joshi, Assistant Jute Agronomist
Mr. S.B. Gurung, Agricultural Officer
Mr. S.P. Pandey, Assistant Soil Scientist

10:30 A.M. Return to Kathmandu, overfly Salleri and Jiri

12:00 P.M. J.S. Neiderhauser and J.D. Sakya proceded to Helambu, site of proposed potato seed production center

Mr. D.P. Manandhar, Assistant Horticulturist
Mr. Jimi Lama, JTA

18 (M) 8:00 A.M. Team conference in USAID

10:30 A.M. Discussions (AHM, WHF, JSN, and LVC) with HMG counterparts at Khumaltar Farm

10:30 A.M. Meeting with CEDA (DEW and CRB)

2:00 P.M. Meeting with Ministry of Agriculture

Dr. B.P. Dhital
Secretary K.D. Adhikari
Director General B.B. Khadka

19 (Tu) 2:30 P.M. Meeting with USAID (AHM only)

Dr. Charles Grader, Director
Dr. P.D. Smith, FAD
Mr. Jacob Crane, Program
Miss Carol Peasley, Program
Mr. Charles Antholt, USAID/W

Schedule for Moseman, Crowder, Freeman, B.B. Khadka, Grader

20 (W) 10:30 A.M. Depart Kathmandu STOL

11:55 A.M. Arrive Dang

1:10 P.M. Depart Dang

1:40 P.M. Arrive Nepalgunj to pick up Mr. B. Dangol, Regional Agricultural Development Director

Mr. Robert Bartlett

2:30 P.M. Depart Nepalgunj

2:50 P.M. Arrive Surkhet

Mr. Khetti, Acting Assistant District Agr. Develop. Officer

Mr. Rama, JT

21 (Th) 8:00 A.M. Depart Surkhet

9:00 A.M. Arrive Tibrikot, Karnali Sheep Farm

Mr. S.B. Singh, Acting Livestock Officer and Farm Manager

11:00 A.M. Depart Tibrikot

11:10 A.M. Arrive Jumla Agricultural Research Station

Mr. H.P. Gurung, Station Manager
Mr. M.B. Adhikari, DADO

1:40 P.M. Depart Jumla

2:20 P.M. Arrive Doti Experiment Farm

Mr. C.R. Yadav, Assistant Plant Protection Officer
Mr. T.R. Sharma, Acting DADO
Mr. G.P. Sharma, Veterinary Lab. Assistant

22 (F) 8:35 A.M. Depart Doti

9:30 A.M. Arrive Nepalgunj Agricultural Research Station

Mr. K.K. Shrestha, Acting General Manager
Mr. S.P. Upreti, Acting Cotton Develop. Officer
Mr. D.C. Shahupathic, Assistant Agricultural Botanist
Mr. G.P. Pandey, Assistant Agronomist

10:30 A.M. Meeting in office of Regional Director - Dangol

Mr. S.K. Shrestha, Assistant Agric. Officer, Nepalgunj
Mr. Devaki Shrestha, Assistant Agric. Develop. Officer (NPJ)
Mr. U.P. Rijal, Regional Manager (NPJ)
Mr. S.D. Pant, Project Incharge of Resettlement Project, Banke
Mr. S.M. Shrestha, Regional Manager, ADB
Mr. K.M. Shrestha, Irrigation Engineer
Mr. K.R. Regmi, Assistant Agronomist, Surkhet
Dr. S.L.P. Gupta, Veterinary Doctor
Mr. N.A. Khan, Senior Agric. Officer (NPJ)
Mr. H. G. Gorkhali, Loan Officer, ADB
Mr. K.P. Paudyal, CDO (NPJ)
Mr. Robert Bartlett, USAID, Nepalgunj

1:25 P.M. Depart Nepalgunj to return to Kathmandu

Schedule for A.H. Moseman, L.V. Crowder, L.P. Sharma and Mr. P.J. Rana, Deputy Director General for Livestock

23 (Sa) 8:00 A.M. Depart Kathmandu, Helicopter

8:15 A.M. Arrive Chitlang Sheep Farm

9:35 A.M. Depart Chitlang

9:55 A.M. Arrive Panchasaya Khola Sheep Farm

Mr. N.P. Shrestha, Livestock Officer and Farm Manager
Mr. Robert Greenfield, Peace Corps
Mr. Rich Monosson, Peace Corps

	12:00 P.M.	Depart Panchasaya
	12:25 P.M.	Arrive Langtang, Kyanochin Cheese Factory
	1:30 P.M.	Depart Cheese Factory
	1:40 P.M.	Arrive Langtang Village
	2:00 P.M.	Depart Langtang Village, Via Kathmandu for refueling to Jiri
	3:00 P.M.	Arrive Jiri Livestock Station
		Mr. S.P. Adhikari, Farm Manager Mr. L. Sherchana, Livestock Officer Mr. Nemang, Dairy Products Development Officer
24 (Su)	8:00 A.M.	Depart Jiri
	8:20 A.M.	Arrive Khimti Livestock Farm
	8:55 A.M.	Depart Khimti
	9:05 A.M.	Arrive Thodung Cheese Farm
		Mr. Pasang, Farm Manager
	10:45 A.M.	Depart Thodung
	11:05 A.M.	Arrive Syangboche, Solukhumbu Yak Farm
		Dr. P.M.S. Pradhan, Farm Manager
	12:20 P.M.	Depart Syangboche
	1:25 P.M.	Arrive Kathmandu
25 (M) through 28 (Th)		Preparation of Report

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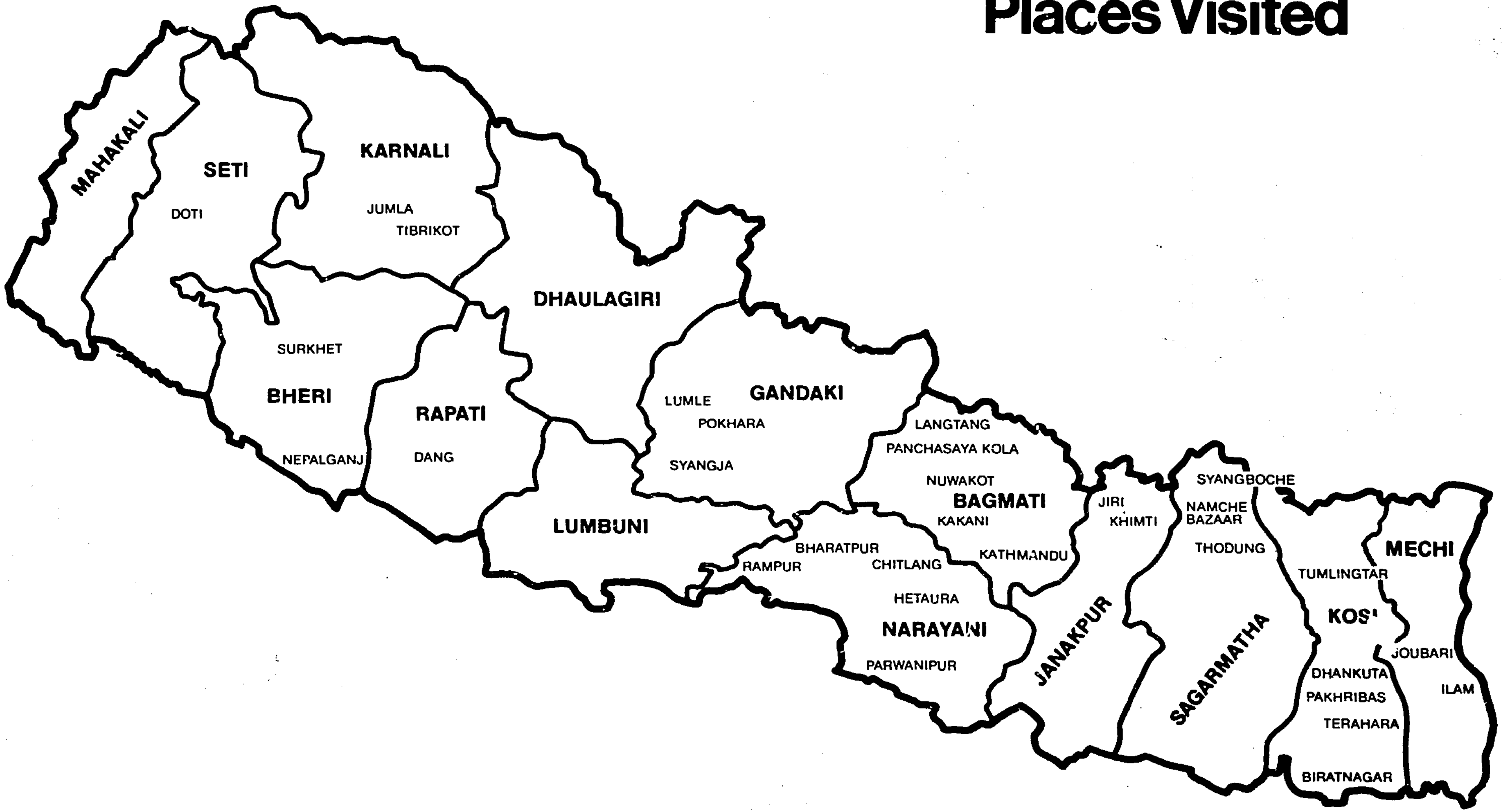
Annex III
Places Visited



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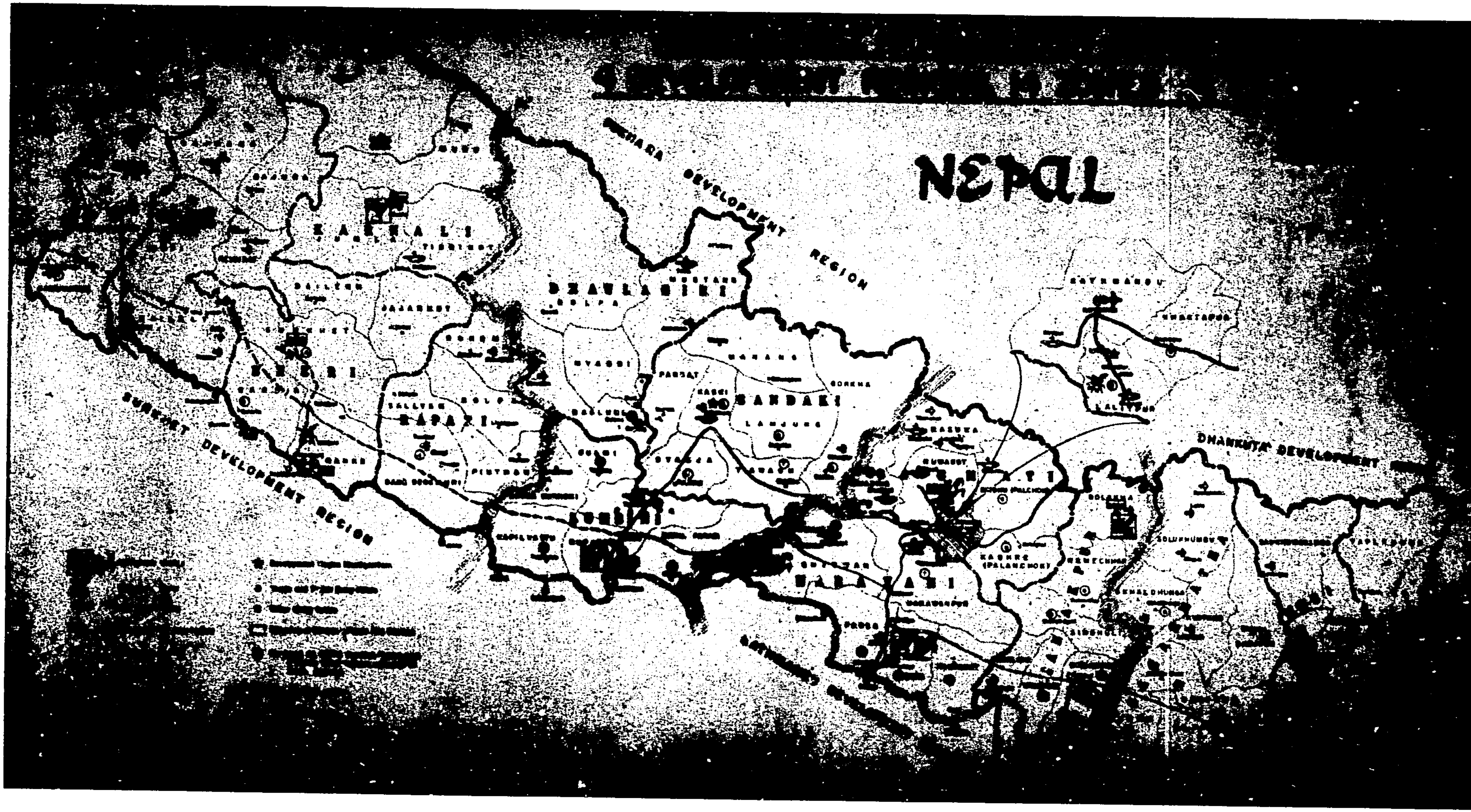
NEPAL
DEVELOPMENT REGION
SURKHET DEVELOPMENT REGION
DHANKUTA DEVELOPMENT

SELECTED AGRICULTURAL DEVELOPMENT PROJECTS

The several agricultural development projects visited by the Team furnish guidance in the identification of specific problems in Hill agriculture, in the relative success of various approaches to development, and major constraints as recognized after several years of operation.

1. Gandaki Agricultural Development Project

The project was set up in 1969 pursuant to an agreement between HMG and the Government of the Federal Republic of Germany. The Project Headquarters is located at Khairenitar, about 30 kilometers southeast of Pokhara along the Prithbi Rajmarg (Kathmandu-Pokhara Highway) which was opened up in 1973.

The project area is in the Gandaki Development Sector or Western Development Region. The sector consists of three zones, Gandaki, Lumbini and Dhaulairi. Five of the Gandaki zone's seven districts are covered by the project, i.e., Kaski (where Pokhara Town is), Syangja, Tanahun, Gorka and Lamjung. The total population in the five districts is about one million.

The area of these five districts is 821,000 ha. of which some 73,000 ha. are under cultivation. Average size of farm holdings is about 0.4 ha.

The objectives of the project are 1) to achieve an overall increase in agricultural production by an intensified extension service coupled with sources of credit to farmers and their cooperatives for agricultural inputs, 2) to reduce migration from the Hills to the Terai, and 3) to attain diversification from purely subsistence to market-oriented production. Replacement of fallow with rabi crops was realized by increased wheat cropping. Improved hand tools, better storage of farm produce and seeds, expansion of vegetable cropping, introduction of cash crops, encouragement of improved varieties of fruits, upgrading the local stock with pedigree Murrah sires, and introduction of fodder cultivation are among the activities carried out by the Project.

HMG is currently providing 250 Nepali staff members (mainly technical, excluding ADB and AIC staff) at Project Headquarters as well as at field level. The German staff consists of the German Project Officer, Agronomist, Farm Manager, Irrigation Engineer and Workshop Manager.

2. The Lumle Agricultural Center

The Re-integration Training Scheme, sponsored by the British Government (Ministry of Overseas Development) under the Colombo Plan, offers training designed to assist retiring ex-servicemen to become gainfully employed on their retirement from military service. There are at present over 20,000 pensioned ex-British Army Gurkhas in the hills, to be joined by a continuous stream so long as men continue to serve in the British Army. The majority of the ex-soldiers are agriculturalists by choice and by upbringing.

The Lumle Agricultural Center was established in 1969 as a part of an overall Re-integration Training Scheme supported by the UK and intended to demonstrate improved agricultural methods under physical conditions closely resembling those found in the soldiers' homes by:

1. Training courses at the Center's demonstration farm, and

2. Sending members of the farm staff out on extension work to follow up trainees and to help and advise them and other farmers in their villages.

This was the first agricultural training center in Nepal designed primarily to assist high altitude farming, consistent with HMG's high priority accorded to agricultural and economic development in the hills. The Center is intended to serve ex-soldiers whose homes lie in the hills of Western Nepal. The site for the Center comprises approximately 100 acres of South-facing hillside. The cultivated terraces lie between 4,800 and 5,600 feet and above this, mixed rhododendron jungle reaches up to about 7,300 feet. The Center is located between the villages of Khar and Lumle, 12 miles west of Pokhara, on the main track to the Kali Gandaki via Naudanra, Birithanti and Tatopani. After the rice harvest, it is possible to motor from Pokhara to Nalpani, at the foot of Kaski Danra. From there the project is reached by a good foot-track in 2 hours. To walk the whole distance from Pokhara takes about six hours, climbing about three thousand feet.

The intention of the project is to teach general agriculture and animal husbandry applicable to altitudes from about 5,000 feet upwards. It is hoped not only to improve methods used for traditional crops, but also to introduce new crops. The courses at the Center are confined to ex-British Gurkha soldiers, whose travel and subsistence is met from British funds. These men are expected to return to their villages capable of being regarded as "leader farmers." In addition, extension teams go out from the Center to assist and advise farmers in the areas in which the Center operates. With the agreement of HMG it is assumed that the project will continue for as long as there is a demand for such assistance.

3. <u>The Pakhribas Agricultural Center</u>

When Lumle Agricultural Center was established in 1969 to train ex-servicemen from the Hills in Western Nepal the ex-soldiers from Eastern Nepal were provided similar opportunities at the Jiri Multi-purpose Development Project of the Home and Panchayat Ministry.

In 1972 it was decided to set up an additional training unit in Eastern Nepal and the Center at Pakhribas, at an elevation of 5,500 feet was started in October 1973. Special attention will be given to agronomy, horticulture and livestock at Pakhribas, with training, extension and development activities planned on the basis of experience at Lumle.

The Pakhribas Center lands, about 120 acres of which 40 acres are now cultivated, were provided by HMG. The operational costs are borne by the British Government.

The crop and livestock development projects are moving forward vigorously and there will be a continuous study of the needs and direction of efforts for the project as it evolves.

4. The Integrated Hill Development Project

During the late 1950's HMG and FAO established a buffalo-breeding station in Jiri (Dolakha District). These efforts were continued by the Swiss Association for Technical Assistance (SATA) since 1960. In addition to the Jiri farm, a medical service was established, a forest and pasture program was started and extensive research in grain and vegetable crops was conducted.

In 1964, HMG and SATA entered into an agreement governing expanded activities in Jiri for agricultural and social development. With the formation of the Jiri Education Section, the Civil Engineering Section, the Panchayat Training Center and the Agriculture Extension Section, Jiri became truly a Multipurpose Development Project (JMDP).

By the end of the 1960's, a working area of about 700 square kilometers had been created around the Jiri Valley. This included 34 village panchayats in the districts of Dolakha, Ramechhap, Okhaldhunga and Solu-Khumbu. Agricultural and horticultural extension, medical services, teachers' training, civil engineering activities, as well as forest and pasture improvements were carried on in the vicinity of Jiri. This work has left its imprint on the life of the local population and has yielded valuable experience in integrated development efforts in the Hills.

One of the major drawbacks in almost all of the project activities was the lack of suitable communication and transportation between the project's working area and more advanced economic centers of the country (Terai or Kathmandu). This precluded the extending of the scope of JMDP beyond the limits of the traditional subsistence economy. In September 1972 HMG and the Government of Switzerland agreed to proceed with a road into the project area, to furnish a framework for an Integrated Hill Development Project. All project preparations undertaken since that time have been based on the conviction that a road project without the overall concept of integrated development would make as little sense as an integrated development project without a road. The two elements cannot be separated.

HMG and the Government of the Swiss Confederation agreed on March 8, 1974 to undertake the Integrated Hill Development Project (IHDP) in the region between the Sun Kosi in the west and the Khimiti Khola in the east. As a backbone to this integrated project a 100 km gravel road is in preparation, linking Lamosangu (on Kodari Road) to Jiri.

The project's intensive working area of 600 square kilometers covers large parts of Sindhu Palchok, Dolakha and Ramechap Districts and is identical with the command area of the road. The region is characterized by a high density of population and increasing pressure on the arable land, pastures and forests. It is a food deficit area, by about 20%, with an almost purely agricultural subsistence economy--being mostly marginal--and therefore with little interregional economic interaction. The imprints of man's quest for food, fodder and fuel are visible everywhere and the balance between human activity and natural resources is being destroyed.

The differences in altitude in the working area, from 700 m up to 3500 m, embrace a wide range of cropping patterns and are also partly responsible for differences in the social and ethnic structure of the population. Illiteracy is very high in the project area (90%) and communication and information within the area and out of the area is poor. Active and motivated young people are searching for jobs outside the region because social mobility is low and job opportunities beyond the agricultural sector are rare. This leads to a high migration rate, some permanent and some seasonal.

The overall objective of integrated development activities is to restore the long-term balance between man's activities and the potentials of nature. The project is giving attention to increasing food production and its nutrient value by activity in agriculture and horticulture; by improving farm and forest-management (fodder and wood); by making new local energy resources available (gobar plant, solar energy, hydropower), by working in erosion control, soil conservation and proper water management; and by stepping up efforts in population control (health and family planning) and education (formal, functional and adult education). As the region cannot be made economically autonomous in the future, the production of agricultural and non-agricultural products for marketing will be taken up--to provide employment and to bring additional cash for food and energy into the region. A transportation system is a prerequisite for the interregionalization of the Hill economy and the planned gravel road will link the villages in the Hills to serve their inhabitants.

Planning and implementation will be interlinked, starting with trials and experiments where needed; evaluating and reconsidering the activities continuously. The project will work with the local people and emphasize extension work and training. In order to bring about changes in the socio-economic structure the project will not only focus on quick achievements by some well-off farmers but also will try to reach small farmers and landless people as well.

5. The Hill Agricultural Development Project

This project, initiated as a cooperative undertaking of HMG, UNDP and FAO in 1974, reflects the growing concern of HMG about the Hills, including:

1. The general, continuous deteriorating situation in Hill areas, with increasing population, declining agricultural productivity, and increasing erosion and destruction of natural resources;

2. The social and economic imbalance and the need for more regional integration between Hill and Terai areas, to provide an expanding basis for regional economic integration;

3. The need for assembling the information available about Hill conditions and about potentially available improved technology as a first step in strengthening HMG planning capability for Hill agriculture development.

The long-range objectives of the project are to raise farm incomes and productivity in Hill areas; to increase employment opportunities; to improve the socio-economic position of Hill communities; to strengthen social and economic regional integration; to maintain and improve soil fertility in Hill areas and to preserve a productive ecological balance within the Hill environment.

The immediate objectives are to establish within the Ministry of Food, Agriculture and Irrigation an Information Center for Hill Agriculture, as a permanent date and documentation center to identify and prepare development projects and programs for Hill areas; to provide technical and financial support to Hill agricultural development activities; to plan projects and programs related to Hill agriculture development and to formulate a long-term development policy and plan for Hill agriculture.

The project is located in the Ministry of Food, Agriculture and Irrigation. The Project Manager, appointed by HMG, reports to the Secretary, MFAI. The project is intended to cover all of Nepal except the Terai: i.e., a total of 55 administrative districts and excluding only the 20 districts of the Terai. Sector coverage is comprehensive and includes agronomy, horticulture, livestock, forestry, fisheries, soil conservation and irrigation, together with the agricultural development services (research, extension, credit, supply and marketing). In view of the broad coverage, the project will operate as much as possible through other projects and departments, particularly with regard to much of the information collected. The project became operational in July 1974 and has been set up initially for a two-year period. In order to meet project objectives, an extension of the project for the five years of the fifth Development Plan, with an expanded level of inputs, has been proposed.

6. The Potato Improvement Project

The Potato Improvement Project supported by the Indian Cooperation Mission is a comprehensive effort with attention to all potato growing areas of Nepal. The Team visited the potato station at Joubari and the discussion of the ICM activity at that station is presented in the section on the Coordinated Potato Development Program in this report.

OFFICERS OF THE DEPARTMENT OF AGRICULTURE

POST	CLASS	NAME	TRAINING	SPECIALIZATION
A. Directorate:				
Director General	1	Bed Bahadur Khadka	MSc	Pl Path
Deputy Dir Gen	1	Bidur Kumar Thapa	MSc	Soil
Dpty Dir Gen	1	P.J. Rana	MSc	Poultry
Dpty Dir Gen	1	Keshab Bahadur Rajbhandari	MSc	Hort
Dpty Dir Gen	1			
Planning Officer	2	Madan Bahadur Shrestha	MComm	
Assistant Planning Officer	3	Yadav Dev Pant	MComm	
Asst Plan Off (Actg)	3	Ram Prasad Sharma	Agri Dpl	
B. Agriculture Information Section:				
Chief Agri Information	1	Kiran Mani Dikshit	BSc Ag	Animal Husband
Asst Agri Inf Off	3	Chandra Kumar Bhattarai	SLC	Ag Dpl
Asst Inf Off	2			
Asst Audio Visual Off	3	Bala Prasad Sharma	IA	AV Train
Asst Inf Off	3	Madan Bahadur Manandhar (T)	BScAg	
C. Agricultural Extension and Training:				
Chief, Agri Ext and Trng	1	Tek Raj Joshi	MSc	Agronomy
Agri Trng Off (Actg)	2	Sudarshan Bhakta Mathema	BScAg	
Asst Agri Trng Off	3	Sagarnath Upreti	MA (Nepali)	
Asst Agri Trng Off (Actg)	3	Madan Krishna Shrestha	IADpl	
D. Rural Youth Section:				
Rural Youth Officer	2	Govind Bir Pandey	BSc Pure Sci	Rural Youth Train.
Assistant Youth Off	3	Rama Autar Sha	BScAg	
Asst Youth Off (Actg)	3	Shyam Bikram Rana	SLC	Sheep Train.
Asst Home Science Off	3	Chandra Thapa	BSc	Home Science

POST	CLASS	NAME	TRAINING	SPECIALIZATION
E. Entomology Section:				
Chief Entomologist	1	Prithu Narsing Rana	AIARI	Entomology
Senior Entomol (Actg)	1	Dr. Keshab Chandra Sharma	Ph D	Entomology
Entomol (Actg)	2	Gopal Prasad Kafle	MSc	Entomology
Entomol (Actg)	2	Ram Bahadur Pradhan	MSc Pure Sci	
Asst Entomol	3	Bishnu Kumar Gawal	BScAg	
Asst Entomol	3	Samundra Lal Joshi	BScAg	Plant Quarantine Train
Asst Entomol	3	Ganesh Kumar K.C.	BScAg	
Asst Entomol	3	Bhimsen K.C.	BScAg	
Asst Entomol	3	Basanta Prasad Adhikari	BScAg	
Entomol	2	Fanendra Prashad Newpani	MScAg	Entomology
F. Livestock Section No. 1:				
Chief Livestock Off (Actg)	1	Kedar Raj Pandey	BScAg	Inland Pasture
Livestock Off	2	Tej Bahadur Basnet	MSc	Poultry
Livestock Off (Actg)	2	Laxmi Prasad Sharma	BScAg	
Asst Livestock Off	3	Ronu Bahadur K.C.	BScAg	
Asst Livestock Off	3	Hari Ram Shrestha	BScAg	
Asst Livestock Off	3	Madan Lal Shrestha	Dpl	Dairy
Asst Livestock Off	3	Jageswar Jha	BScAg	
G. Livestock Section No. 2:				
Chief Livestock Off	1	Keshav Raj Keshari	MScAg	Sheep Husb
Livestock Off	2	Laxman Prasad Tripathi	MScAg	
Livestock Off	2	Ram Milan Upadhaya	BSc Pure Sci	IDD
Livestock Off (Actg)	2	Satrughan Lal Pradhan	MScAg	Wool Tech
Asst Livestock Off	3	Lal Bahadur Newang	IDD	
Asst Livestock Off	3	Surya Bahadur Singh	BScAg	
Asst Livestock Off (Actg)	3	Bal Mukunda Sedai	Dpl	Poultry
Asst Livestock Off (Actg)	3	Parthiv Bahadur Tandan	Poultry Train	
Asst Livestock Off (Actg)	3	Mukund Prasad Goutam	Poultry Training	
Asst Livestock Off (Actg)	3	Lila Prasad Rai	Poultry Dpl	

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POST	CLASS	NAME	TRAINING	SPECIALIZATION
H. Soil Science:				
Chief Soil Scientist	1	Manik Lal Pradhan	MScAg	Soil Sci
Soil Sci	2	Ranjit Shaha	MScAg	Soil Sci
Soil Sci	2	Ganga Prasad Dev	MScAg	Soil Sci
Soil Sci	2	Dr. Amrit Bahadur Karki	Ph D	Soil Sci
Soil Sci	2	Bibya Laxmi Barajacharya	MSc	Chemistry
Asst Soil Sci Off	3	Purna Lal Maharjan	MScAg	
Asst Soil Sci Off	3	Dambar Bahadur Tamang	BScAg	
Asst Soil Sci Off	3	Tej Bahadur K.C.	MScAg	
Asst Soil Sci Off	3	Shanker Bahadur Pradhan	MScAg	
Asst Soil Sci Off	3	Shanti Bhatta Rai	MScAg	
Asst Soil Sci Off	3	Prabhakar Bikram Shah	MScAg	
Asst Soil Sci Off	3	Dil Prasad Sherchand	BScAg	
Asst Soil Sci	3	Surya Laxmi Joshi	MScAg	
Asst Soil Sci	3	Binod Prasad Sharma	BScAg	
Asst Soil Sci (Actg)	3	Bhisma Nath Regmi	Dpl	
Asst Soil Sci	3			
Asst Soil Sci	3			
Asst Soil Sci	3			
Asst Soil Sci	3	Shanker Lal Chaudhari	BScAg	
Asst Soil Sci	3	R.B. Maskey	BSc	
Asst Soil Sci	3	Upendra Man Sainju	BScAg	
I. Veterinary Section:				
Chief Veterinary Dr. (Actg)	1	Dr. Shambhu Nath Rakurel	DSc	Ani Sci
Vet Dr (Actg)	1	Dr. Mankeswar Nath Pandey	MVSC	
Vet Dr	2	Dr. Durga Dutta Joshi	MVSC	
Vet Dr	2	Dr. Nat Raj Joshi	MVSC	
Vet Dr.	2	Dr. Arun Chandra Gupta	MVSC	
Vet Dr	2	Dr. Madha Sudhan Sharma	BVSC, AH	
Vet Dr	2	Dr. Padam Nath Sharma	BVSC, AH	
Vet Dr	2	Dr. Udaya Singh	BVSC, AH	
Asst Vet Dr	3	Dr Mukti Nareyan Shrestha	BVSC, AH	
Asst Vet Dr	3	Dr. Keshav Nath Upadhaya	BVSC, AH	
Asst Vet Dr	3	Dr. Tralokya Nanda Bhidha	BVSC, AH	
Asst Vet Dr	3	Dr. Bir Mardan Basnet	BVSC, AH	
Asst Vet Dr	3	Dr. Surendra Kumar Shrestha	BVSC, AH	
Asst Vet Dr	3	Dr. Hari Kishor Chaurasiwa	BVSC, AH	
Asst Vet Dr	3	Dr. Navendra Bahadur Singh	MVSC, AH	

POST	CLASS	NAME	TRAINING	SPECIALIZATION
J. **Horticulture (Vegetable Development Section):**				
Chief Vegetable Scientist	1	Dhubra Raj Pandey	MSc Hort Veg Train (9 mos. in Japan)	
Veg Sci	1			
Veg Sci	2	Muktti Nath Pokharal	MSc Hort	
Asst Veg Sci (Actg)	3	Ram Krishna Shrestha	Ag Dpl	
K. **Potato Development Section:**				
Chief Potato Development Off (Actg)	1	Janak Dev. Sakya	MSc Hort	
Potato Sci (Actg)	2	Laxmi Parsad Khairgol	MSc Hort	
Asst Potato Sci	3			
L. **Fruits Development Section:**				
Chief Fruits Development Sci (Actg)	1	Ram Badal Shaha	MSc Hort	
Fruit Dev Sci (Actg)	1	Babu Kaji Bhomi	MSc Hort	
Asst Fruit Sci	3	Chaudhari	BScAg	
Fruit Sci	2	Tej Harayan Sinha	MScAg	
Asst Fruit Sci	3	Narayan Das Joshi	MSc Hort	
M. **Plant Pathology Section:**				
Chief Plant Pathologist	1	S. Moin Saha	MSc	Plant Path
Senior Plant Path (Actg)	1	Birendra J. Thapa	MScAg	Plant Path
Plant Path	2	Purushottam Amatya	MSc	
Plant Path	2	Krishna Shrestha	MSc	
Asst Plant Path(Actg)	2	Mrs. Keshari Laxmi Manandhar	Ph D	
Asst Plant Path(Actg)	2	JuJu Bhai Manandhar	BScAg	
Asst Plant Path	2	Miss Binu Pandey	MSc Botany	
Asst Plant Path	3	Sunder Kumar Shrestha	MScAg	
Asst Plant Path	3	Bhandri Bdr. Karki	BScAg	
Asst Plant Path	3	Ganesh Bahadur Thapa	BScAg	
Asst Plant Path	3			
Asst Plant Path	3			
Asst Plant Path	3			

POST	CLASS	NAME	TRAINING	SPECIALI-ZATION
N. Fisheries Section:				
Chief Fisheries Off (Actg)	1	Sasank Narayan Sarakar	BScAg	
Fish Off	2	Krishna Gopal Raj Banshi	BScAg	
Asst Fish Off	3	Rama Nath Sharma	BScAg	
Asst Fish Off	3	Kanji Bahadur Karki	MSc	
Asst Fish Off (Actg)	3	Hanumacha Shrestha	BScAg	
O. Regional Agricultural Director's Office, Biratnagar:				
Regional Agri Dir	1	Ram Chandra Gupta	MScAg	Ext
Senior Agri Off	1	Jaya Raj Joshi	MScAg	Agron
Agri Off	2	Narayan Prasad Regmi	BScAg	
Asst Agri Off	3	Trailokya Nath Shrestha	MScAg	
Asst Agri Off	3			
Asst Agri Off	3			
Agricultural Farm Tarahara, Biratnagar:				
Chief Manager (Actg)	1	Narendra Giri	MSc (jute)	
Veg Sci (Actg)	2	Madan Mohan Das	BScAg	
Asst Entomol	3	Dhurba Narayan Manandhar	BScAg	
Asst Plant Path	3	Durga Nanda Chaudhari	BScAg	
Asst Soil Sci	3	Surya Prasad Pandey	BScAg	
Horticulture Farm, Tarahara:				
Asst Horticulturist	3	Toyanath Misra	BScAg	
Horticulture Farm, Dhankuta:				
Asst Horticulturist	3	Bhairab Raj Kaini	BScAg	
Asst Hort	3	Ratna Dhoj Shahi	BScAg	
Fish Farm, Tarahara:				
Asst Fisheries Off	3	Surendra Jha	BScAg	
Potato Production Farm, Jaubari:				
Asst Horticulturist	3	Moti Ram Loti	BScAg	
Veterinary Hospital, Rajbiraj:				
Asst Vet Dr	3	Dr. Upendra Misra	DSC, AH	

POST	CLASS	NAME	TRAINING	SPECIALI-ZATION
Veterinary Hospital, Illam:				
Veterinary Dr	2	Dr. Tej Bahadur Basnyat	MVSC, AH	
Asst Vet Dr	3	Dr. Thakur Parsad Subba	BVSC, AH	
Veterinary Hospital, Bhojpur:				
Asst Vet Dr	3	Dr. Bibek Das Shrestha	MVSC, AH	
Livestock Farm, Tarahara:				
Asst Vet Dr	3	Jage Swor Jha	BScAg	
Veterinary Hospital, Morang:				
Vet Dr	2	Dr. Bhabananda Thakur	MVSC	
Jaubari Farm:				
Potato Protect Off (Actg)	2	Buddhi Ratna Scherchand	BScAg	
Livestock Farm, Solukhumbu:				
Vet Dr (Actg)	2	Dr. Prabesh Man Singh Pradhan	BVSC, AH	
P. Regional Agricultural Director's Office, Pokhara:				
Regional Agri Dir	1	Bindoswari Prasad Singh	MSc Ent	
Senior Agri Off(Actg)	1	Bhola Nandan Karmacharya	BScAg	
Agri Off	2	Uma Nath Sharma	BScAg	
Asst Agri Off	3	Shiva Sundar Shrestha	BScAg	
Asst Agri Off(Actg)	3	Pitanubar Lal Shrestha	SLC Dpl	
Asst Agri Off	3	Krishna Chandra Paudel	BScAg	
Fisheries Center, Pokhara:				
Fisheries Off(Actg)	2	Sundar Kumar Shrestha	BScAg	
Fisheries Center, Bhaihaw:				
Fisheries Off	3	Hridaya Narayan Manandhar	BScAg	
Citrus Development Program, Pokhara:				
Chief Citrus Dev Offl		Padam Prasad Shrestha	MSc Hort	

POST	CLASS	NAME	TRAINING	SPECIALIZATION
Horticulture Farm, Mustan:				
Farm Manager(Actg)	2	Ram Krishna Raut	MSc Hort	
Asst Hort Off	3	Madan Kumar Rai	BSc	
Chief Hort (Grape)	1	Pasang Khambach Sherpa	Dpl in Group	
Horticulture Farm, Palpa:				
Asst Hort	3	Rajendra Prasad Mehata	MScAg	
Livestock Farm, Pokhara:				
Livestock Officer (Actg)	2	Shre Govind Sha	BSc	
Asst Livestock Off	3	Sikandar Shaha	BSc	
Veterinary Hospital, Bhairahawa:				
Asst Vet	3	Dr. Abdul Ahamad Khan	BVSC, AH	
Veterinary Hospital, Palpa:				
Asst Vet	3	Dr. Tulsi Prasad Shrestha	MVSC	
Veterinary Hospital, Pokhara:				
Veterinarian	2	Dr. Sundar Lal Shrestha	MVSC, AH	
Veterinary Hospital, Baglung:				
Veterinarian	3			
Veterinary Hospital, Mustang:				
Agricultural Farm, Bhairahawa:				
Farm Manager(Actg)	2	Mahes Prasad Pant	MScAg	
Asst Agri Engineer	3	Narayan Prasad Bhattarai	BScAg Engr	
Soil Scientist	3	Ram Chandra Munakarmi	BSc	
Asst Plant Path	3	Bharat Prasad Upadyaya	BSc	
Regional Agricultural Director's Office, Nepalganj:				
Regional Agri Off	1	Bharat Dongol	BScAg Dpl	
Senior Agri Off	1	Ananta Bahadur Shrestha	MScAg	

POST	CLASS	NAME	TRAINING	SPECIALI-ZATION
Asst Agri Off(Actg)	2	Ram Krishna Shahu	BScAg	
Asst Agri Off	3	Charkra Bahadur Shanker	BScAg	
Asst Agri Off	3	Shambhu Shrestha	BSc	
Asst Agri Off	3	Thakur Prasad Pradhan	BScAg	
Agricultural Station, Nepalganj:				
General Manager (Actg)	2	Krishna Kumar Shrestha	BScAg	
Cotton Off	2	Shankar Prasad Upreti	MScAg	
Asst Botanist	3	Dular Chand Pathik	BScAg	
Asst Agronomist	3	Raghab Chandra Bahadur Singh	BScAg	
Asst Agron (cotton)	3	Govinda Prasad Pandey	BScAg	
Asst Agri Engineer	3	Shree Krishna Adhikari	BScAg Engr	
Agricultural Farm, Doti:				
Asst Plant Protect Off.	3	Chita Ranjan Yadab	BScAg	
Agricultural Station, Shurkhet:				
Asst Agronomist	3	Gopal Prasad Sivakoti	BScAg	
Asst Plant Protect Off	3	Krishna Raj Regmi	BScAg	
Agricultural Station, Jumla:				
Asst Chief Off(Actg)	1	Hari Prasad Gurung	MSc Hort	
Asst Plant Protect Off	3	Prashu Ram Lal Karna	BSc	
Horticulture Farm, Tibrikot:				
Asst Pomologist	3	Daman Bahadur Dhungana	BScAg	
Horticulture Farm, Humla:				
Horticulture Farm, Baitadi:				
Asst Pomologist	3	Yaksha Raj Panta	BScAg	

POST	CLASS	NAME	TRAINING	SPECIALI-ZATION
Sheep Farm, Tibrikot:				
Asst Livestock Off	3	Surya Bahadur Singh		BSc Livestock
Veterinary Hospital, Nepalganj:				
Vet Off	2	Dr. Shiva Lakhan Prasad Guptta	BVSC, AH	
Veterinary Hospital, Kanchanpur:				
Asst Vet Off	3	Dr. Pralhad Sapkota	BVSC, AH	
Veterinary Hospital, Kailali:				
Asst Vet Off	3	Dr. Nubal Kisher Yadab	BVSC, AH	
Veterinary Hospital, Jumla:				
Asst Vet Off	3	Dr. Hari Kishor Chauvasiya	BVSC, AH	
Veterinary Hospital, Dang:				
Asst Vet Off	3	Dr. Lal Bahadur Chand	BVSC, AH	
Plant Quarantine Check Post, Nepalganj:				
Plant Quarantine Off	3	Abdur Rahut	BScAg	
In the following hospitals				
Humla, Piuthan, Surkhet, Doti, Baitadi, (Patan): no veterinarian				
Agricultural Engineering Section:				
Chief Agri Engineer	1	Top Bahadur Basnet	BScAg Engr	
Agri Engr	2	Hem Bilas Pandey	MScAg	
Asst Agri Engr	3	Jagadamba Prasad Pradhanang	Overseas Train	
Asst Agri Engr	3	Prem Sundar Pradhan	Dpl	
Asst Agri Engr	3	Bal Krishna Shrestha	BScAg	
Asst Agri Engr	3			
Asst Agri Engr	3			

POST	CLASS	NAME	TRAINING	SPECIALI-ZATION
Farm Irrigation and Water Utilization Section:				
Water Utilization Chief (Actg)	1	Purshottam Prasad Gorkhali	BScAg	
Water Util Off(Actg)	2	Ridhi Narayan Jha	BScAg	
Asst Water Util Off	3	Mahes Man Shrestha	BScAg	
Agricultural Station, Giri:				
Chief Farm Manager (Actg)	1	Shankar Prasad Adhikari	BSc Ani Husb	
Agronomist	2			
Livestock Off	2			
Asst Agron	3	Misri Lal Shaha	BScAg	
Asst Livestock Off	3	Laxman Serchand	BScAg	
Asst Plant Path	3	Krishna Bahadur Shrestha	BScAg	
Maize Development Program, Rapti:				
Chief Maize Coordinator	1	Gopal Rasha Rajbhandry	MScAg	
Maize Dev Off	2			
Asst Maize Dev Off	3	Rajman Prasad Chaudhari	BScAg	
Asst Maize Dev Off	3	Ram Chandra Prasad	BScAg	
Oil Seed Dev Off	2	Ganga Bahadur Pradhan	MScAg	
Asst Oil Seed Dev Off	3	Mawe Lal Saisawal	BScAg	
Agricultural Station, Rampur:				
Chief Farm Manager (Actg)	1	Isworri Raj Regmi	BScAg	
Farm Manager	2			
Livestock Off	2	Nitedhoj Joshi	MScAg	
Asst Agron	3	Raj Man Prasad Chaudhari	BScAg	
Asst Soil Sci	3	Ram Chandra Prasad	BScAg	
Asst Oil Seed Off	3	Mauje Lal Jaisawal	BScAg	
Asst Livestock Off	3	Gopal Narayan Gupta	BScAg	
Asst Agri Engr	3	Jitendra Dhoj Rana	BSc Engr	
Asst Plant Path	3			
Wheat Development Program, Khumal:				
Chief Wheat Coordinator	1	Achut Nath Bhatta Rai	MSc Wheat	
Agron (Actg)	2	Thaneshor Pokharel	BSc	
Asst Wheat Dev Off	3	Bachhu Thapa	BScAg	

POST	CLASS	NAME	TRAINING	SPECIALI-ZATION
Paddy Development Program, Parwanipur:				
Paddy Coordinator (Actg)	1	Dr. Bal Bahadur Shahi	DSc	
Paddy Dev Off	2	Rajeswor Nath Mallik	MScAg	
Paddy Dev Off(Actg)	2	Govind Prasad Koirala	BSc	
Paddy Dev Off	2	Ram Man Joshi	MScAg	
Soil Officer	2	Dhurba Joshi	MSc	
Asst Paddy Dev Off	3	Gyan Lal Shrestha	BSc	Paddy Train
Asst Soil Off	3	Ram Prasad Upreti	BSc	
Asst Sugar Cane Dev Off	3	Bijaya Kumar Dutta	BSc	
Prabhanipur:				
Asst Agron	3	Ram Prakash Yadav	BSc	
Asst Soil Off	3	Ram Narayan Sha	BScAg	
Asst Agri Engr	3	Rameswor Bhakali	Ag Engr	
Asst Entomol	3	Satendra Prasad Sing	BScAg	
Asst Hort	3	Loknath Devkota	BScAg	
Asst Agron	3	Ranu Pradap Sha	BScAg	
Asst Plant Path	3			
Regional Agricultural Director's Office, Kathmandu:				
Regional Director	1	Dr. Bharat Lal Karmacharya	Ph D	
Senior Agri Off	1	Dr. Prakriti Samshar Rana	Ph D	
Agri Off	2	Asta Dhyos Joshi	BSc	Dairy farming
Agri Off	2	Jagadish Raj Baral	MScAg	
Asst Agri Off	3	Shiva Kumar Chaudari	BScAg (Honors)	
Asst Agri Off	3	Netra Mani Devkota	BScAg	
Veterinary Mgr	2	Dr. Vivaka Das Shrestha	MVSC	Ani Nutri
Agri Off	2	Jaya Narsingha Rama	MScAg	
Farm Mgr (Actg)	2	Birendra Bickram Shaha	BSc	
Farm Mgr	2	Dyarika Naryan Manandhar	BScAg (Honors)	
Asst Agri Engr	3	Ram Prasad Satyal	BScAg Engr	
Asst Plant Path	3	Rishi Raj Sharma	BScAg	
Asst Vet Off	3	Nanda Lal Sharma	BVSC, AH (Pass)	
Asst Livestock Off	3	Nanda Prasad Shrestha	BScAg (Honors)	
Asst Pasture Off	3	Dipa Narayan Shaha	BScAg (Honors)	
Asst Vet Off	3	Shri Vatsha Man Malla	BVSC, AH (Pass)	
Asst Fisheries Off	3	Bhola Ram Pradhan	BScAg	
Asst Hort Off	3	Balram Sainju		

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POST	CLASS	NAME	TRAINING	SPECIALIZATION
Asst Hort Off	3	Badhi Ratna Serchand	BScAg	
Asst Farm Mgr	3	Surath Babu Aryal	BSc (Honors)	
Asst Hort Off	3	Shambu Narayan Singh	BScAg	
Asst Fish Dev Off	3	Shukra Kumar Pradhan	BScAg	
Farm Mgr	3	Pushkar Prasad Regmi	BScAg	
Farm Mgr	3	Madhava Bahadur Pant	BScAg	
Asst Entomol	3	Chandra Kumar Sen	BScAg	
Vet Off (Acting)	2	Bho-la Maher Shrestha	BVSC, AH	
Asst Botanist	3	Ashok Mudvari	BScAg	
Asst Vet Off	3	Braja Kant Jha	BVSC, AH	
Farm Mgr	2	Krishna Kumar Sharma	BScAg	
Vet Off	2	Kesharna Raj Sharma	BVSC, AH	
Asst Hort Off	3	Jaya Krishna Lal Karmacharya	BScAg	
Asst Hort Off	3	Damador Kumar Shrestha	BScAg	
Asst Hort Off	3	Narendra Jung Thapa	BScAg	
Asst Vet Off	3	Mukti Narayan Shrestha	BVSC, AH	
Asst Agron	3	Kausal Kishor Lal Karna	BScAg	
Asst Hort Off	3	Loka Nath Shrestha Dewaju	BScAg	
Asst Vet Off	3	Jagadish Narayan Prasad	BVSC, AH	
Asst Botanist	3	Bimal Kumar Baniya	BScAg	
Asst Soil Sci	3	Nabin Kumar Rajbhandary	BScAg (Honors)	
Asst Hort Off	3	Bedhi Raj Dhakal	BScAg	
Asst Hort Off	3	Kedar Budha-Thoky		

THE INSTITUTE OF AGRICULTURE AND ANIMAL SCIENCE

There appear to be two sets of problems associated with IAAS. The first has to do with operation of the Institute, of the kind usually faced by new institutions, particularly those starting up in a new location. They affect primarily the Institute itself. The second has to do with program emphasis, and not only has implications for the Institute itself, but also is likely to have repercussions on other institutions. The two sets of problems are somewhat interrelated.

1. Operation of the Institute

Starting up a new institute in a new location involves problems of staffing and facilities. The staffing problems include the following:

1. Agricultural graduates (B.Sc. and above) feel their professional base is in the Ministry of Agriculture. There is no incentive to transfer to the IAAS permanently, and being deputed for a year or two does not help their careers. The IAAS needs special incentives. Substantially higher pay would be one, although this would involve matching Ministry retirement benefits. A chance to go abroad for higher degrees is another.

2. Housing for staff is barely adequate for those already at Rampur, with no space available for additional staff.

3. Schooling for dependents is not available so wives and children now stay in Kathmandu.

4. Transport. The campus is remote, and the nearest town of moderate size is Bharatpur which is seven miles away by road (but over one hour because of the poor condition of the road). There is some public transport but the Institute does not have vehicles to provide transport for staff and dependents.

5. Jobs for wives. Jobs have been created for wives of four staff members. More may be done about this problem.

The IAAS needs 79 staff members, and it now has 32. Eleven of the 32 are Indians hired on one year contracts, of which five have arrived at Rampur (with M.Sc.'s in Fisheries, Pathology, Agronomy and Farm Management).

Discussions with the Nepali IAAS staff at Rampur indicated the nature and seriousness of concerns. Of 22 Institute staff who made the transfer from Kathmandu to Rampur, only four remained. Schooling is the single major problem. The nearest primary school, at Manglepur, about one mile away is considered to be of low quality. The nearest primary and secondary schools of acceptable quality are at Bharatpur. The children would have to walk and it is too far. They felt the quality of housing was adequate, but there are not enough units. They expressed considerable resentment at the higher salary paid to the Indians on contract (Rs. 1,000 per month versus Rs. 570 for a Nepali of equal rank, plus free housing for the Indians whereas Nepali staff pay Rs. 35 or Rs. 50 per month depending on size of the flat). They did not express any national hostility towards the Indians, and felt the students would not.

The staff expressed concern over the lack of hostel and teaching facilities. Hostel space is inadequate for the present student body, so some students have to rent rooms in nearby farmers' or merchants' houses, at Rs. 25-30 per month compared to Rs.13 per month in the hostel.

2. <u>Program Emphasis</u>

The 1972 MUCIA report (pg. 69-70) recommended the following "specific aims and objectives:"

1. To provide well educated, trained, committed, and dedicated manpower to fulfill both the immediate and long-term needs of the entire agriculture sector.

2. To bring the benefits of modern scientific agriculture to the different communities of the Kingdom through cooperation with appropriate branches of His Majesty's Government and other organizations.

3. To fulfill the need for vocational agricultural graduates, which would be required to serve the secondary vocational schools of the country.

4. To conduct research efforts complementary to the teaching function, which will also provide knowledge needed for agricultural development and improved levels of living.

5. To serve as the Kingdom's major academic resource for knowledge of the agricultural sectors.

6. To gather, store, and disseminate knowledge regarding agricultural development in the academic and professional community.

The foregoing are very comprehensive and essentially describe a major national agricultural university. They could only be reached in 20 to 30 years of intensive development.

The USAID PROP for IAAS lists "functions" of IAAS (copy attached) which are more modest, and include:

1. Training for agricultural institutions in Nepal of:

    a. JT's and JTA's
    b. degree personnel
    c. present staff of MFAI and commercial personnel through short courses and in-service programs

2. Meeting national agricultural education manpower needs through:

    a. training Vo Ag teachers
    b. nonformal training of out of school youth and adults

3. Meeting needs of the farming community through:

    a. short courses, on campus and off
    b. pilot programs with model villages
    c. training programs with other institutions, such as ADBN.

Regardless of the program emphasis intended for IAAS, it is now in fact almost solely a Vo Ag teacher training institution.

One of the reasons for establishing the IAAS at Rampur was to put the JT and JTA trainees in a rural setting, with plenty of Institute land for them to gain practical experience. Due to lack of staff, however, a plan evolved for the trainees to spend three months at a Department of Agriculture experimental station or farm for practical training, followed by six months at Rampur for "theory" courses, and then the last three months in in-service training in an agency that uses JTA's, presumably their future employer. This plan has in turn been scrapped and the intention is to put all JTA trainees on the research stations or farms for the full year. In addition to intensive practical experience (supervised by the staff at the research station) the research staff will also present the "theory" lectures. The research staff are supposed to receive some extra pay for their effort, supposedly Rs. 200 per month.

The Rampur campus at present is reserved for the JT training and the Vo Ag teacher training. There is an intention to start Diploma agriculture training when staff members permit.

The first batch of 23 students in the Vo Ag Program will receive a Diploma Ag. Education in December. At that time 67 more will start their third semester and 60 will start their first semester. All have their I.Sc. The first batch of 23 were Vo Ag teachers before, but the succeeding groups come directly from their I.Sc.

With regard to JT's, 44 will start their third semester in December, and 61 will start their first semester (on the farms). Figures were not obtained for the number starting JTA training. The USAID IAAS PROP lists 167 for FY 74 and 250 for FY 75 in the JTA program.

There are a number of basic issues with respect to the IAAS that should be reassessed, including:

1. The effect on agricultural stations and farms of training JTA's

2. The emphasis on Vo Ag teacher training, to the exclusion of diploma level training, and neglect of JTA's

3. The creation of new institutions and facilities while under-utilizing present ones (change for the sake of change)

4. Inter-Ministerial difference in responsibilities and interests regarding agriculture.

5. The curriculum and teaching methods.

One of the five stations/farms where JTA's will be trained is the Parwanipur Rice Station. This is a well run station, the headquarters of the National Coordinated Rice Program, and has 23 staff members with a minimum of B.Sc. education. Activities include horticulture, fisheries, poultry, and other crops as well as rice. Some of the staff would undoubtedly make good teachers and trainers for JTA's. But placing the burden of a full year of training of 40 to 50 JTA's on the present staff will have a serious impact in reducing the quality and quantity of research by the station. Exposing the JTA's to the research staff at Parwanipur for short periods of two to three months would be highly beneficial, but the capacity of the Parwanipur staff is to handle five or six in this way, not 40 or 50.

Additional hostels for the JTA's will have to be built at Parwanipur if that station is to handle the full number of 40 to 50 JTA's planned for it. It would seem preferable, however, to add more facilities at IAAS Rampur since the bulk of the IAAS land (350 acres) is not geing used well, in fact, much of it is being rented out to private farmers. The experimental plots at Parwanipur cannot be used for practical training of the JTA's who will need to do their work on regular production plots. These could be established at IAAS.

A recent survey of the agricultural sector in Nepal suggests that NESP's training target of 650-1,000 vocational agricultural teachers from 1972-76 is unrealistic. It recognizes that in the near-term IAAS cannot be expanded to cater for all requirements, and HMG must assign priorities to the different agricultural training programs. It appears that HMG will place highest priority on training of "middle level" manpower (presumably above the SLC and below the B.Sc.) mainly for extension. From the review by the RF team it is doubtful whether there is enough tested but as yet unadopted new technology available for extending. Nepal should not repeat the "extension bandwagon" mistakes of other developing countries. There is need for more emphasis on higher level manpower to produce something to be extended -- more personnel at the B.Sc. and M.Sc. level to produce the research results that otherwise will not come from the recently established national coordinated crop development programs.

The JTA's and JT's are only as effective as their backstopping and supervision. The DADO is the key and more impact is likely from improving the present DADO's and adding more of them than in increasing the number of JTA's and JT's without effective DADO supervision. The plans for increasing DADO strength, both in terms of numbers and in quality through improved training are not clear. This would be a critical area for improving service to farmers since the JTA's presumably work only under the DADO's.

The IAAS is now primarily a vo-ag teacher training institute, and is likely to become even more so under support of the USAID contract team. This raises the question of why the NVTC at Sano Thimi, into which the HMG and USAID have invested heavily, is not being utilized for vo-ag teacher training. Given the constraints on present manpower and the critical need for further trained manpower for agriculture, it appears that the JTA college and the NVTC vo-ag programs have been curtailed and a rather ineffective (until it gets established) IAAS substituted. There appears to be some growing conflict of interest between the Ministry of Food Agriculture and Irrigation (MFAI) and Education (ME). Previously, the MFAI ran the JTA college and employed its graduates, and the ME ran the NVTC and employed its graduates. Now, with the IAAS under the University -- which is under the ME, it is natural for IAAS to stress vo-ag teacher training and to give lesser priority to training personnel more directly essential in agricultural development.

The USAID PROP stresses the concept of the "upside down" curriculum. This term or concept means that a student is first exposed to the practical aspects of a problem and then studies the scientific principles that lead to solving the problem. Broadly, this is what all effective and concerned teachers try to do -- impart an understanding of the practical application along with the teaching of a concept, principle, or theory. In agriculture, while a student is learning how to physically grow a crop he is also studying the principles of crop production, how seeds germinate, the nutrient requirement of plants, limiting factors of diseases, pests, etc. The "upside down" method improperly used can be ineffective and downright harmful, if the student mechanically and without understanding is forced to perform as a laborer in growing a crop and then at a later point sits through a long series of lectures on theory that to him have no relation to growing the crop. The distinction or distraction between theory and practicals has no place in effective teaching or training and this distinction was made all too frequently in the background documents and in discussions with those concerned with the IAAS.