A.I.D. Project Impact Evaluation No. 33

Food Grain Technology: Agricultural Research In Nepal

May 1982

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FOOD GRAIN TECHNOLOGY:

AGRICULTURAL RESEARCH IN NEPAL

PROJECT IMPACT EVALUATION No. 33

by

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U.S. Agency for International Development

May 1982

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FOREWORD

In October 1979, the Administrator of the Agency for International Development (AID) initiated an Agency-wide ex-post evaluation system focusing on the impact of AID-funded projects. These impact evaluations are concentrated in particular substantive areas as determined by AID's senior executives. The evaluations are to be performed largely by Agency personnel and result in a series of studies that, by virtue of their comparability in scope, will ensure cumulative findings of use to the Agency and the larger development community. This study, Food Grain Technology: Agricultural Research in Nepal, was conducted in January 1982 as part of this effort. A final evaluation report will summarize and analyze the results of all the studies in this sector and relate them to program, policy and design requirements.

SUMMARY

In 1957, the U.S. Operations Mission initiated support for a broad-ranging agricultural development effort in Nepal. This project continued without pause for seventeen years, largely in pursuit of the objective of increasing Nepal's foodgrain production capacity by enabling and encouraging Nepali farmers to apply the techniques of scientific agriculture. While the U.S. financial and technical assistance was continuous, the emphasis, the pace, and the amount of Nepali involvement were altered considerably during the course of project implementation. The project began as a "General Agriculture" initiative and gradually evolved to its concluding emphasis on the development and dissemination of "Food Grain Technology."

The project successfully contributed to the establishment of agricultural research and extension systems by training almost 600 Nepalis to the B.S., M.S., and Ph.D. levels and by constructing facilities for research at five stations in the Tarai -- at Nepalganj, Bhairawa, Parwanipur, Janakpur, and Rampur. With the assistance of the extension service, improved wheat, rice, and maize varieties tested on the research stations were spread to farmers across the Tarai. Some of the selected improved varieties proved widely adapted to Nepal's enormous range of agroecological conditions and spread into the Hill and Mountain farms as well. Other parts of the "technology packages" -- which included recommendations for fertilizer, time of planting, spacing, and irrigation -- were not so widely adopted.

In trying to assess more precisely the differences that could be attributed to the implementation of the Food Grain Technology project, we first examined statistical fact sheets and research reports. We then talked with agricultural leaders (many of whom had apparently taken advantage of training opportunities offered under the project) and with agricultural producers. We took a long view in these dialogues, trying to comprehend the pattern of changes which had occurred in the agricultural sector over the past two decades. While looking at reports of experimental trials and at growing fields of wheat and mustard, we discussed not only what had happened, but what might not have occurred had the project never been implemented.

Our examination provides both a sense of solid accomplishment and a basis for some disquieting fears. On the positive side, we found that:

-- a functioning research system has been developed;

-- farmers are immensely aware of the need for and problems with krishi bikash -- agricultural development; and

-- extension and research services can, at times, work together in complementary, mutually-reinforcing activities which result in new varieties and knowledge in the countryside.

On the negative side, we found that:

-- researchers and farmers are not in complete agreement on which agricultural problems need to be addressed , nor are the channels for communication as open as they might be;

-- the "green revolution" as it has occurred in Nepal has not yet resulted in long-term security and economic independence as expected but has contributed to economic and environmental destabilization; and

-- the productivity of farmers, extension workers, researchers, and those agencies charged with input supply distribution is far from optimal.

Thus, researchers articulate the need to continue the search for new varieties which are higher yielding, more disease resistant, and produce grain with acceptable qualities of taste. Farmers agree that variety development is important, although they emphasize other criteria for variety selection as well. Farmers also recommend that increasing reliability of water and fertilizer supplies is more important for handling their problems of deteriorating soil fertility and declining farm sizes, of low yields and high risks. The role of agricultural research and extension is not in question; at stake are the issues of research priorities and their relevance to farmers' resources and constraints.

The fact that farmers have adopted components of technology packages at all may reflect less the persuasive rhetoric of research and extension than the farmers' response to the increasing pressure of population and to their families' requirements for food and cash. Nevertheless, without the technology packages, it is unlikely that Nepal's farmers would be as productive as they are today.

PREFACE

Asked to reminisce about changes which have occurred over time in Nepal's agricultural sector, one official recalled that

> ...in the old days (the early 1960's), extension was ahead of research. Extension agents relied on Indian news and seeds. But farmers were ahead of extension! This is no longer the picture. Research is coming in at a par with extension.....

Left unspoken was the possibility that farmers are still ahead of both research and extension. And not included in his summary was another major set of actors in the agricultural scene -- those who distribute improved seeds, fertilizers, pesticides, and irrigation water. It was a natural oversight. For in the "old days," with no improved production inputs to distribute, few roads and trucks to transport them, and few irrigation systems extending beyond a village's boundaries, the roles which these actors now play were not yet written.

As we set out on this evaluation of the impacts of U.S. assistance in the development of Nepal's agricultural research and extension institutions, we only superficially appreciated just how far "modern agriculture" in Nepal had come in 25 years. But we travelled the Tarai from Bhairawa to Biratnagar for two weeks, questioning nearly 100 farmers, visiting demonstration plots in farmers' fields and research station experiments laid out in neat randomized blocks, and touching base with cooperative managers, extension staff, and rice retailers, with Agricultural Input Corporation managers and panchayat level assistants in extension.

We have tried to identify and understand patterns of change associated with U.S. support for:

- the growth and function of the agricultural research system;
- the evolution and effectiveness of the agricultural support system -- extension services, the supply of inputs, and to limited extent, storage and markets; and
- the increasing productivity and welfare of Nepali farmers, particularly in the Tarai.

Emphasis has been placed on the research system's growth and functions for three reasons:

1. U.S. assistance to Nepal in the 1960's is generally agreed to have laid the foundation upon which subsequent research development, including that supported by other donors, has been based.

2. American assistance to the research system has been continuous since 1957.

3. Experience elsewhere has shown that the development of improved technologies through agricultural research may well be a precondition to progress in other areas.

ACKNOWLEDGEMENTS

The team owes a debt of gratitude to the many present and former officials of His Majesty's Government who took time to share their views on the development of agricultural research and agriculture in Nepal. Station directors were pressed to prepare budgets and plans before the Summer Crops Workshop which was held in Parwanipur during the last week of our visit. District Agricultural Development Officers were rushed with fertilizer projections and training seminars. We are also grateful to the AID Mission in Nepal. Thanks are particularly due to William Nance, Program Officer, for his warm welcome and unflagging support, and to the AID drivers and mechanics who enabled us to talk to farmers across the Tarai. Both Rabi Adhikari and Surya Dunghel must also be cited for their excellent work in translating thousands of questions and responses for those of us whose Nepali (and Hindi and Bhojpuri) was less than adequate.

It is, of course, the farmers to whom we owe most of the insight which we gained into farming conditions in Nepal. They gave most generously of their time and hospitality.

PROJECT DATA SHEET

1. Country: Nepal

2. Project Title: Food Grain Technology (also known as General Agriculture, Food Grain Production)

3. A.I.D. Project No.: 367-11-110-054; 367-0054

4. Project Implementation:
   a. Project Authorized -- 1957
   b. Final Obligation -- 1974
   c. Final Input Delivery -- 1978

5. Project completion - Final Disbursement: FY 1978

6. Project Funding: U.S. $4,206,000
   U.S.-owned local currency:
   Approximately $10 million equivalent
   Cooperating country contribution:
   Approximately $5 million equivalent

7. Evaluations: Project Appraisal Reports, 1972 and 1974

8. Responsible Mission Officials During Life of Project:

   a. Mission Directors: John S. Benz, William C. Ide
   b. Project Officers: Raymond E. Fort, Dale G. Strong, Philip D. Smith

9. Host Country Exchange Rates:

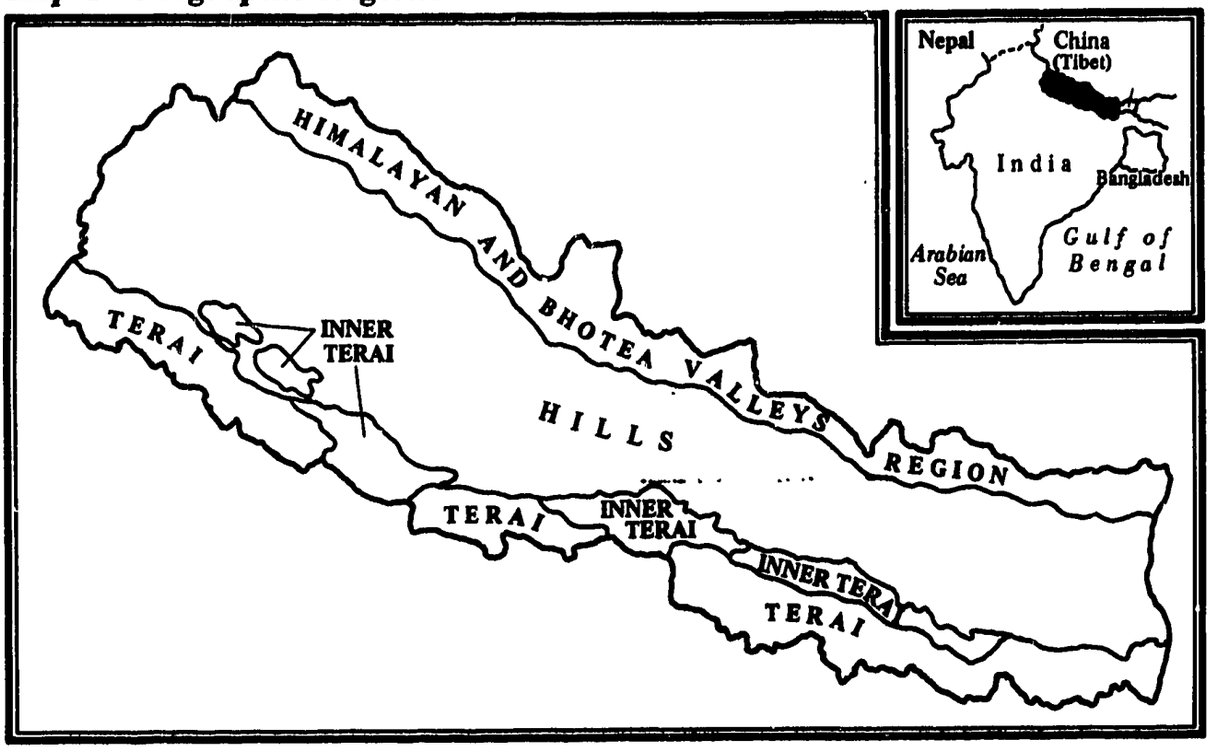
   a. Name of Currency: Rupee
   b. Exchange Rate at Time of Project: Rs. 10.26 =$1

GLOSSARY

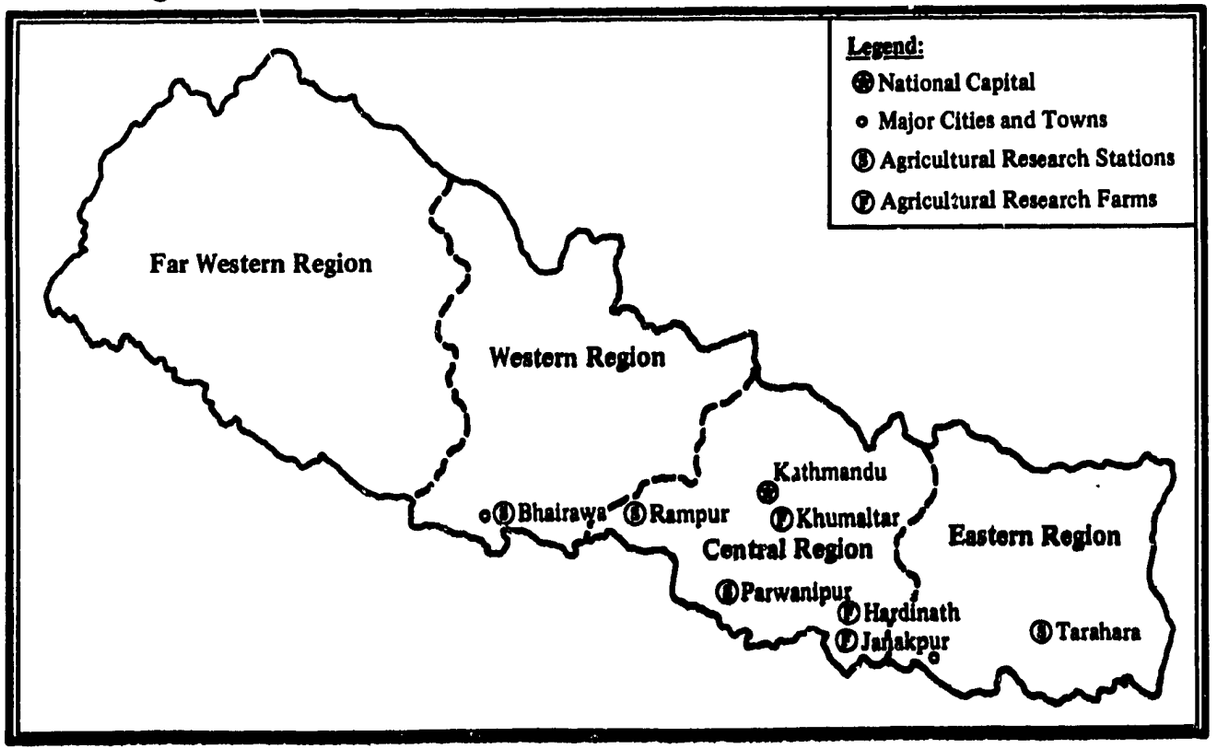
ADB	Asian Development Bank
ADO	Agricultural Development Officer
AIC	Agricultural Inputs Corporation, the government monopoly for fertilizer, seeds, and other inputs
APROSC	Agricultural Projects Services Center
HMG/N	His Majesty's Government of Nepal
ICP	The Integrated Cereals Project, an AID-supported project for agricultural research
JT/JTA	Junior Technician; Junior Technical Assistant (extension agents)
Krishi bikash	Agricultural development in Nepali
Maund	A grain measure, one maund = 82.2 lbs.
Minikits	Small seed/fertilizer packets for demonstration and testing purposes
NPK	Nitrogen, phosphorus, and potassium; the components of inorganic fertilizer
Panchayat	The smallest political division; each district is divided into a number of panchayats
PCV	Peace Corps Volunteer
Sajha	Cooperative
Terai	Same as Tarai, different spelling
USAID/N	U.S. Agency for International Development/Nepal

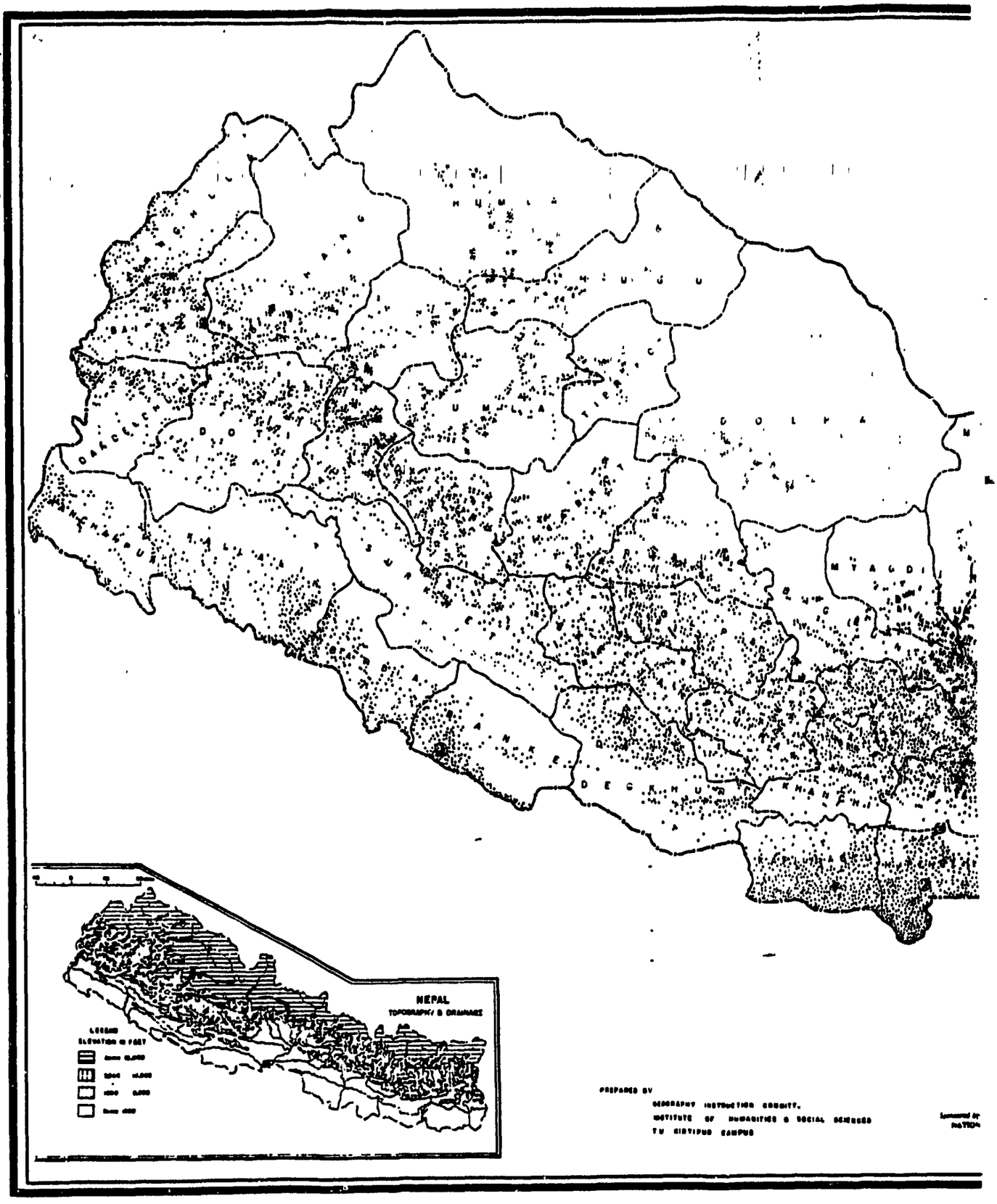
NEPAL

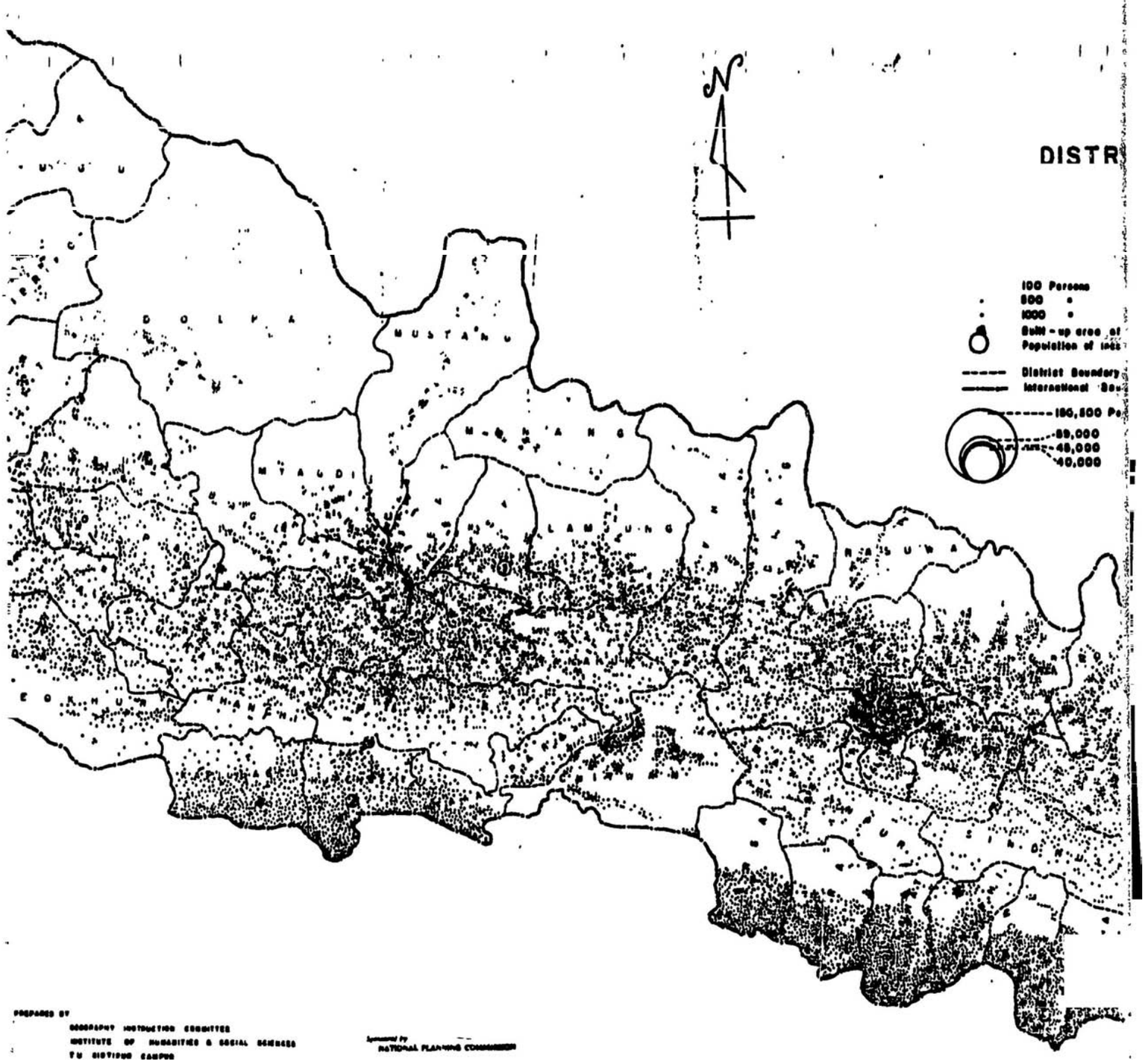
Map 1 Geographic Regions



Map 2 Development Regions and Agricultural Research Stations and Farms




NEPAL
TOPOGRAPHY & DRAINAGE
LEGEND
ELEVATION IN FEET



PREPARED BY

GEOGRAPHY INSTRUCTION COMMITTEE

INSTITUTE OF HUMANITIES & SOCIAL SCIENCES

TU KIRTIPUR CAMPUS

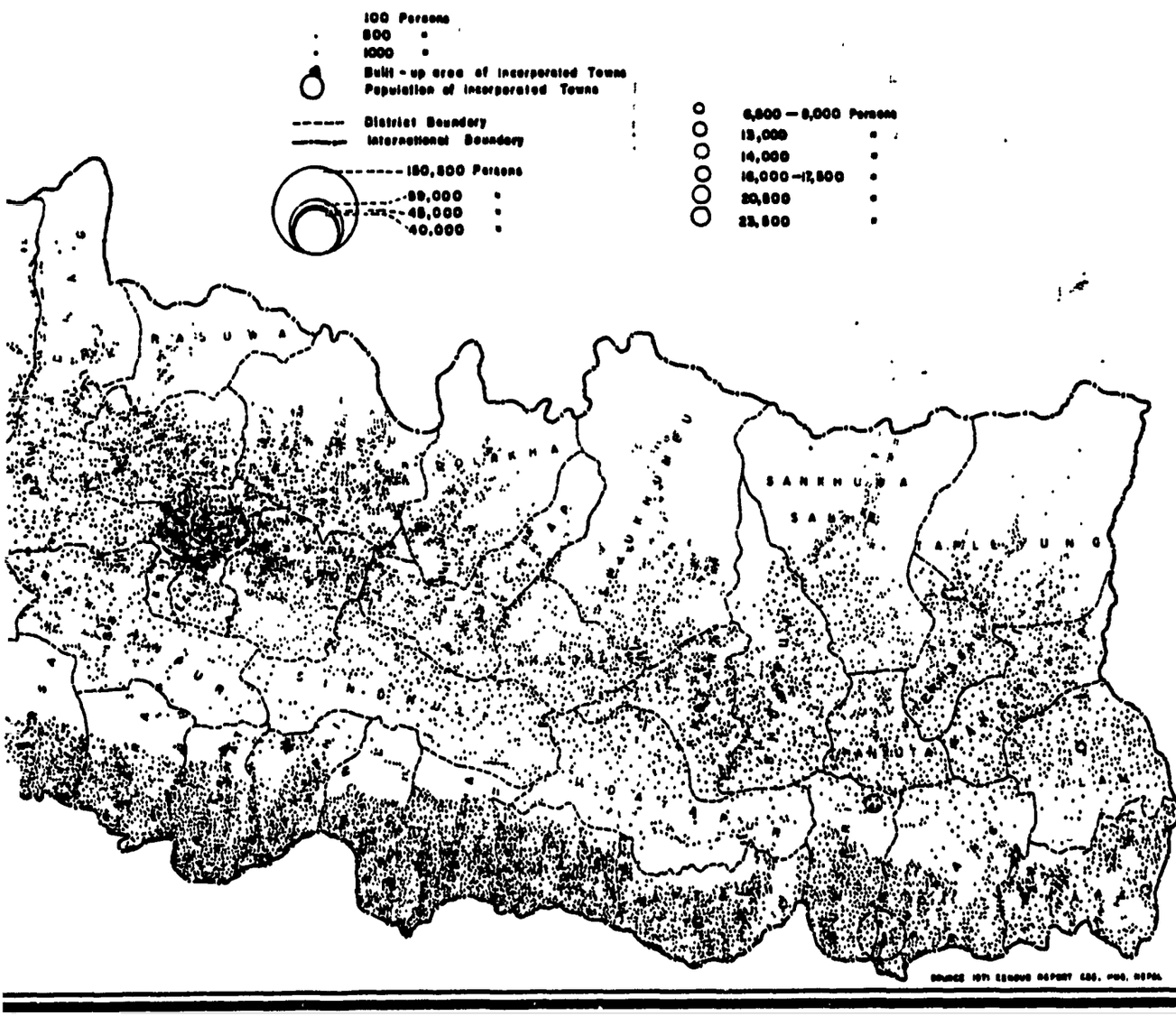
Sponsored by

NATIONAL PLANNING COMMISSION

NEPAL

DISTRIBUTION OF POPULATION

(1971)



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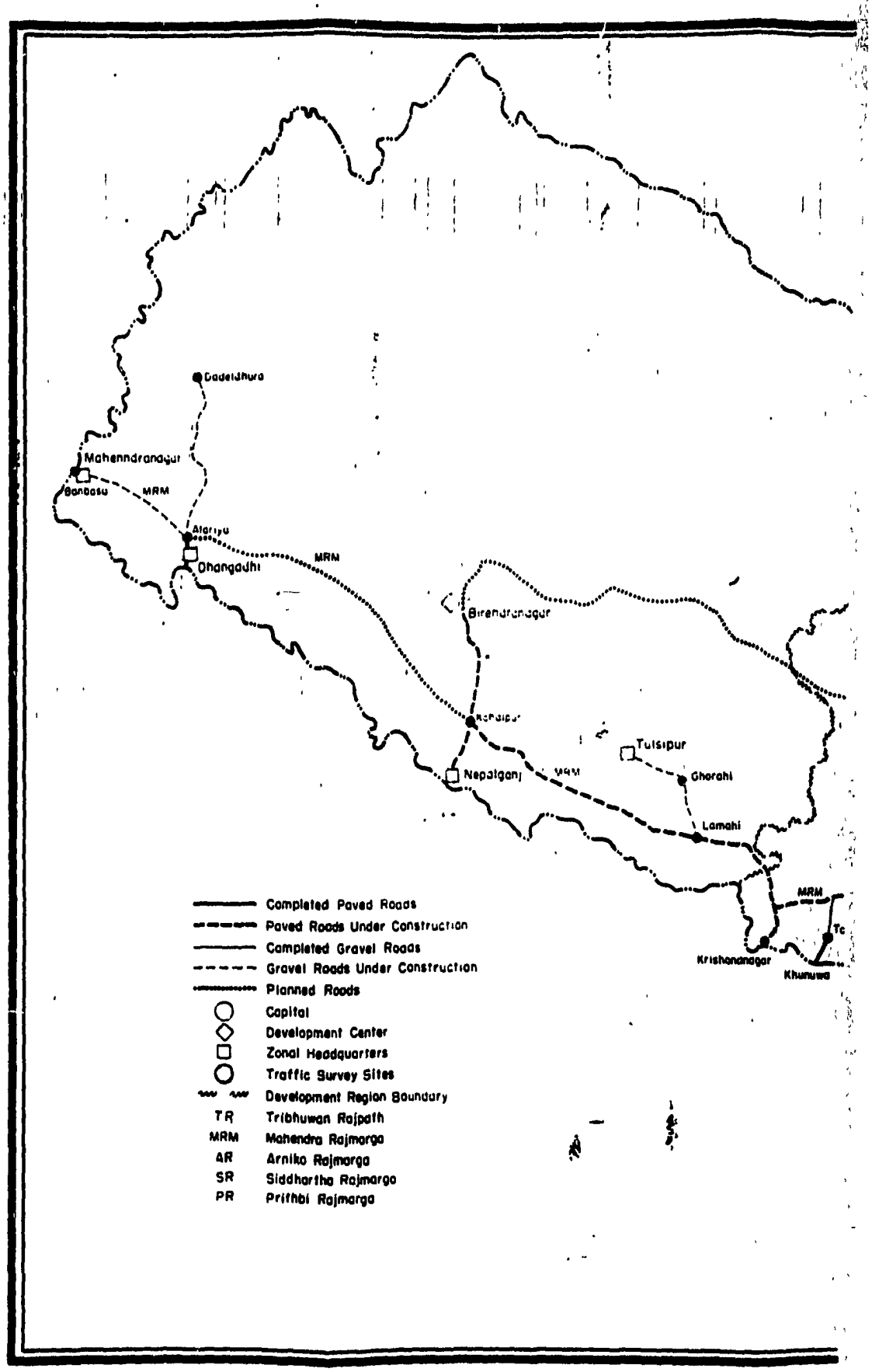
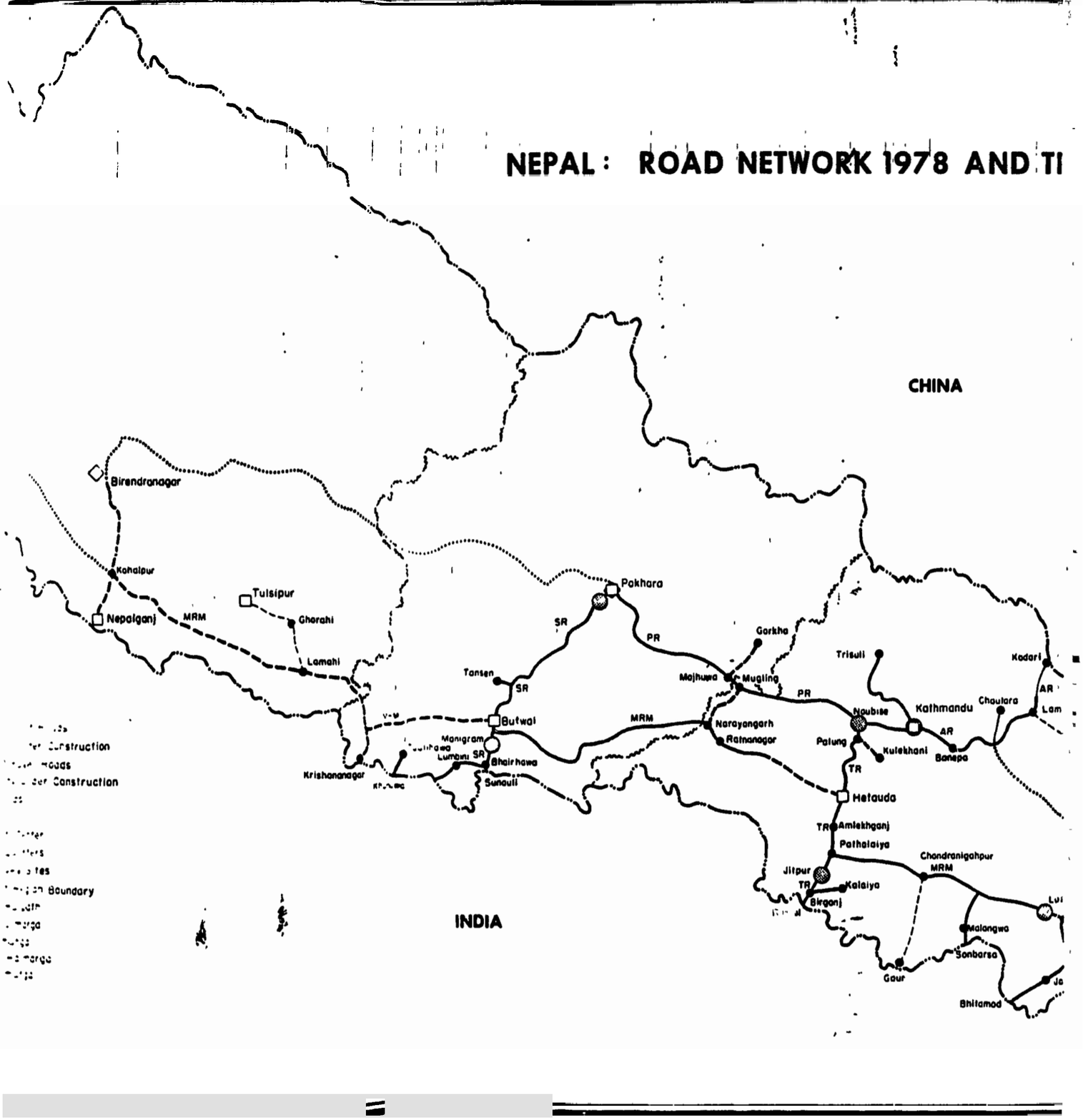
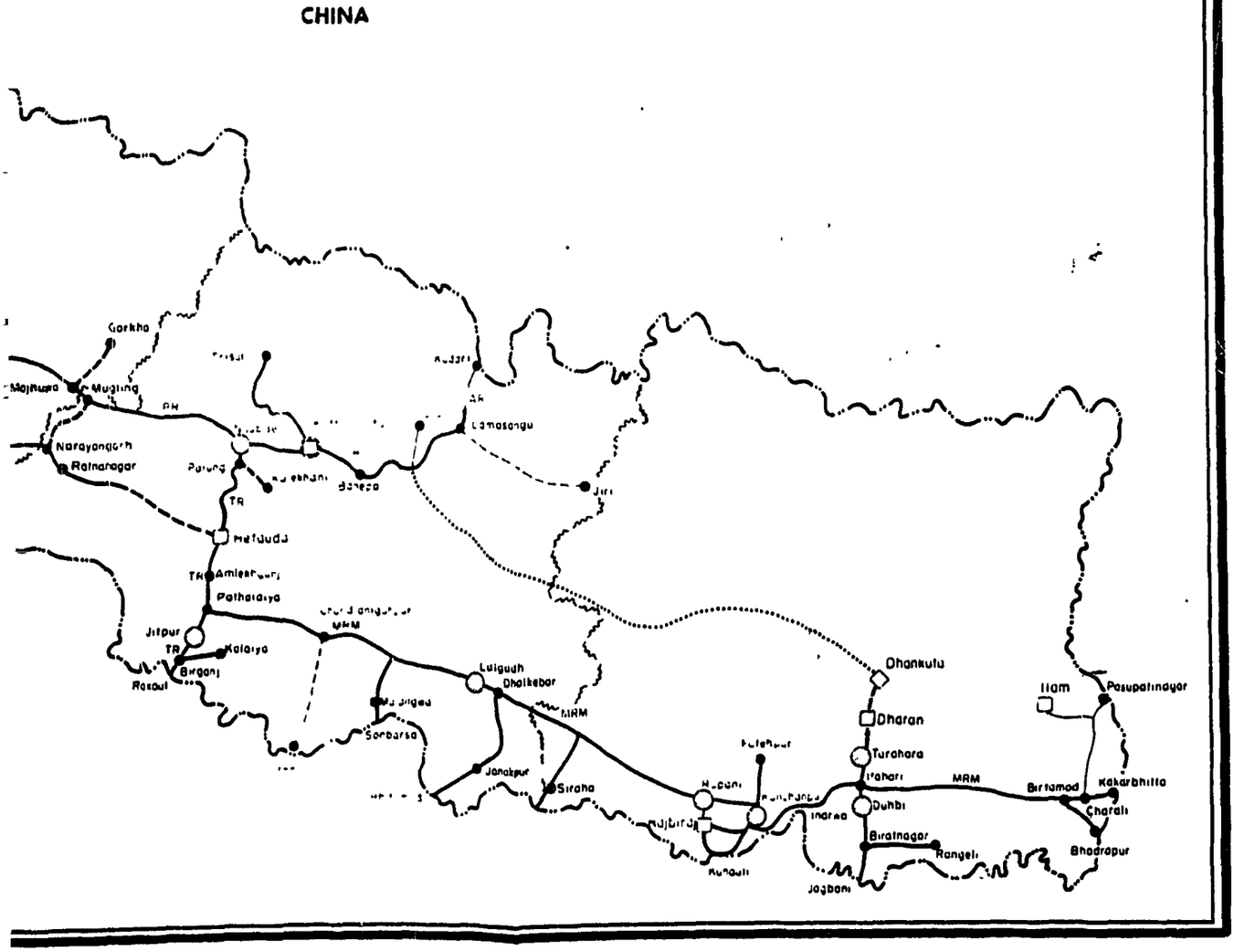

Dadeldhura
Mahenndranagar
Banbasa
MRM
Dhangadhi
MRM
Birendranagar
Nepalganj
Tulsipur
Ghorahi
Lamahi
MRM
Tc
Krishnanagar
Khunuwa
Completed Paved Roads
Paved Roads Under Construction
Completed Gravel Roads
Gravel Roads Under Construction
Planned Roads
Capital
Development Center
Zonal Headquarters
Traffic Survey Sites
Development Region Boundary
TR Tribhuwan Rajpath
MRM Mahendra Rajmarga
AR Arniko Rajmarga
SR Siddhartha Rajmarga
PR Prithbi Rajmarga


NEPAL : ROAD NETWORK 1978 AND TI
CHINA
INDIA
Birendranagar
Kohalpur
Tulsipur
Nepalganj
MRM
Ghorahi
Lamahi
Tansen
SR
Pokhara
PR
Gorkha
Majhuwa
Mugling
Trisuli
Kodari
AR
Lam
Chautara
Kathmandu
Naubise
Banepa
Kulekhani
Patung
Narayangarh
Ratnanagar
Butwal
Manigram
Lumbini
Bhairhawa
Sunauli
Krishnanagar
TR
Hetauda
Amlekhganj
Pathalaiya
Jitpur
Kalaiya
Birganj
Chandranigahpur
Malangwa
Sonbarsa
Gaur
Bhitamod
Construction
Boundary

AD NETWORK 1978 AND TRAFFIC SURVEY SITES



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I. THE PROJECT SETTING

Shortly after World War II, the power of the Rana family autocracy which had ruled Nepal for a hundred years began to erode. With the end of that regime in 1951, the first steps were taken to bring the nation into the 20th century. Regular contacts with the ideas, economies, and people of the rest of the world were initiated. The United States and India played, by all accounts, major roles in shaping these contacts. They offered both financial and technical assistance in education, health, and industrial development as well as in agriculture and transportation.

Because of the proximity of the Tarai to India and the already existing family and cultural ties between people on both sides of the border, India's assistance has largely been focussed on this region or in linking this region (and thus all of India) with the capital in the Kathmandu valley. Road construction and irrigation development along the major rivers which flow from Nepal through India have been important elements in Indian programs. The U.S. program recognized that the majority of Nepali people lived in the Hills, that hilly to mountainous region, heavily dissected by rivers, which lies between the rugged Himalayas and the flat plains of the Tarai (Maps 1 and 3). But the underutilized potential of fertile lands in the malaria-ridden Tarai and perhaps the greater ease of communication there also led the U.S. agricultural assistance program to a certain concentration of efforts in the Tarai. Together, India and the U.S. provided more than three-fourths of the foreign aid which Nepal accepted between 1951 and 1970.

A fact sheet about the U.S. program from 1952 to 1969 summarized that "the purpose of American aid is to assist Nepal in its programs for economic and social progress. The United States' aim is that Nepal be able to carry out its own development, without outside assistance." This objective echoed those of the new Nepali government, which expressed commitment to economic growth and to improving the quality of people's lives.

In the early 1950's, the economy was overwhelmingly agrarian. Expectations for development were centered on improving the productivity and income of the farming sector; the challenge of fulfilling those expectations was immense. Although population growth was slower than it is today, the effects of overcrowding on good agricultural land in the Hills were already apparent. An FAO survey of farms in the Kathmandu valley showed that, in 1953, the average family of seven tilled a holding of only 1 to 1.5 acres. There was considerable unsettled land in the Tarai, but endemic malaria hindered

resettlement and expansion of cultivation there. Those who farmed in the Tarai in spite of the mosquitoes had the benefits of larger farms but the disadvantages of heavy taxation and poor transportation. One author's impression was that, "The little left to the Tarai peasant after rent and debt payments was hardly enough to avert starvation. A bad harvest in these circumstances was disastrous" (14, p. 10).

It was not until 1956 that the Tribhuwan Rajpath, constructed by India, linked Kathmandu with the Indian border near Birganj. Other motorable roads between destinations in Nepal simply did not exist. The difficulties of transportation are important to keep in mind. They account in part for the limited monetization and trade in the agricultural economy and for the evolution of cropping systems which emphasized food self-sufficiency rather than the optimum exploitation of potential inherent in the soil and water conditions.

The environment for rapid agricultural development in the 1950's was not auspicious. It was in this environment, however, that the foreign assistance for development had to work. The first program in Nepal to receive American support was a village development training center opened in Kathmandu in 1952. The isolationism and feudal policies of the former Rana regime meant that few Nepalis had a strongly developed sense of what the government of Nepal could do for them. But Paul Rose, the first U.S. Operations Mission Director, underscored the widely-held assumption that the village development project would begin to bring about

> ...an organized effective means of distributing increased services to the people and a channel through which people may pass their judgement about problems and solutions to the central government. (Quoted in 14, p. 32).

Initially, the U.S. support to this and other projects consisted largely of providing the advice needed to get them off the ground. Apparently, however, neither the villagers nor the central government were as responsive as had been envisioned, so the U.S. assistance program became, for a time, more directly involved in providing the management and technical skills for development projects. In the latter part of the decade, the U.S. approach shifted once again -- from "straightforward administration of projects to the use of projects as a means to develop government institutions capable of carrying out even larger programs on their own" (14, p. 70). Nationwide impacts were desired and there were limited numbers of skilled Americans willing to work in a Nepal which required one to travel circuitously through India in order to reach another Tarai town or to trek for several days up river valleys or over mountains to reach even a major Hill town.

More food, foreign exchange, and productive employment for the vast majority of the labor force were necessary to achieve increases in both national and individual welfare. All provided compelling reasons for continued U.S. involvement -- and growing Government of Nepal involvement -- in agriculture. The fairly successful combination of a resettlement and a malaria eradication program carried out in 1955-58 in the Rapti valley (now called the Chitwan District -- and the site of the national maize research program headquarters) provided some encouragement. The long term project which is the subject of this evaluation was thus begun in 1957.

II. THE PROJECT DESCRIPTION

The project envisioned in 1957 was, in many ways, not the project which concluded in 1974. In the seventeen years of project implementation, the emphasis, the pace, and the level of Nepali involvement in the project shifted considerably.

Project No. 367-11-110-054 as originally conceived had several components, among them, training, extension, research, and construction. Readily available documentation is somewhat fragmentary but it appears that initially extension, training, and construction received priority -- probably in that order. The training of professional Nepali agriculturalists to B.S. and more advanced levels and the fielding of large numbers of local extension agents was consistent with the earlier-stated intentions of the U.S. assistance program to work with and through the Government of Nepal and to have a nationwide impact. In retrospect, however, the construction program indicated an implicit "Tarai first" strategy. The research stations receiving construction funds were all in the Tarai, within 20 miles of the Indian border (Map 2).

The project was first named "General Agriculture," aptly reflecting its broad sectorwide objectives. In 1968, it had already been extended two years past its intended completion date and renamed the "Food Grain Production" project. By 1968, nearly $4 million had been allocated to the project's various components; 106 persons had gone to the U.S. and 51 to "third" countries -- mostly to India -- for training in agriculture and natural resources. Several American advisors had been associated with the project, mostly working with various divisions in the Ministry of Agriculture. The advisors' end-of-tour reports provide interesting contemporary assessments of project emphasis and progress.

One of these advisors, Donald J. Carter, working as the Project Coordinator for the Agricultural Extension and Training

component of the project, wrote in 1965 that

> ... convincing 2 million farm families of the merits of modern scientific agricultural techniques (and training them how to adopt them successfully) is no easy task...It requires a considerable amount of time...By profiting from experience in the USA and other countries it is hoped to speed up this process in Nepal; even though the problem is aggravated by illiteracy, poor transportation and communications, etc.....

Carter also reported that "it appears Nepal is ready for 'take off' with an extension program that will make a real impact on production." The AID Mission disagreed:

> [Carter] ...has painted a somewhat overly rosy picture of this activity. In very general terms USAID does not consider this project to have been a success...we have not managed to adapt the agricultural extension techniques so successful in some parts of the United States to local conditions...

Further, the Mission Director at the time felt that

> ...there [was] doubt that either the Agriculture Department or the Government of Nepal as a whole place sufficient emphasis upon extension. Government... contributions, nominal in the past, must be increased and involvement and support extended to policy levels...

It appears from such comments that there was a mid-1960's shift within the project from an emphasis on extension to one stressing the development of Nepali research capacity. A 1969 project appraisal report summarized:

> ...The early agricultural activities concentrated mainly on extension-type efforts in which the farmers were exhorted to work harder and to do better almost exclusively within the framework of their existing technology...

Glen Johnson's arrival in 1967 as an Agronomy Advisor to the Department of Agricultural Education and Research seems to highlight the shift in project emphasis toward research and the development of improved agricultural technologies. In his end-of-tour report, Johnson notes that upon arrival, he "was indeed surprised to find 69 persons engaged in agricultural research that were holding B.S., M.S., or Ph.D. degrees." Although Johnson professed to be "disappointed to find HMG/N and USAID/N trying to conduct basic agricultural research on nine farms and stations without the basic, essential equipment..." he

cited with some pleasure progress made in the Nepal Agriculture Research Program

> ... based on introductions and varietal trials which have come into Nepal regularly since 1967... over 150 new varieties of paddy, maize, and wheat and over 800 varieties of sorghum and soybeans were put on trial in 1968-69...

Thus when Raymond Fort took up a position as the Chief of the Food and Agriculture Division in USAID/Nepal in October 1969, his priorities were clear:

> "A. To establish research competence in the field of agricultural production;
> B. to improve the operation of the Extension Service;
> C. to investigate ways of improving the market operations of farmers;
> D. to assist the Ministry of Agriculture and National Planning Officials to develop plans, policy, and strategy for agricultural development; and
> E. to serve when asked as a resource person on Panchayat Development (local self-government) matters."

Between 1970 and 1974, project activity seems to have been most intense. About 15 direct-hire AID employees and four contractors were posted to the various research stations and organizations in Kathmandu to assist in developing agricultural research capabilities. In 1971, the project name was altered again -- this time emphasizing the technology development rather than production targets -- to "Food Grain Technology." The project completion date was firmly set at 1974. Annual Project Agreements on budgets, experiments, and staffing for each station were worked out in painstaking detail by the AID Mission and the Ministry of Food and Agriculture in Kathmandu. While there was obvious frustration that the careful plans were never completely carried out due to fiscal and staffing problems both in AID and in the Government of Nepal, they appear to have started the process of program budgeting for the research system.

The program during this period was geared largely toward adaptive research, that is, bringing improved varieties of selected foodgrains (rice, wheat, maize) into Nepal, planting them out at research farms, screening them for yield and disease resistance, and systematically selecting, multiplying, and releasing promising lines. Fertilizer trials were conducted to test various levels of nitrogen, phosphorus, and potassium. Some work on optimum planting dates, plant spacing, and weed control was also carried out. While most of the effort was expended on-station, farmers' field trials were apparently conducted in some areas, drawing on the outreach capabilities of

the extension service. One collection of 1200 local rice varieties was made in 1970/71. On-farm storage improvements, paddy milling and marketing assessments, nutritional quality analysis, and some economic studies were other research-related activities supported under the Food Grain Technology project at one time or another.

While not all varieties identified in the adaptive research process proved to be popular with farmers, the process resulted in the selection of wheat varieties, particularly RR-21, and rice varieties, particularly Masuli, which are well-suited to the Tarai and to cropping systems there. Both wheat and rice varieties were officially released just before the end of the Food Grain Technology project. The design of the technology "packages" which include the improved seeds enhanced the role of extension services and input delivery systems although it also, as will be discussed below, made their shortcomings more apparent.

The extension aspects of the Food Grain Technology project continued to involve training, the fielding of agents, and the implementation of a program of demonstrations and field trials on farmers' fields. Again, a certain amount of advisory assistance was provided to the Ministry offices in Kathmandu.

By 1974, when the Food Grain Technology project was ended and the current Integrated Cereals Project (ICP) began, the U.S. had provided financial, technical and commodity assistance to Nepal valued at nearly $16 million under project number 367-0054. The Government of Nepal had gradually assumed a slightly greater share of the costs associated with the growing agricultural establishment. Almost 600 Nepalis had been sent for degree-level or short-term training under the project. In later years, increasing numbers of the degree candidates went to Indian agricultural universities. Since these universities were less expensive than their U.S. counterparts, this permitted greater numbers of students to attend. A follow-up study on training prepared by the AID Mission in 1974 estimated that 80 percent of the agriculture and natural resource returnees were employed in positions directly utilizing their training, although another evaluation report indicates that "directly" might be an overstatement. This latter report includes an example: "50% of the agricultural engineers trained as part of this project are not working as ag engineers at this time. They are working in ag facilities, but not necessarily as ag engineers."

III. PROJECT IMPACTS

Sitting in an armchair perusing foodgrain production statistics for Nepal, one could only conclude that the efforts to transform agriculture through research and extension have been in vain. Food and Agriculture Organization (FAO) indices for food production in Nepal were 92 in 1956, 100 in 1969-71, and 110 in 1978. The repeatedly targetted three percent annual increases in output have never been achieved. Population growth, on the other hand, has occurred. Increased investments in research and extension have thus been associated with an

> ...average annual growth rate of agricultural production in Nepal ...[of] 0.4 percent in the last decade [the 1970's] as against more than two percent rate of growth in population. This paradoxical input-output relation in food production in Nepal has been a matter of serious concern (35).

The FAO indices for *per capita* food production underscore the concern; they declined from a level of 120 in 1956 to 91 in 1978. Paddy yields were two metric tons per hectare in 1964/65; in 1978/79, after years of research, new varieties, and more than triple the amount of fertilizer imports, paddy yields were 1.85 metric tons per hectare (41, p. 108). The poor production record is also apparently somewhat of a mystery to researchers themselves, who feel that known technology could boost production significantly. As one said, "These farmers have to be convinced. I don't know why they aren't."

Inaccurate production statistics, bad weather, stubbornly traditional farmers, declining soil fertility, adverse changes in climate, unrecorded sales to India and any number of other explanations can -- and have been -- considered. With little direct evidence to support any of them, however, the evaluation team saw no alternative but to get out of the armchair and talk with those ultimately responsible, the farmers themselves. With their voices and opinions echoing in our minds, we also talked with researchers, extension agents, and those who distribute fertilizer, seeds, and credit. By hearing about plans and problems from all corners of the sector, we began to understand the realities behind the production numbers. Only at that point did we feel ready to assess the impacts of the project.

Although the emphases of the Food Grain Technology project had evolved during the course of implementation, its broad objectives were to:

- establish a national research organization capable of adapting and generating new technologies;

- introduce these new agricultural technologies, including improved seed varieties and chemical fertilizers, to farmers, by building an extension service;

- develop Nepal's capacity as a nation to sustain and expand agricultural production, not only through research and extension, but by fostering the growth of a profitable, surplus-producing, agricultural sector; and

- improve the productivity and welfare of farming households.

These intentions directed our inquiries and our search for the "differences" which could be attributed to the fact that this project had taken place.

A. Establishing National Research Capacity

One crop coordinator characterized the development of Nepal's research capacity as analogous to the development of rural transport in the country. "First," he said, "we had a completely top-down approach -- the helicopter. Then, STOL (short take-off and landing) strips made it possible to visit more regularly. Roads followed, so more people could at least get closer. And now we're beginning to see feeder roads -- and coming a bit closer to the grass roots."

Just recently, the Department of Agriculture endorsed the view that researchers should be in touch with farmers' problems by issuing a guideline that 40 percent of research staff time should be spent off-station, on farmers' fields. Given the lean staffing situation in most stations and the number of tasks besides research that many are expected to do (such as serving as subject matter specialists for extension training, producing seed, and assembling minikits), this dictum is likely to be difficult if not impossible to meet. Nevertheless, it reflects a healthy development in attitude for the future orientation of the research system if the effects of research station capabilities must ultimately be visible in farmers' fields.

The Food Grain Technology project can take some credit for helping to develop this attitude. The project offered some concrete contributions to its realization, namely: the development of research stations away from Kathmandu, training for a large enough group of agricultural scientists that not all could be absorbed by Kathmandu's bureaucracy, and the concept of farmers' field trials.

The project's resources helped in the process of building the necessary working environments for research outside of Kathmandu. Physical facilities and equipment at the Bhairawa, Rampur, Parwanipur, Janakpur, and Nepalganj stations (Map 2) owe a great deal to the construction funds and commodities supplied under the Food Grain Technology project and its successor, the Integrated Cereals Project. Comparison of staff lists for 1970 and 1980 for some of the stations supported under the projects indicate that the training efforts facilitated substantial increases in numbers of trained scientists and needed additions of new research skills.

In 1970, 96 of the 114 college graduates with B.S., M.S., and Ph.D. degrees in agriculture were posted to Kathmandu. In 1980, 355 of the 625 persons identified as degree-holding, high-level agricultural manpower in government positions were, according to an APROSC study, posted outside of Kathmandu. As the crop coordinator indicated, research scientists may not yet be completely aware of farmers' constraints, but they are at least physically in the same vicinity.

The research foundation is impressive, particularly when one considers how rapidly it was built. But it is important, in terms of assessing impact and drawing lessons for the future, to look beyond the bricks, mortarboards, and irrigated experimental plots, and to consider the research system's performance.

Were the choice of sites and the definition of the initial research task as adaptive research, for example, appropriate? Or, given the low level of infrastructure and staff availability which existed at the start of the project, would not a concentration of effort in one or two stations have had the effect of assembling a critical mass of research talent earlier, possibly avoiding the shortages of staff and resources which are still cited as major constraints to performance at many stations? Or, given that the majority of project support went to stations in the Tarai, and that the research emphasis is biased toward Tarai crops, how valid is a claim that a "national" research capacity has been created? Or, given the resources allocated, how could the relevance of the stations' efforts to farmers' problems have been improved and how much impact could they have had on farmers' utilization of improved agricultural technology? There are no objective answers to these questions, of course, but the Nepal experience is instructive. Three issues are explored briefly here.

Concentration or Dispersal?

As noted earlier, the research effort in Nepal has been dispersed among several stations. Yet, on balance, the development of several research stations in agroecologically

similar areas of the Tarai has probably been beneficial in terms of impact. Transportation constraints precluded rapid communication between research stations and farmers' fields on a regular basis even over fairly short distances until the basic road networks were developed. Even now, vehicle running expenses and monsoon floodings constrain the amount of researcher-extension agent-farmer contact. If the knowledge about improved technologies is supposed to get out as rapidly as possible, then it makes sense, under these conditions, to have the site at which such knowledge is generated as close to users as possible. This was especially true when the research function was primarily adaptive and consisted of planting out varieties from elsewhere and selecting desirable varieties for local conditions. A good agronomist under this research plan could adequately play an important research role. Moreover, if another agronomist at another station were doing similar trials, the benefits of dispersed verification and extension probably outweighed the costs of the duplicated efforts.

Researchers now seem to be moving toward more applied research, however. The research program is being modified to address particular local problems, such as weeds, soil fertility, and cold tolerance, and to the breeding of new varieties incorporating local materials. There may be a growing rationale for more specialization among stations and personnel and for the concentration of complementary research skills at single sites.

To date, the multi-station commodity improvement programs and the national Summer and Winter Crops Workshops seem to have been able to bring about needed focus and professional interchange and to avoid duplication of experiments. The commodity improvement program mechanism permits researchers posted at different stations to work collaboratively on experiments focussed on a particular crop -- varietal selection, plant nutrition, disease resistance, etc. The Rice Crop Improvement Program, for example, is headquartered at Parwanipur; the director of the RCIP also serves as the director of that research station. The Wheat and Maize Crop Improvement Programs are headquartered at Bhairawa and Rampur, respectively, again under the leadership of the station directors. In the early 1970's, each of these and other commodities was the subject of an annual seminar at which results were reported, problems discussed, and, apparently, a plan for the next year's trials communicated. In the late 1970's, it was decided that meetings on each separate commodity were too time-consuming for participants and the Summer and Winter Crops Workshops were instituted to accomplish the same purposes as the commodity seminars. The Commodity Improvement Programs continue to prepare annual reports and, within the structure of the Workshops, to serve as focal points for

coordinating and guiding research. The dispersed stations are thus tangibly linked into a functioning network for research which seems both effective and appropriate for the crop research underway.

This discussion does not, however, take into account possible duplication of functions among agencies conducting research other than on crops. Ramesh Sharma has noted, in his useful study of agricultural research in Nepal, that the division and possible duplication of effort is very likely. There are sixteen agencies in four different ministries conducting agricultural research, including research on livestock, agro-economics, and non-food commodities (tobacco, for example). Sharma concludes, "Where there is a large number of diverse organizations without a central level unit to guide overall research, overlapping and duplication of work is a distinct possibility. Interviews conducted with various researchers in Nepal confirmed this assertion" (35, p. 7). While the Government of Nepal recently rejected a proposal to consolidate research coordination under a special unit, one attempt to avoid possible duplication should be mentioned. The recent conversion of the Janakpur station to livestock research and the consolidation of crop research activities in the nearby farm at Hardinath, for example, seem to represent a sensible reorientation of research priorities and illustrate governmental willingness to undertake moves to reduce possible duplication. But this is clearly an aspect of institutional performance which will continue to need attention.

Tarai Bias or a National System?

Even the casual observer of research reports, bringing only a nodding acquaintance with Nepal's agroecology to bear, can detect the Tarai bias of the foodgrain research effort. The reports emphasize yield potentials for new varieties of rice, wheat, and maize, recommendations for the use of fertilizer, and optimal planting dates. They contain assumptions on timely water delivery. All imply that Hill farmers will have less to learn from researchers than Tarai farmers. Although transportation of improved agricultural inputs to the Hills is subsidized, both the difficulties of transporting seeds and fertilizers up mountain trails and Hill farmers' lack of financial resources and incentives to buy the new inputs effectively limit their distribution and use. While many farmers in the Tarai may not have effective access to the technologies recommended by researchers for reasons of purchasing power, information, or supplies, at least their access is better.

Neither Hill farmers nor producers in the Tarai may find improved varieties of crops they feel are appropriate to their

conditions, but Tarai farmers stand a better chance. Ramesh Sharma attempted a quantitative assessment of relative resource allocations to research by crop. Over 80 percent of the millet is grown in the Hills, yet research efforts on millet and pulses were, by his calculations on their importance in terms of area and value, "grossly underinvested. In absolute terms paddy has claimed the largest crop research budget." Over 80 percent of paddy is grown in the Tarai. Sharma goes on to say, however, that even paddy "...is relatively underinvested in research in spite of its predominant importance in terms of cultivated area, production value, and source of foreign exchange" (35, p. 28). Comparing research budget and manpower allocations to a consumption criterion as well, Sharma concludes that only maize and wheat research seem to be adequately staffed and funded. He points out that "maize is a staple crop in the Hills and has a large production potential..." and suggests that "...relatively higher levels of resource allocation for this crop should continue." He does not, however, question the present focus of most maize research in the Tarai.

The irrigation bias of the improved agricultural technology developed by the Tarai research stations is understandable from a research management perspective; no researcher would voluntarily risk losing the results of a whole crop cycle to water stress or drought when irrigation facilities are available, thanks in part to the Food Grain Technology project. Farmers do face such risks, however. As one farmer put it, "I know I should irrigate on the 21st day, but what am I to do if there is no water in the canal?" Estimates of irrigation coverage even in the Tarai run only between ten and fifteen percent, and are lower in the Hills. Some measure of water control may be available during the monsoon to a slightly higher proportion of the farmers in both areas. Even if major development work in irrigation systems were concentrated in the Tarai, however, coverage will still not be total. Thus, for the future, the Tarai bias in research could well widen the gap between yields on the stations and yields in farmers' fields -- unless more options for rainfed conditions are examined.

Improved Relevance and Impact?

Both commodity emphasis and assumptions about irrigation indicate divergences between farmers' interests and researchers' concerns. Other researcher-farmer communication gaps can also be noted. These are well-articulated by farmers: "What we need is not a better variety that requires even more fertilizer, but a good variety that requires less fertilizer." Farmers share an interest with researchers in high output, but as one demonstration farmer in Parsa District said, "The JT's[1/] think the demonstration is good because the yields are going higher. What they don't see is that my costs are going higher, too."

1/ Junior Technicians, or senior extension agents.

Given the riskiness of the farming environment in the Tarai and the meager assets of the farming households, the high-input new technology packages for rice and wheat were exactly what the farmers could not use. After experimentation with them, those farmers who had enough land and water generally fit new technologies in as small parts of their cropping system. Wheat fit in most easily because it often replaced fallow and could grow using the residual soil moisture from the monsoon. Those farmers with irrigation facilities took advantage of the production opportunities in the early season by using improved short-season rice varieties. While many farmers tried some fertilizer, virtually no farmers used the recommended amount -- because it represented a much too risky investment. 1/

Still other farmers noted increasing problems with livestock. Animals for plowing are essential, their manure is useful for fertilizer and increasingly necessary for cooking fuel, but grazing area has been severely reduced -- partly by reduction of forest areas in the Tarai, but mainly by the more intensive cropping of cultivable land. Animal-minding in many villages has become a full-time job but even then, many farmers noted decreases in herd size due to lack of fodder. It is encouraging to note that forage production is receiving some attention at a few of the stations, although, as Appendix C explains, the farmers may be forced to find a solution before the researchers do because of the seriousness of the shortage in some areas.

In sum, there is ample evidence that Nepal's agricultural research capacity has been developed. It should also be clear that room for improved performance and impact remains. We turn then to consider the roles of other institutions in disseminating the research results.

B. Introduction of New Technologies

It is generally taken as axiomatic that research and extension have to work in tandem if levels of farm output are to be significantly increased through the use of improved (i.e., scientifically based) agricultural technologies. Less often included as an explicit corollary to this axiom is the fact that the new technologies generally require new resources from off the farm; hence, the critical roles of those who supply these resources --fertilizers, seeds, pesticides, water, and credit -- and the transport system are overlooked. The view that farmers could do better with their current resources -- a view which apparently was part of the early conceptualization of this

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1/ See Appendix D for a more detailed discussion of risk.

project -- has a few die-hard adherents in Nepal as elsewhere. They point to cases of poor management and assert that proper extension instruction alone could increase these farmers' output. But, by and large, the process of technology development, extension, and adoption is accepted to include the notion of inputs from outside the farm. This implies a certain amount of marketed output and exchange outside of the household. Changes in other sectors of the economy have also reinforced a trend toward greater monetization and trade.

As one progressive Tarai farmer put it, "Before we didn't have to educate our children, we didn't have to follow clothing fashions, we didn't have to go to Birganj." Now, his cropping pattern includes sugarcane for sale 40 kilometers away at the sugar mill in Birganj; his son was home on vacation, having just completed his School Leaving Certificate; and the farmer himself was wearing a heavy-knit, factory-made sweater over his kamij and dhoti against the January cold. We interviewed him in the office of the sajha (cooperative) manager, who was occupied with tidying up the books from the last cycle of sales of wheat seed and fertilizer. The delivery of these inputs from the Agricultural Inputs Corporation (AIC) store in Birganj had been late,[1/] and many farmers -- including our progressive respondent -- had made decisions to reduce their risk. They decided to use less fertilizer or none at all this season because they knew they had missed the optimal planting date and were going to have lower yields anyway.

Researchers identifying improved seed varieties and providing foundation seed have to rely on the extension service, the cooperative or other means of communication to get the information on using these varieties out to farmers. Farmers may find the information helpful, but often perceive both themselves and the extension service as helpless to act on the advice. There are a lot of "if's" involved in the successful completion of the adoption cycle: if the rains come on time, or, for example, if the electricity is available to run the pump and the canals are not silted up, irrigation water may be available; if the AIC manages its farmer seed multiplication and storage system well, the seeds may germinate as expected; if the donors provide the right types of fertilizers or there are adequate foreign exchange reserves to get fertilizer imports moving and the AIC handles the imports in a timely way, it may be possible for the cooperatives to get their supplies on time; if the farmer holds a title deed or a tenancy deed to his land to get credit at the Agricultural Development Bank or has enough cash to buy without credit, then it might be possible to purchase available inputs; etc., etc.

1/ This is significant because the publicly-owned AIC has a monopoly on fertilizer sales.

Only if all such conditions are met is it even reasonable to expect the full impact of the research potential to be realized. There may be a few isolated cases where the system works as intended, but for the majority of Tarai farmers it does not. Interviews indicated that that the chances for fulfilling all the "if" conditions were low for most farmers. They were not, therefore, overly optimistic about achieving significant increases in yields in the near future. They were, quite rationally, experimenting, expanding area planted to new varieties, and hedging their bets as they saw fit. They were planting wheat on part of what was once fallow and linseed on the rest -- wheat to make money and linseed for home consumption as the cost of edible oils had recently risen. They were growing local maize for home use because it stored well, but producing improved maize for the market; they were using AIC- or extension-supplied seed on one plot and personally-imported improved seed from India on the adjacent one; they were planting the short-season rice (IR-8) early when they could get water and still finding time for a monsoon crop of the longer-season Masuli rice variety; they were putting fertilizer on wheat and only compost or nothing on rice; and they were planting jute or mustard with ample fertilizer so that the non-fertilized rice crop following would do well on the residual. From their perspective, they were, in most cases, farming as best they could, given their constraints.

The aggregate statistics do not, therefore, demonstrate the yield potential of the new technologies being used. Only data regarding adoption of and area planted to improved wheat varieties indicate effective introduction of new technologies. Area planted to wheat has more than tripled -- from 100,000 hectares in 1964/65 to nearly 400,000 hectares in the late 1970's. Virtually all production is of new varieties simply because so little wheat was traditionally grown. Comparable data for rice show continued reliance on traditional varieties of that crop and a much slower expansion in area planted (40, p. 72). But many farmers believe that they are ahead of where they would have been without them, although they also realize that with certain changes -- more irrigated land, lower tenancy rents, timely fertilizer, etc. -- they could produce more.

Virtually everywhere we visited in the Tarai, farmers were aware of the new varieties and many, if not all, farmers have grown them in the last five years. They are also aware that high applications of fertilizer are recommended and they are knowledgeable about the sowing date advice. Some farmers had learned such information from other farmers in the community, some from observations made outside the village, others from extension-sponsored demonstrations and/or minikits, and still

others from radio programs. Few farmers had ever visited a research station to see trials there, although by chance we encountered one farmer who had actually attended a ten-day course at the Janakpur station in 1970 or 1971. He now made it a practice to stop in regularly to see what was going on, but it should be noted that he had exceptionally easy access to the station. Near Rampur, too, farmers mentioned going to the research station to get fresh seeds. In general, therefore, farmers were convinced that modern science-based agriculture did offer some possibilities for improved yields. The gap between potential and actual productivity has persisted because farmers do not -- or cannot -- act upon their convictions.

C. Developing Nepal

The question which logically follows the previous discussion is: If the potential yield benefits of the new technologies are not being realized now, is the research process likely to be able to develop new technologies which will at least permit current yield levels to be sustained or to increase at the rate of population growth? A related question is: Will farmers be able to take advantage of such technologies to permit the agricultural sector to be able to contribute a surplus to the national economy? These future-oriented questions can be answered in part only by looking at the past and the present.

As we have noted in the previous section, improved agricultural technologies generally imply farmers' use of resources from outside their farms. As we discuss at some length in Appendix C, farmers' own resources of land, animals, and water are coming under increasing pressure of population and, under current conditions of technology adoption, the fields are being more rapidly depleted of plant nutrients than in the past. As we also noted above, the "if" conditions which need to be met if intensified production is to be sustainable are most often not fulfilled. Farmers are adopting only parts of technology packages. The high-technology bias of the research results to date has thus contributed, albeit unwittingly, to a probable decline in the soil fertility of the Tarai. Farmer after farmer noted the phenomenon in interviews, emphasizing that continuous cultivation of plots had always affected fertility adversely but that, with more intense cultivation -- two or three rather than one grain crop a year, the process had accelerated. The request of the farmer for a good variety which uses fewer inputs comes echoing back.

From scattered conversations with researchers and discussions in various workshop reports, it would appear that some researchers are listening. The skills to take action at the experimental level also seem to be there. Leguminous fodder

research such as that being done at Tarahara and Janakpur is only a short distance removed from work with green manuring. The long-term fertility trials being conducted simultaneously at several stations are well-conceived and should prove extremely useful in coming to grips with the long-term problems farmers are already beginning to see and deal with. The analyses of nutrient flows and farmers' use of compost in the cropping systems work carried out under the Integrated Cereals project is insightful. Evidence of a commitment by research leadership to define these long-term problems as research priorities is, however, not yet visible.

Going off the station should help research scientists to understand farmers' problems. But it will be up to them to come up with the solutions and the process is not, given the Integrated Cereals Project findings, likely to be easy. In one report, ICP analysts concluded that,

> ...In general, increasing cropping intensity in Pumdi Bhumdi [a cropping systems site near Pokhara] may not be as simple a task as raising the yields of individual crops. Yields can be increased by changing varieties and by supplying moderate doses of fertilizer with little effect on the other components of the farming system. Increased multi-cropping (i.e., more crops per year), on the other hand, increases the demand of scarce resources such as bullock power, fodder, labor, and compost and/or other sources of plant nutrients and therefore affects to a greater extent the entire farming system." (12, p. 12)

In another report, they conceded that, while improving the whole cropping pattern was the objective, "the formulation of an 'extension package' has proven to be difficult. Conventional extension 'packages' are crop or commodity-focussed." (16).

Increasing the reliability of water and fertilizer supplies were Tarai farmers' recommendations for handling the long-term as well as short-term problems. Farmers whose returns are more guaranteed are already willing to invest more in the way of fertilizer inputs. Increasing irrigation coverage will increase fertilizer demand even more. Acting on the farmers' recommendations to expand irrigation coverage, however, will not only cost the government money, especially where private boreholes for irrigation are not feasible and only major river basin development will do, but will also require the government to find sufficient foreign exchange to cover the expanded fertilizer imports. Nitrogen fertilizer must continue to be imported, although apparently there are limited opportunities for phosphorus production in Nepal. Where are the government revenues to fund irrigation investments to come from; what sector is to earn the foreign exchange? Since Nepal remains a

largely agrarian society, the answer is clear.

But past research efforts have not resulted in the expected production of significant marketable surpluses of commodities. Rice was anticipated to become a major earner of foreign exchange, but export data for the 1970's show a poor record. A growing agricultural sector could also have been expected to result in an improved tax base. Recent changes in revenue legislation, however, may have reduced the ability of the government to capture surplus from current production in order to make the necessary public investments, particularly in irrigation, which will support future sectoral growth. There seems to be little prospect of Nepal's agricultural economy fostering its own growth. Continued infusions of foreign aid will be needed to sustain levels of productivity already achieved. Improved technologies in agriculture have not yet fostered economic independence. Nepal has not developed the capacity "to carry out its own development, without outside assistance."

D. Improving Household Productivity and Welfare

While most farmers in the Tarai are just keeping ahead of their households' food and cash needs with the help of improved varieties and small applications of chemical fertilizer, some are finding farming very profitable. The question recurs: "If some can benefit from modern agriculture, why can't others?" When research and extension services launched under the Food Grain Technology project set out to promote a package of improved technologies, the "trickle down" theory was in vogue. Progressive and innovative farmers were to serve as models for others to follow. Finding these model farmers was relatively simple. Usually they were landed, wealthy, politically powerful, had irrigation, and could afford to offer free housing to the extension worker. The implied obligation and proximity were important because if there were problems with the experiment, the extension worker was often key to their solution. Either he could draw on his own training or he could serve as a direct link to those higher up in the research, extension, or input supply systems.

This model was not, of course, perfect. But it helped to spread the information about the new technology packages across the Tarai. As the new ideas trickled down, however, the packages came apart. Initially, some of the smaller farmers took the whole package -- seeds, fertilizers, water, time of planting, method of sowing, etc. -- but they soon realized that all the conditions which were more or less guaranteed on the

model farm were far from secure on theirs. All the conditions, the "if's" mentioned above, were necessary to their getting a good return. The chances of fulfilling the conditions had to be reassessed. So Nepali farmers, especially small farmers whose tolerance for risk is very low, have grown increasingly selective about the technology package. While this selectivity has resulted in yields per hectare and incomes well below the theoretical maximum for each crop technology, it is likely that most farmers have achieved a balance between the old and the new technologies. They have taken from the package what they felt they could afford, or, more correctly perhaps, what they felt they could not afford to do without.

The technology recommended by the Nepal research system might be scale neutral in that it does not require mechanical equipment or substantial quantities of inputs. But the technology is apparently not neutral in application, partly because the risk of adoption and the cash requirements are not equally easy for small farmers, tenants, and large farmers to shoulder.

Impressions are that income gaps in the rural Tarai have widened, although this generalization masks considerable shifting among groups within the overall distribution. Retrospective questioning of farmers indicated that some households are getting better off; others are gradually declining. The only ones whose status has definitely worsened are those who are at the bottom. Those fortunate enough to take full advantage of the new technology have been able to improve their households' welfare significantly, particularly by diversifying their operations and putting their profits into more land, rice mills, bazaar apartments, or other commercial enterprises. Where roads or irrigation infrastructure have been improved and because population pressure has intensified, the price of land has risen substantially -- to four, five, or six times the values of a decade ago -- while the price of rice, for example, has only doubled. Purchasing land for farm expansion is still possible, but many purchases come at the expense of others' entire farms. Those in debt or those at the margin are forced to leave and go elsewhere to work or to continue on in a landless, somewhat precarious existence. Figures for the Tarai show an increase in the percentage of small and marginal farmers since 1970; survey data also indicate that 40 percent of farmers are partly and wholly tenants, not all of them with secure tenancy certificates (32).

The two major hopes for improved family welfare expressed by smaller, poorer farming households at this time seem to be the acquisition of more land and more education for their children. As one farmer who owned one small piece of land, was a tenant on another, and share-cropped on a third explained,

"Given my expenses, I have to farm as much land as possible. So my landlord and I have come to an agreement that I will pay him a share on all three crops, rather than a fixed rate on one crop as required. It is a good piece of land and I have good production there."

On the education side, the benefits for many rural youth are far from clear. Completion of school, at least to tenth grade, does not offer a great deal of opportunity as far as employment is concerned. Jobs in the government and in the small number of industries in the modern sector are difficult to find without contacts.

V. FINDINGS: A SUMMARY

This examination of patterns of change associated with the agricultural research and extension efforts supported by the Food Grain Technology project provides both a sense of solid accomplishment and a basis for some disquieting fears.

On the positive side, we noted the impressive establishment of a functioning, decentralized but coordinated, research system. Training investments have paid off with the presence of substantial numbers of skilled staff in both research and extension organizations. We found widespread recognition and selective adoption of the improved agricultural technologies. Krishi bikash is a part of many Tarai farmers' vocabularies, reflected in the marked increases in cropping intensity which wheat and early rice varieties have helped to make possible. Research and extension services have worked together on outreach, demonstrations, field trials, and popularization of the new packages of improved technologies. Not all farmers have had personal contact with the extension service or even know where the research stations are, but through the process of neighbor learning from neighbor, the language of improved technologies has begun to be spoken with understanding.

On the more negative side, we found researchers and farmers concerned with different problems, differently prioritized. Researchers cannot understand why farmers will not adopt packages which are demonstrably profitable and farmers cannot understand how researchers can expect them to take so much risk. The conditions which each farmer has to fulfill to be a progressive adopter appear not to be recognized by many researchers. The fact that farmers are adopting components of the technology package at all may reflect less the persuasive rhetoric of research and extension than the farmers' response to the increasing pressure of population in the Tarai and to their families' requirements for food and cash income. Farmers may

well be using the improved technologies to the point where they are keeping up with their needs; only a minority seem to have sufficient resources to use improved technologies to get ahead. Many, if not most, Tarai farmers perceive the lack of assured water supplies to be their major constraint to more productive use of new technologies. One farmer, when asked to list what he thought his greatest farming problems were, said, "Water first, and then money." Pausing, he corrected himself, "No, if I had water, then I would have money."

The potential for serious ecological deterioration associated with the increasingly intensified cropping is alarming. Population pressure on land, and the opportunity to triple-crop land with a sequence of early rice, monsoon rice, and wheat or with a rice, wheat, maize rotation have combined to reduce the amount of land for grazing, the amount of manure for fertilizer, and the amount of forest -- causing a substitution of manure and straw for firewood in some places. The combination ultimately adversely affects the fertility of the soil. Just stabilizing this cycle will require major changes in the coming decades.

In economic terms, the picture also looks somewhat bleak. The reliable foodgrain production expected and needed to feed Nepal's growing population is not yet a reality. Nor has an exportable surplus been sustained. Instead, there is a sense of holding one's own in many households in the Tarai. Among many of the people we interviewed -- researchers, extension agents, and farmers -- there is a sense of frustration at not consistently being more productive. Needed resources , whether laboratory equipment, bicycles or fertilizer and water, are not yet reliably available, and productivity suffers. Like its farmers, Nepal may have to redouble efforts to stimulate agricultural development, not because it can afford to -- but because it can't afford <u>not</u> to.

VI. LESSONS LEARNED

1. <u>Understanding the objectives, resources and constraints of farmers is the key to establishing appropriate research priorities</u>.

   -- Establishing these priorities may not result in "success" as defined in terms of large differences in output or yield per hectare.

   -- An understanding of the constraints, objectives, and resources of farmers by the researchers, moreover, will not necessarily allow them to remove all constraints or allow farmers to tap unused resources.

-- The existence of constraints forces a choice in research strategy. A strategy can take the persistence of constraints into account or it can assume their removal.

2. Off-station research is necessary to understand what farmers can and want to do and can facilitate the research process. But getting off the station does not guarantee that the researchers will better understand the farmers' resources, objectives, and constraints, or that researchers will develop technologies more appropriate to the needs of farmers.

3. Coordinated, planned research efforts on a multi-year basis offer some promise for achieving certain research results which may otherwise never be addressed -- long-term soil fertility, for example.

4. Long-term environmental considerations have to be part of the research.

5. Top-down decision making on staff resources, programs, and budgets, combined with the need to keep research in touch with farmers, makes it imperative that information channels within the research organization are as open as possible.

6. Maximum contact among researchers, extension staff and farmers pays off.

7. Government intervention in the distribution of agricultural inputs may be useful in the market promotion stage, but a monopoly may not be appropriate when farmer demand is strong and inputs cannot be produced by the farmers themselves.

8. System development and evidence of concrete results take time. Foreign experience in extension and research may not "speed things up" as expected.

REFERENCES

1. Acharya, Meena, 1979. The Status of Women in Nepal. Volume 1, part 1. Center for Economic Development and Administration, Tribhuwan University, Kathmandu.

2. Agricultural Projects Services Centre (APROSC), May 1981. "Evaluation Study of Agricultural Farms and Stations in Nepal"

3. APROSC, 1981. Nepal: Trained Manpower for the Agricultural Sector, Vol. I and II.

4. Axinn, George H. and Nancy W. Axinn, 1981. Social Impact, Economic Change and Development -- with Illustrations from Nepal. Rotterdam University Press.

5. Calkins, Peter, 1976. Shiva's Trident: The Impact on Income Employment, and Nutrition of Developing Horticulture in the Trisuli Watershed, Nepal. Ph.D. dissertation, Cornell University, Ithaca, NY.

6. Ender, Gary P., 1980. The Development of Road Transportation in Nepal and its Relationship to Agricultural Development. Ph.D. dissertation, Cornell University, Ithaca, NY.

7. Gurung, H. B., 1981. Food Systems and Society in Nepal: An Overview. New Era.

8. Hagan, A. R., 1976. "The Agricultural Development of Nepal: Analysis of the Agricultural Sector." Special Report 189, International Series 11, Agricultural Experiment Station, University of Missouri - Columbia.

9. IADS/APROSC, 1981. Agreement and proposal for evaluation of minikit performance in rice, maize, wheat soybeans.

10. S. N. Lohani, et al. Cropping System Research in Nepal. Field Trials Report Winter Season, 1977/78.

11. Mallick, R. N., 1981. Rice in Nepal. Kala Prakashan, Kathmandu.

12. S.B. Mathema and M. G. Van Der Veen. "Parcel, Farm and Community Level Variables Influencing Cropping Intensity: Pumdi Bhumdi, Nepal," Cropping Systems Program Technical Report, HMG: February, 1980.

13. Mellor, J. W. et. al, 1979. Report to the International Fund for Agricultural Development of the Special Programming Mission to Nepal.

14. Mihaly, E. B., 1965. Foreign Aid and Politics in Nepal: A Case Study. Oxford University Press.

15. Nepal, HMG, USAID/IADS. Integrated Cereals Project, various reports.

16. Nepal, HMG, Ministry of Food and Agriculture, Department of Agriculture, Integrated Cereals Project, various reports.

17. Nepal, HMG, Ministry of Food and Agriculture, Department of Agriculture, National Maize Development Program, 1980. "Maize and Finger Millet: The Eighth Summer Crops Workshop."

18. Nepal, HMG, Ministry of Food, Agriculture, and Irrigation, Department of Irrigation, Hydrology, and Meteorology, 1977. Climatological Records of Nepal.

19. Nepal, HMG, Ministry of Food and Agriculture, 1981. Nepal's Experience in Hill Agricultural Development. Proceedings of the Seminar on Nepal's Experience in Hill Agricultural Development. March 30 - April 3, 1981. Kathmandu, Nepal.

20. Nepal, HMG. The Integrated Cereals Project Review Papers, October 23 - November 2, 1979.

21. Nepal, HMG. Wheat Reports. 8th Winter Crops Workshop, September 4-5, 1980.

22. Nepal, HMG/USAID, 1974. Participant Directory, 1952 - 1973.

23. Nepal, HMG, Ministry of Food and Agriculture, Economic Analysis and Planning Division. Agricultural Statistics of Nepal, 1972.

24. Nepal, HMG, Ministry of Food, Agriculture and Irrigation, Department of Food and Agricultural Marketing Services, AGricultural Statistics Division, 1977. Agricultural Statistics of Nepal.

25. Nepal, HMG, Ministry of Food and Agriculture, Economic Analysis and Planning Division, 1971. Farm Management Study in the Selected Regions of Nepal, 1968-69.

26. Nepal, HMG, Ministry of Food, Agriculture and Irrigation. Food and Agricultural Marketing Services Department, Economic Analysis Division, 1978. Production Costs and Return (some crops in selected districts).

27. Nepal, HMG. Annual Report, National Wheat Development Program, various years.

28. Nepal, HMG. Barley Research Program, various years.

29. Nepal, HMG. National Rice Development Program.

30. Nepal, HMG. National Maize Development Program.

31. Nepal Rastra Bank, Quarterly Economic Bulletin, Volume 15, No. 3, Mid-April 1981.

32. Nepal Rastra Bank, 1980. Agricultural Credit Review Survey, Nepal.

33. Nepal Rastra Bank, 1972. Agricultural Credit Survey, Nepal.

34. Pradhan, B. B., 1981. The Overlooked Link in Agricultural Planning - The Farmer.

35. Sharma, Ramesh P., May 1981. "Agricultural Research Resource Allocation in Nepal." Unpublished report for APROSC.

36. USAID/Nepal, end-of-tour reports: Raymond E. Fort, Glen D. Johnson, Thomas L. Wilson.

37. United States AID Mission to Nepal, 1981. Thirty Years of American Assistance to Nepal.

38. USAID/Nepal, Various Project Agreements (Food Grain Technology).

39. Whiteman, P. T. S., February, 1980. "Agronomy Research in the Hill Areas of Nepal", FAO Hill Farming Agronomist. Hill Agricultural Development Project. A Terminal Report, Kathmandu, Nepal.

40. World Bank, 1979. "Nepal: Agricultural Sector Review." Report No. 2205-NEP.

41. World Bank, 1981. "Nepal: Policies and Prospects for Accelerated Growth." Report No. 3577-NEP.

42. Wortman, Sterling, "Accelerating Nepal's Agricultural Progress", A Report for the Secretary of Agriculture, His Majesty's Government of Nepal. Kathmandu, Nepal, 1980.

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APPENDIX A

METHODOLOGY

As is usual with impact evaluations, time moved by much too rapidly. As one of our team members, an ex-PCV in Nepal, protested, "We can't do this in American time; we have to get in time with Nepal!" Nevertheless, the schedule was tightly-packed.

One week was spent touching bases in Kathmandu, reading documents, and making a field visit to Lele, the cropping systems site in the Kathmandu valley. This "staging" week was essential to absorb the project history and bring it up to date, to meet with the senior officials who lead the government participation in the agricultural sector -- the Deputy Directors General of Research and of Extension, and the General Manager of the Agricultural Inputs Corporation. A list of topics to be investigated in the Tarai was also drawn up, partly on the basis of issues which were developed in discussion. Our five-person team then acquired two interpreters with excellent Peace Corps language training background -- so they could understand the three of us who did not speak Nepali -- and split into two mini-teams.

The Eastern Team focussed on the environs of research stations at Parwanipur, Tarahara, Janakpur, and Hardinath, talking with researchers, farmers, extension agents, cooperative managers, and shopkeepers. As agreed before leaving Kathmandu, farmers were selected to represent different degrees of access to roads and markets, sizes of holdings, tenure status, ages, and possible contact or non-contact with extension agents. Systematic interviews were done with about 25 of the people visited; other conversations were informal.

The Western Team focussed on the Bhairawa and Rampur areas, talking with staff at the Institute of Agriculture and Animal Sciences as well as the types of people interviewed by Eastern Team. Both teams managed to apply similar amounts of "Tarai make-up" -- the fine dust that floats up through every crevice of the jeep to coat hair and clothes and faces -- by travelling over the back roads and tracks of several districts. In general, we felt satisfied that a representative, if not statistically replicable, sample of interviews with nearly a hundred farmers had been obtained in the two weeks in the field.

When some statistical indicators from this sample were compared to other available information on farm households, we found that we had managed to cover the spectrum of farm sizes

and had confirmed a positive relationship between farm size and family size. We could group the farmers interviewed on the basis of total farm size in categories roughly similar to those used in the major agricultural credit survey done by the Nepal Rastra Bank in 1979; average farm size and distribution of households among categories were remarkably similar (Table 1).

Table 1.

Average Size of Farm and Farm Family

Farm size category	Credit Survey		Evaluation		
	Ha.	Family Size	n	Ha.	Family Size
Large (over 5 ha.)	9.34	15.5	12	9.72	13.7
Medium (2.68 - 5 ha)	3.82	8.9	6	4.01	11.2
Small (0.67 - 2.68 ha)	1.85	6.7	21	1.70	7.8
Marginal(less than 0.67 ha)	0.54	5.4	6	0.53	6.2

We had managed to include progressive as well as traditional farmers, owners as well as tenants, farmers who knew what minikits were and were glad to show us their demonstration plots as well as farmers who were completely unfamiliar with the program and were more interested in getting a message to the Agricultural Development Officer about their needs for a JT, and farmers whose grandfathers and fathers had tilled the same soil for decades before them as well as farmers who had recently migrated from the Hills. We simply walked into villages and talked with the first person met and we went to see special farmers with the help of the Junior Technicians. We saw beautifully functioning irrigation systems and canals that were bone dry; we saw lush plantings of wheat as well as demonstration plots of maize in which only two seeds had germinated. Chance meetings with agricultural assistants and with panchayat-level assistants working under the new "T and V" program (a method of extension training and use of paraprofessionals being tested under a World Bank-supported project) were useful in helping to understand the roles and skills of the professional extension service. Personnel from the Agricultural Inputs Corporation and the cooperatives were contacted at the district and village levels.

Reassembled in Kathmandu, the team looked through the documents again with new eyes and tried to fit some last-minute

interviews into the hours of writing. Many impressions and general observations could not be quantified; many questions could still not be answered. Some were settled through debate and others were simply shelved. Any remaining errors of interpretation and judgement are, of course, the responsibility of the team.

The team was composed of five persons with varying levels of experience in Nepal and in agricultural research and extension. Our two Nepali speakers had been Peace Corps Volunteers in extension from 1969-72; both were able to revisit panchayats in which they had been JTA's and to talk with farmers with whom they had worked. Gary Ender, now an agricultural economist with the U.S. Department of Agriculture, had also returned to Nepal in the late 1970's for dissertation research on the agricultural impacts of road development in Nepal. Gregory Heist, now a graduate student in agronomy at Cornell University, is looking forward to a career in international agricultural research. Josette Murphy, currently an economic anthropologist with AID's Office of Evaluation, is also the coordinator for the series of impact evaluations on agricultural research. Joseph Beausoleil, an agricultural economist with the Office of Rural Development and Development Administration in AID/Washington, had acquired some familiarity with Nepal's farming sector in a previous short trip and brought to the evaluation team a great deal of experience in agricultural credit and cooperative programs in Latin America. As team leader, Emmy Simmons, an agricultural economist in AID's Office of Policy Development and Program Review, brought experience on two other impact evaluations to bear. This enabled her to remain calm while everyone else voiced doubts about the team's ability to grasp the realities of twenty years of agricultural development and agricultural research efforts in four weeks.

It is, indeed, likely that the team has failed to comprehend fully the magnitude of the impacts which the agricultural research and extension services have had and will have on the agricultural sector in Nepal. It is also likely that we have not understood completely what would have occurred if the project had never taken place. We are particularly sensitive about our inability to spend any time getting a comparative view of agricultural change in the Hills where there has apparently been little contact with either the research or extension services. Nonetheless, we are persuaded that we have captured the spirit of agricultural change in the Tarai in 1982.

APPENDIX B

ADOPTION OF NEW TECHNOLOGY BY THE FARMERS IN THE TARAI

by
Joseph W. Beausoleil

I. Interpreting Data

If one were to judge the Food Grain Technology project on the basis of yields of rice, wheat, and maize, it would have to be considered a dismal failure. Only wheat yields have shown an increase over the past 20 years. Productivity of rice has remained relatively stable while maize yields have decreased (Table B-1).

Table B-1. Average Yields for the Basic Grains (in metric tons/hectare)

Years	Rice (Paddy)	Wheat	Maize
1961-65	1.95	1.05	1.95
1966-70	1.95	1.27	1.90
1971-75	1.96	1.01	1.81
1976-80	1.82	1.15	1.59

SOURCE: FAO Production Yearbooks for 1972, 1974, 1976, 1978, and 1980. (These figures differ slightly from the World Bank figures used elsewhere in this report. In either case, the accuracy of the data is questionable.)

It would be unfair, however, to draw such a conclusion from these kinds of data. Average yields say nothing about how much variation exists nor do they explain why it exists. Rice yields for individual farmers may vary from a high of six metric tons to a low of less than a metric ton per hectare, for example -- around an average of almost two metric tons per hectare. The variation may be due to climatic conditions, natural resources, or the technology used. It may also be due to a number of other factors, including the socio-economic conditions of the farming household, its objectives, the prices in the market, and the number of animals owned. The following descriptions of four farming systems in the Tarai attempt to provide a flavor of such factors as the basis for better understanding of foodgrain yields and yield variations in Nepal. A more quantitative analysis of costs and returns associated with the adoption of rice and wheat technologies by such farmers is presented in the next section.

II. Understanding Farmers in the Tarai

Differences in farming in the Tarai are strongly related to farm size. Larger landholders, that is, those having five hectares or more, often produce primarily for a market, have better access to

productive inputs, and can accept risk because they are able to accumulate reserves. Smaller landholders produce primarily for home consumption, have limited access to inputs, and, since they live from year to year, cannot afford to take risks. However, even among the smaller landholders, there are differences in the farming situation. There are those who are basically subsistence farmers but produce some marketable surplus; those who, with efficient use of limited resources, can make ends meet; and those who do not have sufficient land and so require outside income to survive.

The information used to compile what I here call "typical farming situations" was obtained through hour-long, informal but systematic, interviews with farmers. Of the 45 farmers interviewed, 12 had holdings of five bighas[1/] or more and will be referred to as "large" landholders. Of the remainder, six were "medium" landholders, that is, having over four but less than eight bighas of land, 21 were "small" landholders (over one but less than four bighas), and six were "marginal" farmers, with less than one bigha of land. In drawing what are essentially composite portraits -- or snapshots -- of farmers in each group, I identified characteristics of family structure, cropping patterns, animal ownership and use, and information and input access.

To convey a sense of each typical farm as a system, special attention is given to the interrelationships among crops and livestock. The focal point of each snapshot, however, is the farmer or decision-maker who allocates scarce resources to produce the necessities for the family.

A. The Large Landholder

Our large farmer was born in the Tarai. He operates his twelve hectare farm with his extended family. Since he is elderly, he has recently left the day to day running of the farm to his eldest son. His second son was educated and has moved to Kathmandu and three of his daughters have married and moved away, leaving 18 family members currently living on the farm. The sons who remain on the farm are married and have 12 children, all of whom have been encouraged to stay in school and follow their urban-dwelling uncle's example. In addition to the family, there are several permanent hired hands employed on the farm.

Rice was the principal crop until eleven years ago. Then the farmer seriously began double-cropping with wheat. With irrigation, he has no problem using an improved rice variety, although he still grows about two hectares of local rice for home consumption. He uses inorganic fertilizer when he is able to obtain it, but not at the recommended levels. He thinks too much fertilizer may harm his

1/ One bigha = 0.67 hectares (ha).

soil although he knows he can get better yields using the recommended levels. The fertilizer is usually purchased from the cooperative on credit. He selects his seed from each harvest to plant the following year and continually experiments with varieties obtained from other farmers. Paddy yields have averaged 2.1 metric tons (MT) per hectare for the improved variety and 1.9 MT/ha. for the local variety. The local variety is stored for home consumption at harvest. The 2.25 MT tons of milled rice grown is just about enough for the family's needs.[1/]

Wheat now follows rice. Only one variety is grown, using seed and fertilizer purchased with credit from the cooperative. Wheat is not as labor-intensive as rice, but the costs of the purchased inputs are much higher. A government production program encouraged this farmer to get into wheat, and he will continue to grow it as long as there are no marketing problems. Before he started producing wheat, most of the land would be left fallow after the rice harvest and used for grazing his cattle until rice planting time.

The farmer and his household had many more animals then than now. What was over 50 head of cattle has been reduced to about 15. There are two teams of oxen, one bull, three cows, and seven to eight buffalos. There are also a few goats and a dozen chickens. He makes good use of the manure, although the annual production is only sufficient to apply to two hectares per year. He rotates this application each year to the area that needs it the most. Part of the manure, however, is used in the gobar gas generator (purchased with a loan) and the sludge from this is used in the vegetable garden.

The farmer also has a tractor, also purchased with a loan from the Agricultural Development Bank, which is used for the initial land preparation and for hauling. He still makes good use of the bullock in preparing the land and for threshing the grain, however. Having a bull and a female buffalo ensures that he can continually replace his stock. He has more than enough straw for fodder and greens are readily available along the irrigation ditches all year long to supplment the animals' diet. The total digestible nutrient in the 40 or more tons of straw produced is, in fact, more than enough for his own herd, so the farmer often supplements the low daily wages to his laborers at harvest time with straw.

While the farmer is generally dissatisfied with government services, he does borrow through both the cooperative and the

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1/ Converting this amount to a calorie basis and assuming a requirement level of about 2350 calories per adult per day, it would appear that about 80 percent of the calorie needs of this farming household could be met from its own production.

bank. He has at times been delivered fertilizer that was damaged and the wheat seed purchased in recent years has not been as good as it used to be. He feels he knows more about farming than the JT's, and certainly the JTA's, but admits that a friend who is a JT has been helpful in obtaining inputs, particularly fertilizer, on time.

The large farmer has few immediate constraints to increased production. He has access to information, credit, and inputs, but he has few incentives to maximize his production. This will, of course, change as the family grows. There are six grandsons and all of them could decide to marry and raise their families on the farm. But the grandchildren are being educated and, like their uncle, will probably opt to leave the farm. This family has not felt the population pressures, although the potential to do so is there in the very near future.

B. The Medium Landholder

The medium-sized farmer migrated to the Tarai from the Hills eleven years ago. There are currently nine people in his family, including his wife, their oldest son (with a wife and baby), and four other unmarried children. One son has finished secondary school and is studying at the Institute for Agriculture and Animal Sciences in Rampur. Only the youngest son living at home is continuing in school; the other three children have left school to work on the farm. The farmer originally bought five bighas (3.35 ha.) of land for five thousand rupees. Recently, he had to sell a half-bigha to free himself from a debt and received six thousand rupees for it.

A small part of this three-hectare farm is occupied with the living quarters, stable, garden, and threshing floor. The remainder of the land is intensively cultivated. Rice is the principal crop, planted at the onset of the monsoon, and is followed by wheat, mustard, and maize. Since the soil has good moisture retention capacity, a third crop is sometimes planted after the mustard and maize. Rice yields are good although inorganic fertilizers are not used. The custom of this farmer is to use heavy composting on the mustard (as it is their major cash crop) and then to use the same area for preparing the rice seed bed. Half of the rice grown is a local variety; the rest is improved. Seeds are generally saved from year to year. The local variety yields approximately 1.5 MT/ha. (so the total of 2.25 MT is said to be sufficient for home consumption) and the improved variety yields almost 2 MT/ha. Last year's sale of three metric tons of paddy provided more cash income than was earned from the mustard sale. Mustard is planted immediately after the rice harvest. About a hectare is allocated to this crop; last year, about half of the mustard was retained for home consumption and half was sold. The farmer feels that mustard yields have been going down and attributes this to a weed in the mustard field, but he does not know what to do about it.

Wheat is grown on another hectare. The yields have averaged a little less than a metric ton per hectare. Sometimes the farmer uses inorganic fertilizer; he is convinced of its value but does not always have the extra cash to purchase it. He saves his seed or buys new seed from other farmers or the cooperative. Last year he sold 500 kg. of wheat and used the remainder for home consumption. He attributes his low yields to the late planting of wheat, but notes that his priority is to get the mustard crop in before turning his attention to the wheat crop.

Some of his land lies fallow during the winter but he prepares this for maize in the spring. If there is sufficient rain, he can obtain as much as a metric ton per hectare. In the worst situation, he may only get his seed back. Storing maize is a problem. The traditional way of hanging the unhusked cobs upside down keeps the maize dry but is not very effective against insects. He knows of no better way to protect his stored maize, although he feels it was better to keep some inside on the rafters where the smoke from the stove seems to reduce insect damage. Most of the maize is consumed in the home, although he will sell some if he needs cash. This farmer also grows some winter maize, primarily for fodder. This is necessary, he explains, because there is a lack of grazing land, especially at the end of the dry season. He needs his bullocks to prepare the land and realizes that manure is essential to maintain soil fertility. The present cropping pattern provides sufficient straw to maintain his 12 head of cattle, provided that greens can be found to supplement the straw diet. The animals they keep (including two goats and some chickens as well as the cattle) provide them with milk and cash (from the occasional sale) as well as the manure.

The farmer does not seek the advice of the JTA in spite of the fact that he is unsure of fertilizer use, has a problem storing his maize, does not know how to deal with the parasite weed in his mustard, and is not properly feeding his livestock. He feels he knows much more than the JTA and really does not need his advice. Much of what he has heard from the JTA and from cooperative personnel has not been correct in the past. He does use the cooperative to purchase inputs, but he always uses cash. He maintains some cash balance and always has reserves in some foodgrain or an animal in case of emergencies.

C. <u>The Small Landholder</u>

The small farmer has one and two-thirds hectares of land. He came down from the Hills with his family only five years ago. Of the five children in his family, one, the oldest, is married and has remained in the Hills. His younger children are all in school. Both parents work extra hard so that their children can take advantage of the opportunity to receive an education. This farmer is

a tenant with a Class II certificate, which means that his rent is regulated by law at 11.5 maunds per bigha (or approximately one metric ton of paddy for his farm) per year.

The major monsoon crop is rice, followed by a rotation of mustard and wheat. Both local and improved varieties of rice are grown. He prefers the local variety for home consumption but plants an early-maturing improved variety on about half of his land to allow him to get his mustard planted before the end of the rainy season. Wheat is planted after the rice on the other half. His yields of the local variety of rice average 1.7 MT/ha. and provide almost enough rice, he reports, for his family's needs. The improved variety yields slightly more. This year, he obtained about 2.1 MT/ha., half of which was used to pay his rent. The remainder was stored it in his house, and sold when the price was right. The farmer has been using an improved variety of wheat ever since he began producing this crop. He borrows from the cooperative to purchase seed and fertilizer each year and has paid his loans with the sale of the grain. Last year, with a Rs. 400 loan, he produced 0.8 MT of wheat on two-thirds of a hectare. He sold 600 kg. at harvest and immediately paid back his loan. Mustard is also a good cash crop, as the price is high. He sold 200 kg. last year at the farmgate for Rs. 650 per 100 kg. He saved a little of the mustard for home consumption.

He prefers to use manure rather than inorganic fertilizer with rice. He feels that his six adult animals produce sufficient amounts to maintain soil fertility. He does use some purchased fertilizer on the wheat if he is able to obtain it. He feels that he gets better wheat yields when he does but has reservations about using the full amount recommended. The straw from the rice, wheat, and mustard is sufficient fodder for his animals if supplemented with some greens. During the rainy season, this is not a problem. During the dry season, however, the daughters have to go some distance to collect leaves and grasses to mix with the straw.

The farmer never sees the JTA but he is not concerned. He has learned from others and from his own experience. His family can live satisfactorily with the resources it now has; they are able to bear some adversity because in good years there is a surplus. The children are healthy and able to attend school. If the new tenancy laws by which this family is protected were not respected, however, a family like his would be in a desperate situation.

D. <u>The Marginal Farmer</u>

The marginal farmer has less than a hectare of land. He has been farming in the Tarai for only a few years, having returned to Nepal after serving 10 years in the Indian army. With savings accumulated during that time, he purchased a bigha of land (0.67 hectare) and resumed his career as a farmer rather than complete the

required 15 years of service for an army pension. He was originally from the Hills but preferred to settle in the Tarai because he felt that there were more opportunities here. His family is small; the oldest of his three children is 12 and the youngest is a toddler. He does not plan to have any more children because he barely can support those he has now.

Crowded together on one corner of his farm property are the family's dwelling, the stable with two buffaloes and their calves, and a small vegetable garden. To maximize the cropping area, the farmer has built a loft over his stable to store straw. He has also the good fortune of a shallow well which he dug for drinking water and for use in his garden during the dry season.

Although he learned farming in the Hills, he admits that he has a lot to learn about farming in the Tarai. He seeks help from other farmers and once asked the JTA for advice. But he never sees the JTA anymore and has learned to depend upon himself and his fellow farmers to figure out his problems.

He rents oxen to prepare his land. This requires approximately twenty days work for each crop and costs Rs. 10 per day. He prefers to keep buffaloes rather than oxen because in addition to manure, the buffaloes produce milk. He estimates that the sale of milk compensates for the outlays for oxen rental and he still has the calves to sell at the end of the year.

He grows both local and improved varieties of rice. Using a local variety alone would not provide sufficient rice for his family so he decided to use a higher-yielding improved variety as well. He uses whatever manure is available from his animals but no chemical fertilizer. He saves his seed and originally obtained the improved variety from a friend as a loan. He has never borrowed from the cooperative and has no intention of doing so even though he has a land title which would make him eligible for a loan. Last year's paddy production was 1.2 MT, barely sufficient for his small family.

Except for a small plot for mustard seed, wheat follows rice. He uses an improved variety which he purchases from the cooperative. No chemical fertilizers are used but whatever manure that is available is worked into soil before seeding. His production averages about 0.5 MT. The family consumes most of the wheat but he has to sell some from time to time to obtain cash. Gram or moong bean is planted in relay with the wheat and mustard if there is a late rain. It is allowed to grow after the wheat and mustard is harvested. If it does well, he harvests it. If not, he feels that it is good to plow into the soil when he prepares the land for the rice crop. He has a small vegetable garden which is well cared for, thanks to his wife.

The straw from his rice and wheat provides only about 75 percent of fodder for his buffaloes. There is a forest a few hours walk from the farm where it is possible to graze the animals. This also is a source of firewood. And although it is illegal to cut wood, they do so. Without the forest, they would have to sell one of their buffaloes and would have to use the dung of the remaining animal for fuel. The result would be a complete disruption of their farming system.

The farm operation is insufficient to provide for the family's needs. The farmer or head of household supplements his farming by occasional labor and his wife makes straw mats. Their attitudes are that they have to do it themselves. They do not expect assistance from the cooperative. In fact, they are fearful of borrowing because of the uncertainties of farming. They know that the JTA has given minikits to some of the farmers but they have never received one.

The marginal farmer and his family live in a very precarious situation. They barely make ends meet. Any problem is a serious problem that can set them back. With their limited resources, hard work keeps them afloat, but it is impossible to advance.

II. The Impact of New Technology

These snapshots of four "typical" farmers' situations illustrate the fact that new technology is only being adopted by some of the farmers -- and then in selective ways. It is difficult, if not impossible, to quantify precisely the impact of new technology, given the paucity of longitudinal, quantitative information on farming operations like these.

There is, however, enough information on the costs and returns to the principal cropping enterprises which can be used to compare in somewhat general terms the crop production situation as it is today with what it would be if there were no new technology. The actual situation can also be compared to what it could be if the total packages of new technology were utilized.

Data presented in Table B-3 permit such a comparison for two farming enterprises -- rice and wheat production. These two crops were chosen because they are the major crops for many Tarai farmers and because sufficient data were available. In making the comparison, it is assumed that the other farm enterprises do not change substantially if changes are made in the production modes for these two crops. Thus, the comparison between actual, traditional, and recommended conditions is more valid than it would be if, for example, two competing rainy season crops were involved.

An important source of quantitative information was the Agricultural Credit Survey conducted by the Rastra Bank in 1978. Data on actual cropping intensities, yields, and production costs were taken from this report (and are summarized in Table B-2). The production costs for rice and wheat using the complete technological packages were taken from Rice in Nepal, by B. N. Mallick. The farmgate price was estimated to be Rs. 170 per 100 kg. of paddy and Rs. 144 per 100 kg. of wheat. Actual prices for paddy and wheat obviously fluctuate during the year and from place to place, but these price estimates reflect average prices for 1978.

Table B-2. Basic Crop Data for Wheat and Rice 1978, Agricultural Credit Survey

	Size of Farm			
	Large	Medium	Small	Marginal
Cropping Intensity	152	136	144	166
Crop Yields (MT/ha.)				
Paddy : Improved	2.1	2.0	2.3	1.9
Local	1.8	1.4	1.8	1.7
Wheat : Improved	1.5	1.2	1.1	1.0
Cost of Production (Rs./ha.)				
Paddy : Improved	2154	1975	2174	1107
Local	1573*	1573*	1573	1185
Wheat : Improved	1780	1487	1487	1487

SOURCE: Agricultural Credit Survey, Nepal Rastra Bank, 1979.

* Estimated.

Table B-3 then contains estimates of net returns on a rice and wheat farming operation using traditional, actual, and recommended methods, much along the lines indicated in the snapshots of farms of different sizes. Without improved technology (left column), the assumption is made that farmers of all sizes would put their land into traditional varieties of rice only. For the actual situation (center column), the farmers are assumed to grow enough local or unimproved rice for home consumption and to put the rest of their land into improved rice for ultimate sale. They would follow rice with wheat on a portion of their land and leave the rest fallow until the next rainy season. The portions devoted to these crops are assumed to vary in ways similar to those described as

Table B-3. ...ion of Returns Under Three Modes of Cropping: Traditional

Farm Size Crops (Varity) Net Value	TRADITIONAL YIEL...	 COST2/	 VALUE 3/	 NET	ACTUAL YIELD1/	 ARIA	 COST2/	 ...
LARGE								
Rice (improved)					2.1	10	21,540	35
Rice (local)	1.8	18,876	36,720	17,844	1.8	2	3,146	6
Wheat (improved) 5/					1.5	3.5 5/	6,230	8
Total Net Value				17,844				
MEDIUM								
Rice (improved)					2.0	1.5	2,963	5
Rice (local)	1.8	4,719	9,180	4,461	1.8	1.5	2,360	4
Wheat (improved) 5/					1.2	0.9 5/	1.338	1
Total Net Value				4,461				
SMALL								
Rice (improved)					2.3	0.8	1,739	3
Rice (local)	1.8	2,674	5,202	2,528	1.8	0.9	1,416	2
Wheat (improved) 5/					1.1	0.6 5/	892	
Total Net Value				2,528				
MARGINAL								
Rice (improved)					1.9	0.3	332	
Rice (local)	1.7	830	2,023	1.194	1.7	0.4	474	1
Wheat (improved) 5/					1.0	0.4 5/	521	
Total Net Value				1,194				

1. Agricultural Credit Sur... ...ra Bank, 1980
2. Ibid, includes cash outla... ...imputed value of labor and other non cash inputs
3. Ibid, average value incl... ...products of R.s. 170 for paddy and R.s. 144 for wheat
4. Rice in Nepal, Malik, 19... ...tal cost R.s. 2615 for rice and R.s. 2865 for wheat
5. Rastra Bank, op.cit. crop... ...ntensity estimated at 129% for large, 131% for medium, 137%
6. Estimate based on researc... ...ion experiences.

ree Modes of Cropping: Traditional, Actual, and Recommended

ACTUAL						RECOMMENDED				
NET	YIELD1/	AREA	COST2/	VALUE3/	NET	YIELD6/	AREA	COST 4/	VALUE3/	NET
	2.1	10	21,540	35,700	14,160	3.0	12	31,380	61,200	29,820
17,844	1.8	2	3,146	6,120	2,974					
	1.5	3.5 5/	6,230	8,085	1,855	3.0	12	34,380	51,840	17,460
17,844					18,989					47,280
	2.0	1.5	2,963	5,100	2,137	3.0	3	7,845	15,300	7,455
4,461	1.8	1.5	2,360	4,590	2,230					
	1.2	0.9 5/	1.338	1,555	217	3.0	3	8,595	12,960	4,365
4,461					4,584					11,820
					4,584					
	2.3	0.8	1,739	3,128	1,389	3.0	1.7	4,446	8,670	4,224
2,528	1.8	0.9	1,416	2,754	1,338					
	1.1	0.6 5/	892	950	57	3.0	1.7	4,871	7,344	2,473
2,528					2,784					6,697
	1.9	0.3	332	969	637	3.0	0.7	1,831	3,570	1,739
1.194	1.7	0.4	474	1,156	682					
	1.0	0.4 5/	521	576	45	3.0	0.7	2.006	3,024	1,018
1,194					1,364					2,757

and other non cash inputs
for paddy and R.s. 144 for wheat
rice and R.s. 2865 for wheat
9% for large, 131% for medium, 137% for small and 153% for marginal farmers

"representative" of each class above. For the recommended situation (right column), farmers are expected to put all their land into improved rice in the rainy season and into improved wheat in the dry season, fully using all of the improved technology packages for each crop.

When one compares the net returns of the farmers under actual conditions to those expected using traditional methods, it is easy to understand what most farmers in the Tarai feel that they are not much better off (even though their gross yields could have risen by 26-44 percent). The net value of their production is only slightly higher now (3-15 percent) than before and yet they have to work much harder with a second crop in the winter season. "Better off" can thus have two meanings.

When one compares the actual net returns of the farmers to those possible using the recommended packages, it is easy to understand the frustration of the researchers who cannot understand why the farmers do not adopt the new technologies. Costs would be double or more than double, but returns would be similarly increased. For understanding the farmers then, one has to return to the conditions of farming in the Tarai. The new technologies are mostly high input technologies. Timing of irrigation is essential; yet over 80 percent of the Tarai farmers have no access to irrigation. Farmers have learned that they cannot depend on the Agricultural Inputs Corporation or the cooperative for reliable delivery of seed and fertilizer. In only rare cases have soils been tested; fertilizer recommendations can only be general, therefore, and are not tailored to the farmers' conditions. Farmers have no harvesting equipment and only rudimentary on-farm storage facilities. In a word, the improved technology packages do not fit the conditions of the farmers. They are unable to use most of it and find it of little benefit.

There are some farmers who have yields above the average. They are able to take advantage of the new high input technologies because, like our large farmer, they have access to production inputs. Indeed, this is the simplest explanation of why improved technology is not being adopted. But even if the inputs were available, there are many farmers who would still not adopt these technologies. Their reasons go beyond the agronomic and include economic, social, and even cultural considerations. From the snapshots of the four farming systems above, it is evident that there are many different reasons or even multiple reasons why farmers do or do not adopt the higher-yielding improved varieties.

Most farmers expressed a preference for local rice varieties for home consumption, for example. But some farmers whose production is insufficient to meet family needs have adopted higher yielding improved varieties to make up for the deficit. Others, who

produce enough for family needs, are using an improved variety that is early maturing on the remaining land so that they can plant their cash crop earlier and take advantage of the moisture still remaining in the soil. One rice variety, Masuli, which is neither very high yielding nor early maturing, has been adopted by many farmers because of its superior cooking qualities.

Almost all of the Tarai farmers use an improved wheat variety, but few use the total package of recommendations. Some feel that too much fertilizer damages the soil and so apply only part of the recommended dosage. Others fear that the rains will be insufficient and the fertilizer wasted, and do not, therefore, use any. Most cannot plant wheat as early as recommended because they are still harvesting rice. Broadcasting is the preferred method of sowing even though sowing in rows can save seed and does produce higher yields. Sowing in rows is more time consuming and requires oxen. Both oxen and extra labor are in great demand between rice harvesting and land preparation for the second crop.

Not only must the new technology be an improvement over the present technology, but it must fit the conditions of the farmers. Most large commercial farmers have access to inputs and have no problem adopting improved technology that requires them. Some small subsistence farmers will not adopt early maturing rice varieties which greatly improve the effectiveness of double cropping unless the early maturing varieties produce a rice with the desired eating or selling qualities. Only part of the improved wheat technology is being adopted, i.e., the variety, and it is almost universally being grown using the traditional farming practices.

IV. Implications for Research

There are many implications that can be drawn from the experience of the Food Grain Technology Project in developing improved technology for the farmers in the Tarai. First, a better understanding of the farmers' situation would help to focus research on the farmers' problems. Secondly, more research should be done under farmers conditions. And thirdly, greater use of the farmers should be made in multiplying and distributing improved seeds.

Most of the agricultural research conducted in Nepal has been adaptive. Germplasm obtained from other countries or the International Agricultural Research Centers (IARCs) has been tested for its adaptability under Tarai conditions. The criteria used to judge the adaptability were agronomic and yields were generally used as the primary criterion. If the cultivar met the criterion, it was recommended as an improved variety to the farmers.

This adaptive research process has not been very effective. To improve the process, research should start with the farmer. By

understanding the farmers' objectives, their resources, and constraints, research can focus its efforts on developing technology that fits the farmers conditions.

It is also particularly important in Nepal to understand the interrelationship of crops and animals. Specific crops or cropping systems may be the focus of research, but it is essential that the place of animals are considered in the research work particularly regarding soil fertility, use of by-products, and land preparation.

Some research must, of course, be conducted on the stations, but more emphasis must be given to on-farm research. This is needed because the conditions of the farmers are radically different from the conditions of the stations. Thus, to test a technology under farmers' conditions, the farmers' fields are the most appropriate laboratories. Since the farmer is the one who will ultimately decide on the adoption of the technology, the farmers themselves should be involved in the on-farm testing as active participants and not merely hired hands. Also, it is necessary that the farmers and fields selected for on-farm testing be representative of the farmers and farms in the area. Otherwise, generalizing from the results of the tests will be invalid.

The minikit program in Nepal is a good example of doing research on farmers' fields with farmers' active participation. Unfortunately, the program has been not carefully monitored and little effort has been made to analyze these experiences. The minikit program could be improved if more care were taken in collecting pertinent data on these experiences and if researchers conducted appropriate agronomic and economic analysis on them. The JTA could be helpful in seeing that the reliable data are collected. It should perhaps be noted that minikit recipients to date may not be "representative" so current results may overestimate the interest of all farmers in the program.

Inputs, particularly seeds, should be handled by the farmers themselves. Once research has determined that a variety can be released, the foundation seed should be made available to farmers in much the same way that seeds are made available through the minikit program. Seed multiplication will take place spontaneously just as it does now on a limited scale with the minikit program. Farmers who see good results of other farmers obtain seeds from them. And this is true not only of the minikit program but also for any farmer who sees good results of another farmer with a new variety. This amounts to allowing the farmers to certify seed in their own way. It may not be as technically correct as intended under the present seed multiplication program but is a practical way to accomplish the same end. There are some problems associated with farmers doing their own seed multiplication (such as storage of wheat seed during the rainy season), but simple appropriate technology could be worked out to resolve these kinds of problems. These solutions are easier than those that appear insurmountable under the present program.

APPENDIX C

POPULATION PRESSURE AND AGRICULTURAL CHANGE IN THE TARAI

by
Josette Murphy and Gregory Heist

I. The Tarai: Region of Rapid Change

> ....We came here 22 years ago. At the time, only a few families were cultivating in the area. All the fields you see here were jungle, so we just cleared the land we needed for our fields. There has been no more land to clear for years now, the new settlers buy land from us. There is no grazing land left either. People don't have as many cattle as before; how could we feed them? The forest on this side is a national reserve; we can't take our cattle there anymore. Until three years ago, that hill on the other side of the river was covered with trees, but the government set up a resettlement program and all the trees were cut off. Before, I had 60 head of cattle; now I have three...

Throughout our interviews, we heard the same story of the increase in population in the Tarai and its impact on the traditional farming system. We have also observed the widespread adoption of new farming technology. Farmers mentioned the loss of the forest and its resources, their efforts to increase food production by intensifying their cropping system in spite of a decrease in size of their herds and, therefore, in the quantity of manure or compost available. They cited the problem of diminishing productivity of their land at a time when their needs -- both for food and for cash -- are increasing.

The changes occurring since the 1960's have made farmers receptive to any innovation that can lead to an increase in production and income.

It was in this context of increased pressure to produce that the research stations and extension service began to promote packages of improved farming practices. In 1969, the revised project agreement of the Food Grain Production project stated as its strategy:

> ... a) to increase yields per acre of traditional food grain crops through the use of new seeds, fertilizers, pesticides and better farming practices, and b) to introduce new crops in fallow land to enable farmers to get two or three crops per year.

While such actions can indeed promise increased production, that potential can be fully realized only if all supporting elements -- irrigation, distribution of inputs, credit -- are available in a timely fashion. They can also aggravate the imbalance

between the traditional farming system and the environment that population pressure has already initiated.

II. The Environment of the Tarai.

The Tarai, the southern belt of Nepal, is part of the Indo-Gangetic plain. It includes two-thirds of the total arable land of the country (about 19,000 km^2 out of 28,000 km^2). Yet for generations this semi-tropical plain remained sparsely inhabited, mainly because of malaria.

After malaria was eradicated in the 1950's, the Tarai became a privileged development zone, with programs for resettlement, infrastructure (roads and irrigation,) and agricultural development (including research, extension and input distribution services).

Rice, maize, and wheat are the staple food crops of the Tarai; oilseeds (especially mustard), jute, and sugarcane are the main cash crops. The Tarai is the major production area in the country for cereals (for example, in 1976/77, it produced 80 percent of the rice, 67 percent of the wheat, and 37 percent of the maize grown in Nepal that season). The total foodgrain production has remained fairly stable over the years 1969 to 1977 at about 2 million metric tons for rice and 0.24 million metric tons for maize. Wheat production has increased from 0.12 million metric tons in 1969/70 to 0.24 in 1976/77, mostly because of an increase in area cultivated.

Exports of rice increased in the 1960's but have steadily decreased since then and now stand at less than the 1961/62 level (11, Table 1.7).

The Tarai farmers are cultivating more land per capita than farmers in the Hills (0.30 ha per person versus 0.09 ha per person) and have larger farms on the average (1.7 ha per family versus 0.4 ha) (40, pp. 54,55).

III. Effects of Population Pressures on Land Holdings

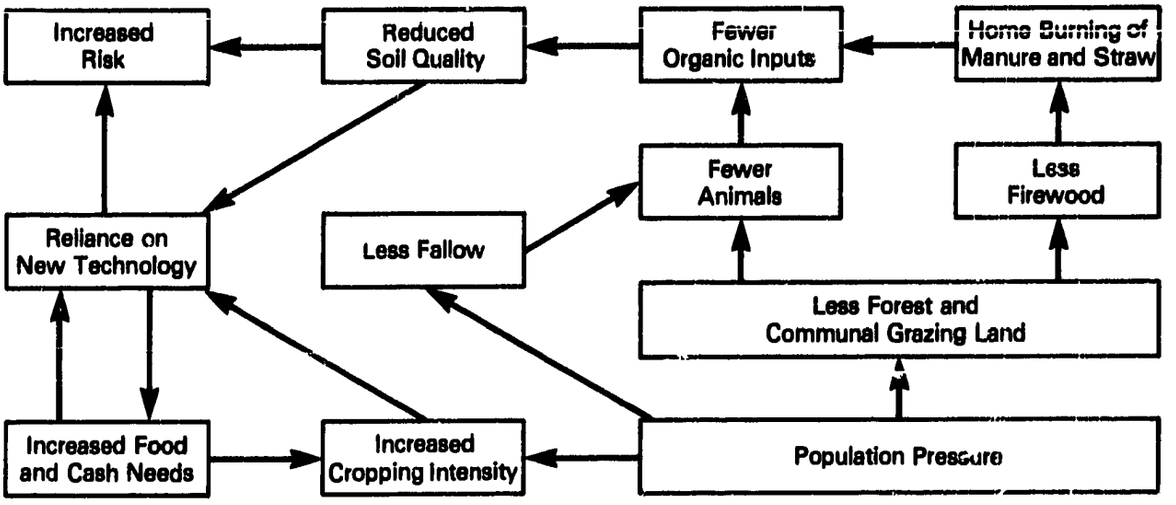
The population of the Tarai increased from 2.9 million in 1952 to 4.3 million in 1971, and to 5.1 million in 1977. This is due in part to natural increase (Nepal has a birthrate well over 2 percent) but also to an influx of new settlers from the Hills, from Sikkim and from other areas.

Indeed, as population pressure in the worsening environment of the Hills is becoming ever more intolerable, the shift in population from the Hills to the Tarai has been accelerating, involving some 400,000 people in 1976 (40). Only 8 percent of this immigration has been channeled through official

resettlement organizations. Seasonal migration has also continued, as Hill people seek temporary employment in the Tarai.

The population increase and the increased demand for food which it generates has led to two major changes in land use, beginning in the 1960's: (1) an increase in area put under cultivation and (2) a more intensive cropping of previously existing fields. The effect of these two types of changes on the environment and on the traditional farming system will be described in this section, and the role of the farming technology available in the 1970's on cropping intensification will be discussed. Figure 1 illustrates the linkages which underlie these changes.

Figure 1. Cause and Effect in Rural Change in Nepal



A. The Increase in Area Under Cultivation

During the first few years of population increase, newcomers could still clear their fields from the jungle at will or, in a minority of cases, could obtain land from the government in a resettlement zone. For a nominal fee, many of the new settlers later received title to the land they had cleared.

As more of the jungle was destroyed, the government created a number of national forests and endeavored to preserve the remaining jungle, so new settlers had to buy land from earlier settlers or rent. Land which had previously been set aside for grazing was also put under cultivation. In many cases, the fields were also cultivated more intensively, with two and sometimes three harvests on the same plot.

Whether these measures, taken under traditional cultivation practices, were sufficient to maintain the total food production per person at its previous level is difficult to say, but two consequences were clearly felt by the farmers themselves over the years: a decrease in the size of their herds, and a loss in land productivity.

B. The Decrease in Size of Herds

Recent statistics for the entire country suggest a slight increase in aggregate livestock population. Most of the farmers we visited, however, told us of a decrease in individual family herds in their neighborhood.

In the earlier, more extensive pattern of land use, cattle (buffalos and oxen) could graze in the forest, on grazing land (sometimes commonly owned by a group of farms), and on fallow fields. As these sources of fodder diminished and apparently were not compensated for by increased residues resulting from the additional foodgrain crop production, many farmers had to give up part of their herd, albeit all tried to keep at least one pair of bullocks for plowing and a she-buffalo for milk.

A decrease in herd size means a decrease in the quantity of manure available, a major drawback in a traditional farming system which relies on compost for maintaining soil fertility and texture. It also means a decrease in the availability of milk and milk products (ghee) which have played an important role in many families as the preferred source of animal protein and a significant part of daily calorie intake, and also as products which can readily be sold.

C. Deforestation

The forests were a source of fodder for the cattle, organic matter for the fields, and firewood. The three uses are linked. As more trees are cut, firewood becomes more difficult to find within a reasonable distance of the home, and some households turn to mixing manure with straw to make cooking fuel. If less manure is also available for compost because of dwindling herds (due in part to declining forest grazing opportunities), the increased use for non-agricultural purposes competes with the agricultural need for compost.

Forests also help protect hillsides and river banks from erosion from the periodic flash floods; this is true in the Tarai as well as in the Hills, although the damage is clearly greater in the foothill areas. In addition, severe erosion in the Hills is increasing the amount of silt reaching the rivers and contributing to more frequent floods, which can be very destructive. In one of the areas we visited, a flash flood

killed about 1,000 people on September 1, 1981, and took away some cultivated land.

No trend in total amount of rainfall can be observed in the data available, but the question has been raised of possible change in the distribution of the precipitation within a rainy season. It is also possible that the amount of water effectively available to the crops is decreasing because of changes in water absorption capacity of the soil and more extensive run-off.

D. Decreasing Land Productivity

A number of older farmers have assured us that yields of local varieties of cereals have been going down since their first few years in the area, a problem they attributed to repeated cultivation of the same plots over the years with insufficient compost. As one farmer put it, "The farther you walk with the same pair of shoes, the thinner the soles become."

The pressure on land use is exacerbated by an inheritance system under which adult sons may demand their share of the family land at any time. When they choose to do so, the land must be divided equally between the father and all the sons. In recent years, it has become more difficult for the sons to clear additional land or to buy some to add to their inheritance. As a result, holdings become smaller and the farmers must intensify their cropping system.

Indeed, over the years, as the size of the households' holdings decreased, either through sale or division among sons, and as both the number of households and the number of people per household may have increased, every plot has been cultivated yearly as the farmers have sought to maximize the total output of each plot. Further decreases in fallow periods have occurred as farmers adopted crops which could be cultivated during the dry season (especially wheat and maize). Thus the improved varieties released by the research stations in the early 1970's fulfilled a felt need of the farmers.

IV. Higher Socio-Economic Expectations

In general, Tarai households have more cash expenses than previously, as the costs of production of improved varieties are high (see Appendix B) and as more -- and more expensive -- material goods are felt to be necessary.

Many new needs are a response to the increasing availability of manufactured goods and the desire to send children to school, as people become more aware of the life style outside of the villages. Radio Nepal plays a big role in informing people in

even remote villages of new farming techniques, of the benefits of family planning and education, and more prosaically through commercial advertising for consumption goods.

Several roads have been built, making it easier for farmers to travel to nearby small towns and eventually to visit relatives back in the Hills. Increased transport facilities also mean that manufactured goods and cloth have become more readily available. As one farmer put it, "Before, when we had some savings we buried the coins in the ground. Now we get on the bus to take the money to the bank, but in any case we buy more shirts and sweaters than before. Can you believe a hat costs 15 to 16 rupees these days? So we have more things, but no money left."

Education has also become an important cost in many families. Primary education is now free until fifth grade, but a sixth grader must pay 10 rupees per month, and the fee increases for each year thereafter. Since most families are likely to have several of their children in school at the same time, school fees can represent a major expense for several years.

Off-farm employment may be available, for example, on nearby road construction sites, or as laborers on neighboring farms. However, the daily wages for farm labor (now officially 8 rupees, in fact ranging from 4 to 10) have not kept up with inflation. For most households the only means to obtain cash is to sell part of the farm production. Since food needs are at least as high as before, the total crop production must be increased.

V. Widespread Acceptance of New Technology

The increase is cropping intensity is not in doubt. Where soil moisture or irrigation permit, farm land in the Tarai is being constantly cropped. In contrast to cereal production in the U.S., where often only grain is harvested, in Nepal the entire crop -- including the stalks and stubble -- is typically harvested and removed from the field. By feeding crop residues to cattle and returning manure to the soil, only some of the nutrients removed will be recycled. The organic matter loss has negative consequences which are already being realized. Fertility drops, texture is degraded, water holding and absorbing capacity is reduced, and, ultimately, the land is more susceptible to run-off and wind and water erosion.

The reported decline in animal numbers implies less manure for each household's crop land. The past use of forests, fallow land, and communal grazing land for feeding animals provided a net import of nutrients to the crop land, assuming that the manure was collected and applied. Considering also the

increasing practice of burning a straw-dung mix as a subsitute for firewood, the shortage of organic matter inputs to the soil becomes apparent.

Of the negative consequences of reduced organic inputs, the major problem, as perceived by farmers and domestic and foreign scientists alike, is the short term critical consequence of lowered soil fertility. Thus, the application of inorganic fertilizer has been widely demonstrated, recommended, and adopted. Only a dozen years ago, most Tarai farmers had neither seen nor heard of chemical fertilizers. Considering also the prevalent use of potentially high-yielding, high-nutrient (particularly nitrogen)- responsive varieties, the rapid adoption of inorganic fertilizer applications is not surprising.

Unfortunately, except in isolated cases, the use of high-yielding varieties and fertilizers has not been accompanied by dramatic gains in production. For a variety of reasons, farmers rarely apply sufficient fertilizer to exploit the yield potential of new varieties. Some of the reasons given are sensible and expected; others reflect farmers' misperceptions about inorganic fertilizers.

The recommended optimal dose for a particular crop is typically determined for the whole nation rather than for specific locations. This means that the recommendation may not be particularly well-suited to a particular farmer's situation. The recommendations for potassium and for phosphorus, for example, seem to be unjustifiably high. Researchers cite the long-term depletion of potassium in the soil and recommend levels of K application designed to forestall such depletion, but the short-term yield gains are difficult to see in a farmer's field. By trial and error, however, many farmers have discovered that, at least for the present, nitrogen is the critical element limiting their yields; consequently, this is often the only nutrient they apply. And they apply only the amount that they think is economically appropriate for them -- given the availabililty of water, their time of planting, the quality of the soil, the crop, etc. While a farmer may well be aware of production benefits of higher fertilizer additions, a lack of cash or fear of defaulting on l ns (if they are available) may also prevent him from applying an optimal amount. In the case of drought, a small farmer does not want to add excessive financial loss for chemical inputs to the already burdensome loss of food.

Problems associated with chemical fertilizer use have been widely publicized and led to widespread fears of "large dose" applications. As high-yielding varieties, particularly with high NPK additions, draw more rapidly on soil micronutrients, it should not be surprising to hear of the occurrence of

micronutrient deficiencies. While such problems may be readily diagnosed (by researchers, with appropriate training and equipment), and corrected with little expense, the less-scientific rumor that spreads among farmers is that fertilizer ruins the soil. Cases of induced acidity due to excessive nitrogen applications have also been reported and publicized. The problem is often associated with the use -- rather than the abuse -- of chemical fertilizer. Farmers also associate fertilizer use with "hardening" of soil and a subsequent "dependence" on fertilizer of soils to which only inorganic fertilizers were previously applied. The hardening phenomenon is no minor problem for animal traction-based agriculture, but, like the other fears and rumors about inorganic fertilizer use, reflects farmers' misperceptions of the phenomena. They typically perceive such adverse outcomes to be the direct effects of fertilizer use rather than the result of a lack of organic inputs.

Despite these fears, the use of at least some chemical fertilizer is prevalent. There is an appreciation in some areas that without the additions of fertilizer, the crop, particularly wheat, may not be worth harvesting as yields will be so low. Many farmers have now not only accepted, but have become dependent on, appropriate maturity, high-yielding varieties and purchased fertilizer inputs. Unfortunately, they have too often been unable to realize the full potential benefits of either.

VI. Social and Economic Consequences

While many farmers are eking out a bare living with the help of improved varieties and low applications of chemical fertilizer, others are finding farming very profitable. The question arises: "If some can benefit from modern agriculture, why can't others?"

When extension and research set out to create a green revolution, the "trickle down" theory was in vogue. The reasoning went thus: If progressive, innovative farmers could be identified and convinced of the merits of new varieties and fertilizers, they would serve as models for others to follow. Targeting adopters was relatively easy. Usually they were landed, wealthy, politically powerful people who, for a variety of reasons, were able to adopt the new technologies rather readily. They typically had irrigation and sufficient land to risk using some for experimentation. They could afford to offer free housing (and sometimes food) to the extension worker (JTA). This was important because if there were problems (e.g., insect pests) with the experiment, the JTA could either solve the problems or, more importantly, provide a direct link to higher level technicians or researchers who could come to the

rescue. After all, there would be no trickle down if the model failed. Such farmers were often rapidly converted to the new way -- continuing to plant new varieties and to apply liberal doses of fertilizer -- because for them it was profitable.

Unfortunately for others, as the new ideas trickled down, the package came apart. Initially some of the smaller farmers took the whole package (if they could not afford fertilizer, loans were provided) but they soon realized high production was not as guaranteed as it may have appeared on the "model farm." The hand in hand guidance of, and rescue by, the JTA typically was lacking, and thus important advice such as timing of irrigation or avoidance of flooding in wheat was not conveyed. If inputs like irrigation or fertilizer were in short supply, the small farmer was least likely to get them. If germination of purchased seed was poor and the farmer complained, he found little or no redress. One total or partial crop failure was enough to put him into unenviable debt. In summary, smaller farmers quickly realized that important technical advice, adequate water, timely access to inputs and the ability to take an occassional financial loss were important parts of the package which they did not possess. So they took from the package what they felt they could afford, or, more correctly, what they felt they could not afford to do without, namely, new high yield potential varieties and sufficient fertilizer to get a crop, low-yielding though it might be.

While the green revolution technology per se might be scale neutral, when considered in light of the foregoing discussion, it obviously is not. It should also be apparent that the gap between the haves and have-nots can widen. From observations and interviews a decade ago and now, we believe the gap has widened.

Those fortunate enough to take advantage of the new technology have been able to improve their wealth, particularly by diversifying and putting their profits into rice mills, bazaar apartments or other commercial enterprises. The price of land has skyrocketed, especially near the new roads, often more than five fold in 10 years. In the past, when a family's land was divided amongst the heirs, an attempt was usually made by all to supplement their share by gradually purchasing more land. With increasing population and finite land resources, this can only be done by some, regrettably at the expense of others.

Seventy six percent of Tarai farmers in 1977 were considered small or marginal compared with 70 percent in 1970. Forty percent of Tarai farmers are tenants (40). For small farmers, life is precarious. Not only does improvement seem unlikely, but relatively small errors in judgment or management can put one in debt and ultimately result in loss of cattle or land.

Alternative sources of income are few, and working as a landless farm laborer is not enviable. While the price of consumer goods has at least doubled in the past 10 years, laborers' wages have risen roughly 50 percent. There is little doubt that this group has become materially poorer. We observed a proliferation of large, multi-variety home vegetable gardens which would appear to bode well for human nutrition. Yet one farmer eloquently told us he felt this vitamin gain was offset by dairy product protein loss due to reduced animal populations.

While small landed farmers express appreciation for the eradication of smallpox and malaria, an improved transportation network and the availability of medical services and education, they also express dismay at being unable to take full advantage. Higher quality education and quality medical attention are often beyond their means. The two major hopes for improved family welfare, namely, acquisition of more land or higher education for their children thus continue to remain hopes. For many Nepalis, this "better life," to which they have been exposed to and dream of, appears further and further out of reach. Only a small minority are appreciably improving their situation.

APPENDIX D

RESEARCH AND RISK

by
Gary Ender

In this appendix, the relevance of agricultural research in Nepal is analyzed in the context of the riskiness of farming in Nepal (i.e., the Tarai). The first section describes briefly the recent historical trends (detailed in Appendix C) which have transformed life and farming in Nepal. The next section details the sources of riskiness in farming. The third section decribes how and why the high input technology most often generated by agricultural research has or has not been feasible for farmers to adopt. Finally, some conclusions are drawn as to the types of technology which research should attempt to develop and how this should be done.

I. Farming and Life Intensity

There are several reasons why life has become more intense in Nepal. The most straightforward and the most important factor causing intensification, however, is increasing population. Its effects are seen in migration, in continuing land fragmentation, and in local shortages of housing or land to build houses. In one village a sajha office had to relocate to another village because its landlord demanded the building back for his family. In the same village, better-off villagers bought houses from poorer villagers, who were then forced to build new houses in a new location apart from the village. With non-agricultural employment opportunities growing slowly, population increasing relentlessly, and cultivated land growing hardly at all, more and more food and fiber must be produced per unit of land.

Increased cropping intensity in turn requires more planning, better coordination of resources, and tighter timing of operations. As the parts of the farming system become even more interdependent, there are losses in flexibility. This in turn makes farming riskier.

In the struggle to provide a good life for their children, Nepali parents have begun to educate their children more. The costs of education, more fashionable or simply better clothes, and other consumer goods which have come to be perceived as required at a decent standard of living have increased the desired minimum income level. Since agriculture is the main source of income, much of this need is again reflected in an increased intensity of land use in farming.

To conclude this brief description of the farmer and his changing environment, it should be noted that farmers, like most of us, are risk-averse. Poor farmers, moreover, have little to gamble with. Nevertheless, many middle-income and even poor[1/] farmers in Nepal are now gambling to a considerable extent in their farming.

II. Farming is a Risky Business

There are many reasons why farming is risky. The one which come to one's mind first is the weather. In Nepal the riskiness of the weather is manifested in the variability of the beginning and end of the monsoon rains and the variability of total rainfall and its distribution.[2/]

To mitigate the effects of variable rainfall one naturally thinks of irrigation. In Nepal, however, only a small fraction of the cultivated land is irrigated (10-15 percent in the Tarai). Land classified as irrigated, moreover, is not likely to have assured irrigation all year round. The struggle to intensify cultivation sometimes leads to struggles between those upstream and those downstream. This is also apparent at the international level, between India and Nepal. The construction of large canal projects has sometimes permantly disabled a community irrigation system without itself providing a reliable source of water. In addition, rivers change their course,[3/] leaving local channels dry.

Another natural factor which is important to Nepali farmers is the incidence of pests and diseases. These may destroy or reduce crops, as well as kill animals needed for traction and manure. Biped and quadruped animals may also be hazardous to standing crops.

In addition to natural factors, several market-related factors play key roles in the process of cropping intensification. On the input side, the first is the availability of improved seed. A farmer who wants to buy seed from AIC through his sajha may find that AIC did not make it

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1/ "Middle-Income" and "poor" are relative here; all of these farmers are poor by world standards.

2/ At Parwanipur, in the central Tarai, between 1971 and 1976 only, the rainfall in April varied between 4 and 165 mm; in May, between 1 and 228 mm; in September, between 100 and 475 mm; in October, between 28 and 240 mm; and the total annual rainfall varied between 893 and 1940 mm.

3/ Deforestation at key points of a river's course may contribute significantly to this process.

Available on time or that the sajha did not or could not get the seed to his village on time. The quality of local roads may be a factor here. A farmer who saves his own wheat seed may have a considerable amount of trouble preserving it through the warm, humid monsoon season, and after a few years, wheat seed produced in farmers' fields will usually lose its vigor. Quality is also a major problem with seed supplied by AIC. Farmers using both corn and wheat seed from AIC this year complained that it looked fine on arrival but gave extremely poor germination.[1/]

The other major marketed input of the Green Revolution is, of course, fertilizer. Here again, farmers have been unable to obtain as much fertilizer of the types they want and on time from AIC. Some are forced to buy phosphorus and potassium they do not want, many sajhas are not functioning, and AIC often has trouble obtaining even donated fertilizer (more than half the total) on time. This year the sajhas went on strike (!), and there is always the problem of a black market in fertilizer because of strong demand in India.

Another set of problems the farmer must contend with is the variability of government policies. Relevant policies include the level of the fertilizer subsidy, the types of intervention in domestic and international grain marketing, and land tenure law enforcement. In the last ten years, Nepal's rice export trade has changed from free trade to a monopoly by zonal rice export companies to licensed private trade; some farmers believe that the rice export companies had a significantly adverse impact on their welfare.

The insecurity of land tenure that affects many small farmers in Nepal is still another risky element in their economic and physical environment. The effective power that many landlords have over their tenants allows them to continue to receive half of all crops when the law stipulates a fixed rent on grain crop; this in turn renders the on-paper profitability of many technologies unachievable, since in addition the tenant must often pay for all the inputs himself. A tenant frustrated by the inability to farm as productively as he thinks possible would, however, be taking a very big risk by doing legal battle with an economically more powerful landlord.

One way to increase the economic power of small farmers is with additional and/or subsidized credit. While credit is not itself a risky element in a farmer's environment, a farmer's possibilities vis-a-vis credit are a reflection of the riskiness

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[1/]The seed may have been "cooked" by the high temperature ....produced by molds or other organisms in storage.

of his investments. Thus a farmer who can and does get a production loan faces the possibility of default if his crop fails due to drought, floods, grazing, etc. There is no true forgiveness (or insurance) in the credit system, although the farmer who never repays and can therefore get no further credit is sometimes said to have received a semi-deliberate transfer payment. Cooperatives were tried and most of them failed ten to fifteen years ago; the sajha system has reinstated cooperatives, however, and those with outstanding debts can get loans upon partial repayment. The ultimate threat against the farmer in debt is to take his land; this seems to have almost never been done, but it may yet be a significant worry to the small farmer with little food security. To avoid going into debt to buy inputs, some farmers save a small amount of cash. By investing in some level of inputs with cash, the farmer achieves no greater chance of success in production. He avoids the perils of debt, moreover, only if he does not have to borrow to eat if his crop fails.

It is clear that in general there are substantial risks involved in farming in Nepal. Thus, to accurately imagine the plight of a farm family in Nepal, one must consider together the problems of minimal assets and the riskiness of the production environment.

III. When Technology Talks, Who Listens?

With the Nepali farmer so precariously situated, one would think that those setting the course of agricultural research would have taken a long look at what the farmer was doing and why, before designing any experiments. Unfortunately, only now are those in control of research beginning to do this.

What has agricultural research produced, and why? Mostly it has been improved technology in the form of new, fertilizer-responsive varieties of rice, wheat, and corn. These were extended with research station recommendations which called for high levels of fertilizer application. These levels were probably set to approximate maximum yield rather than maximum return. In addition, the technology required irrigation, either to make the fertilizer effective or to ensure adequate water control in paddies.

Such an output was, unfortunately, logical from the system which generated it. Agronomists and breeders predominated, soil scientists were few, and agricultural economists, absent. Western agricultural training at the Ph.D. level emphasized maximum yield, and so did the international centers like IRRI.

The preoccupation with yield resulted in a lack of attention to other plant characteristics. Many of these are extremely

important to farmers forced to tailor their crops and cropping systems to a variety of needs and resource availabilities. Some of these characteristics are: amount of straw, quality of straw as thatch or fodder, grain quality and taste (and thus price), and flexibility in planting/transplanting date. Thus farmers in Nepal have typically grown a variety of crops (or several varieties of rice) to reduce their risk, to make best use of their resources, and to meet their needs. Yet agricultural research in Nepal has generally aimed to develop one (or perhaps two in the case of rice) best variety for each crop in each geographical region (Tarai, Hills).

Given the riskiness of the farming environment and the meager assets of farm households, the high input new technology package was exactly what the farmers could not use. After experimentation with it, those farmers who had enough irrigation generally fit the new technology in as a small part of their cropping system. Wheat fit in most easily because it often replaced fallow. Those with sufficient water control took advantage of high solar radiation in the early season by using the improved rice varieities. Virtually no farmers used the recommended dose of fertilizer, however, because it represented a much too risky investment. Many farmers used no fertilizer. Thus the new varieties were used with fortuitous benefit with a level of fertilization at which they were undoubtedly never tested by researchers. Indeed, early three-part demonstrations done by extension workers in farmers' fields included the following treatments: local variety-local method, local variety-improved method, and improved variety-improved method. Improved variety-local method as a possibility was anathema!

In the early 1970's, partly at the instigation of USAID/N, research stations began to test potential new releases in farmers' fields as the last stage of testing. As part of this process the rice variety Masuli was released in 1973. In a farmer's field trial, it was found to have the lowest yield of ten new varieties tested and the best taste. This variety is now ubiquitous in the Tarai. Farmers trade for or buy Masuli seed from their neighbors because it fits into a niche in almost every farmer's farming system. It has many desirable characteristics, particularly flexibility in age of seedlings at transplanting, good taste and price, and good quality thatch, in addition to a yield higher than traditional varieties. It even has the unusual property of being best tasting immediately after harvest and declining in quality thereafter, thus complementing almost perfectly the eating quality of other rices. If farmers are to listen to researchers, the latter will have to start telling them about many more Masuli's.

IV. Dialogue and Division of Labor

Research, extension, and farmers have come a long way in Nepal, individually and as a team coalescing to improve everyone's lot. Feedback among these actors has become significant as a result of previous frustrations and structured meetings. In the same way that all the parts of farming systems in Nepal are carefully adjusted to work together, researchers, extension workers, and farmers must eventually function as a powerful organism with relevant goals and methods.

What farmers in Nepal need, to quote one farmer, is "not a better variety that requires even more fertilizer, but a good variety that requires less fertilizer." That is, farmers need an optimum fertility package, not a maximum fertility package, and it must be suited to their available labor, risk-taking ability, taste, and several other important requirements and resource availabilities. It should also be noted, however, that most farmers are now convinced of the value of fertilizer.

To develop such packages in turn requires the intense cooperation of research, extension, and farmers. In this improved research system, there are likely to be at least three significantly different roles for researchers to perform. First, they should continue to do adaptive trials. In this way, Nepal will continue to benefit from basic research done at international centers and in other national research programs. Before these varieties are released, all three actors should see farmers' fields' results.

Second, research stations should be conduits for varieties from both domestic and foreign sources that will be tested by farmers (after only basic pest susceptibility screening) for a wider range of characteristics. This mechanism will both facilitate the rapid spread of acceptable varieties and promote understanding of what characteristics farmers consider important.

Armed with all of the above information and experience, researchers can begin to breed and select new varieties that are truly relevant to the Nepali context. Some of the coordinated commodity improvement programs in Nepal are entering this phase, but the second role still needs promotion and strengthening.

ANNEX E

TEN YEARS LATER IN SHRIPUR

by
Gary Ender

I arrived in Shripur[1/] with my Peace Corps issue sleeping bag, mosquito net, malaria pills, and water filter, and my radio and tape recorder. We had bumped along the canal bank road many miles in the AID advisor's jeep. I soon settled into a room in the panchayat building. Within a year I had learned to speak and understand Nepali passably and realized that I didn't need my mosquito net, malaria pills, or water filter. The earthen jug kept water cooler.

My job was Junior Technical Assistant - JTA - and while virtually none in Shripur knew my name, nearly everyone knew "JTA saheb." JTA's are the village-level agricultural extension workers who are supposed to know something about everything from cereal crops to fruit saplings to improved implements to baiting rats to feeding pigs. In general the JTA is supposed to go door-to-door with the message of krishi bikash -- agricultural development -- but that was never really my style. I talked to people in tea shops and markets and still managed to work in cereals, fruits, plows, rats, pigs, and much more. Demonstrations of new varieties of rice and wheat were required, and these structured the time I didn't spend in farmer-friends' homes or in tea shops and markets.

Shripur is a panchayat in the eastern Tarai about 15 miles from its district center. After the east-west highway was completed in the district, it was a two-hour walk and about two hours on the bus to the district center. The people of Shripur are a mixture of Hill and Tarai ethnic groups, probably a more diverse population than in most Tarai panchayats. At the time I was posted, PCV-JTA posts were selected partly on the basis of irrigated land, so I was duly impressed by the flowing channels of diverted river water. Like many Tarai areas, Shripur had its former zamindars and other moderately large land owners, as well as small land owners and tenants. There seemed to be very few landless people who were not merchants or artisans.

My arrival in Shripur coincided approximately with the denouement of the local cooperative society. It had managed to bring in significant quantities of wheat seed and fertilizer, but many loans were not repaid, and the zamindar's representative extracted large amounts from the till. This was nothing new, as the zamindar had also started to clean out the

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[1/] Village name is fictitious.

compulsory savings godown and the panchayat coffers. Because of the efforts of the ccoperative and my Nepali JTA counterpart, however, improved wheat seed had entered Shripur. Now, even if farmers were not interested in using fertilizer, they could at least save the seed and share it with their neighbors. Improved rice seed entered in the same way, and rice is even easier to store.

During my stay in Shripur, no agricultural revolution, green or otherwise, occurred. Farmers expressed a variety of ideas about fertilizer. They recognized the growth-enhancing effects of nitrogen, and some teaspooned it around their cauliflowers. Some came to believe that it ruined their soil or that after once using it further use was required. A modest and gradually increasing amount of wheat was grown, where irrigation was possible in the winter, and a few farmers continued to use fertilizer on it. Improved rice varieties from Taiwan and IRRI found their niche in the early season, again where irrigation was available. We had to do some spraying to keep the bugs down, but the cooperative had purchased a sprayer which I could borrow, and my regular trips to the district center to pick up mail allowed me to replenish the local supply of insecticide. Vegetable seeds were a big seller, and I used to collect some "interest" from those who made sinki, dried fermented radish. I built a pen and raised an American pig on local rations. This project was a lot of fun and evoked moderate interest. One Chhetri[2/] decided to raise a pig similarly for profit. Chhetris do not eat or touch pigs, but this farmer saw that by keeping the pig penned and having a hired person to clean the pen, he could turn a profit with no loss of status. There were several pork-eating groups in the area and there were also those among the Brahmins and Chhetris who would openly or clandestinely eat bangur,[3/] as the American pig was called.

Many farmers got to hear my message in four years, but none seemed to be totally convinced about krishi bikash and its new-fangled ways. By the time I left, then, I could tell myself that while the revolution had not started, the seeds had been planted in good places, namely, in the minds of several farmers who were likely to try the new ideas out. By then I knew that most farmers were best convinced by other farmers. Whether or when the revolution would come, though, I could not say.

[2/] Member of the warrior caste.

[3/] A clever linguistic cross between sungur (pig, which is off limits) and banel (wild boar, which anyone can eat).

Returning to Shripur ten years later was enjoyable only because I got to spend time in the homes of my friends. Otherwise it was quite saddening.

The winter fields were the first disappointing sight. There was much more linseed planted than wheat. And quite a number of fields had only rice stubble. Linseed was disappointing to see because, as I soon found out, it only yielded 3 maunds per bigha, whereas wheat would give 30. The price of mustard (edible) oil had risen sharply after I left, but it still was not ten times that of wheat. Linseed could be relayed into the rice before harvest, rather than sown after plowing, so it saved time. But I think the most important clue to the rationale for this uneconomic crop choice was the comment that linseed was supposed to give an assured yield (one farmer even told me that livestock don't like to graze it), whereas improved wheat was susceptible to insects, diseases, sterility, and lack of fertility. Farmers knew that for wheat to do even reasonably well, it needed nutrients from either compost (manure) or fertilizer. Fertilizer was a cash cost and a risk, not to mention available only irregularly in the village. (The sajha (cooperative) had gone on strike at wheat planting time!) And manure was getting harder to come by.

Grazing land had become scarce because small farmers needed to plant more winter crops to feed their families. Roadside ditches, riverbeds now cultivable because of canal works, and other miscellaneous pieces of land were now plowed and planted. More cultivated land and less available manure would lead to lower soil fertility unless fertilizer were used. But I knew from my previous experience that small farmers were those least able to take the risk of using fertilizer. Many times this was particularly difficult because they were tenants and the landlord shared their output but not the cost of inputs.

Some of the tracts of rice stubble I saw I knew to belong to large landlords, some of whom I learned had increased their holdings since I had left. By leaving their land fallow, they could protect its fertility. They might even gain if other people's animals grazed and deposited manure on their fields along with their own animals. In any case, they were not the ones who needed the extra food. They could sit back and squeeze their poorest tenants into selling any land they owned or making a more beneficial tenancy arrangement.

Two other saddening situations became apparent to me as I sat in a roadside tea shop near the home of my host. The first was that I seemed to notice that many "bullock" carts were in fact being pulled by male buffaloes. I asked my friend and he confirmed this. He explained that the scarcity of grazing land

had led many farmers to stop raising cows. Cows had always given less milk than she-buffaloes, but without a cow a farmer cannot reproduce new bullocks, which are essential for good draft power. Bullocks had become very expensive, so when their bullocks got old, many farmers were traveling quite far to buy buffaloes which could be had somewhat more cheaply than bullocks. Perhaps as an economist I should rejoice that these farmers had been brought into the monetized livestock economy. I was sad, however, because I knew that poor people who were not yet ready to enter that economy had been forced out of their self-sufficient system of producing new bullocks.

Fewer cows and less grazing mean less manure, but more people and more difficult access to the forest also mean less firewood per family. My friend told me that his family only made quita -- dung Duraflame "logs" -- for use in one month of the monsoon, when their firewood ran out. But I could see that poorer families had bigger stacks of quita's than his, drying in the winter sun.

The second saddening event I observed concerned debt between a large landlord and a tenant whose own land holding was getting smaller. The tenant had been served with a court paper telling him to appear in the district center on a certain date in the matter of an old loan. According to him the loan dispute had been settled; he had sold land to pay the debt, and he and the landlord had signed an agreement that the debt was canceled. I learned from my friends, though, that in the process of signing papers this probably naive tenant had been duped into signing some other papers which were his current source of anxiety.

As if their own problems were not enough, farmers in Shripur were also suffering from a factor of international origin. The major cash crop in Shripur is jute, and for the last several years the price has been quite low. While I can pick up a telephone in Washington and find out an expert's best guess on the prospects for synthetic alternatives, a farmer in Nepal clearly cannot. Moreover, previous years of low prices have always eventually been followed by years of good prices, so the farmer's intuitive notion may be to keep planting jute and hope for a higher price. Here, too, there is an investment of manure, hired labor, and other valuable resources which represents a significant risk for all farmers.

One intervening factor which has begun to provide benefits to farmers in Shripur is education. The results are still mixed, however. It seems that farm households are sacrificing more to invest in the education of their sons to a higher level than before. In the case of my closest friend, his younger brother studied far enough to become a teacher in the local high school, which was running well without government support. The brother's wife was also a teacher and they had no agricultural

income. My friend's eldest daughter had also studied enough to be a teacher's assistant and was bringing home a modest salary. This example is atypical, however. I met many farmers whose sons had completed ten or so years of education and were engaged solely in farming or in farming and a side business. Their higher education is not likely to make them any more open to modern farming or help them succeed in business; farmers are already open to modern farming ideas, and education beyond literacy and numeracy for a village merchant is probably of little use. The government is still the main source of jobs for which education is the main requirement. Many of these farmers' sons will not have been able to complete quite enough education to quality. Even if they did, the fierce competition makes a 'source' (contact) a necessity.

On the more positive side in agriculture, there have been indisputable benefits from the research and extension system. Varieties like Masuli (rice) and RR-21 (wheat) are widely dispersed in the Tarai. They have fit into the Tarai farming system because they have a number of good characteristics, i.e., more than just high yield. Masuli has good eating quality, brings a good price, and has ample flexibility in age at transplanting. RR-21 has large, bold, white grain, and until recently good rust resistence. IR-8, an old IRRI variety, gives a very good yield in the early season. Although its eating quality is poor, small farmers who have irrigation need to trade quantity for quality.

Meals were always a part of a visit to one of my friends. I ate more meals per day than I ever would have in Kathmandu and still ate fewer than my friends offered. I left Shripur, then, with a full stomach and happy to have been reunited with people who meant very much to me. The lingering doubt I could not dispel was whether most of those in Shripur would have full stomachs and happiness in the coming years.

APPENDIX F

STATISTICAL SUMMARY

Table F-1.
Area Under Improved Varieties of Wheat and Rice
Nepal, 1964-80

Year	Wheat		Rice	
	Total Area ('000 ha)	% Under Improved	Total Area ('000 ha)	% Under Improved
1964/65	100	--	1101	--
1965/66	118	3.7	1111	0.6
1966/67	126	9.0	1100	1.2
1967/68	192	14.4	1154	2.3
1968/69	208	26.1	1162	3.7
1969/70	226	33.8	1173	4.3
1970/71	228	43.1	1182	5.7
1971/72	239	48.5	1201	6.8
1972/73	259	65.7	1140	15.1
1973/74	274	75.5	1227	16.7
1974/75	291	84.8	1240	18.0
1975/76	329	71.0	1256	17.2
1976/77	348	73.0	1262	17.5
1977/78	366	78.4	1264	23.0
1978/79	356	85.4	1263	24.7
1979/80	367	85.7	1254	25.1
1980/81 (estimate)	381	83.5	1276	25.5

Source: Food and Agricultural Marketing Services, HMG/N.

Table F-2.

Area and Production of Major Crops
Nepal, 1964/65 - 1980/81

Years	FOODGRAINS							
	Paddy		Maize		Wheat		Millet	
	'000 Ha.	MT	'000 Ha.	MT	'000 Ha.	MT	'000 Ha.	MT
1964/65	1101	2201	437	--	100	126	24	26
1969/70	1173	2241	433	795	226	265	26	24
1970/71	1122	2304	445	833	228	193	27	25
1971/72	1204	2358	435	730	247	225	28	25
1972/73	1142	2010	446	822	259	312	27	25
1973/74	1227	2416	453	814	274	308	28	26
1974/75	1240	2452	458	827	291	331	28	26
1975/76	1256	2605	452	797	329	387	26	25
1976/77	1262	2386	645	797	348	362	25	21
1977/78	1264	2282	445	740	366	411	26	22
1978/79	1263	2339	454	743	374	454	26	22
1979/80	1254	2060	432	554	367	440	26	23
198/81 (Est.)	1276	2464	457	743	381	482	26	23

	CASH CROPS					
	Sugarcane		Jute		Oilseeds	
	'000 Ha.	MT	'000 Ha.	MT	'000 Ha.	MT
1964/65	9	126	32	39	108	51
1969/70	13	216	52	49	103	57
1970/71	14	236	55	53	106	55
1971/72	15	245	60	59	111	57
1972/73	15	246	54	55	122	60
1973/74	16	267	33	40	114	54
1974/75	15	251	34	41	112	65
1975/76	15	253	33	41	113	68
1976/77	18	311	40	45	108	61
1977/78	23	387	47	56	133	78
1978/79	23	379	45	66	144	92
1979/80	23	384	57	68	118	63
1980/81 (Est.)	25	479	49	59	123	77

Source: Ministry of Finance, Economic Survey, various years.

Table F-3.
Indicators of Improved Technology Adoption, 1967 - 80
Selected Years, Three Selected Districts

	All Nepal	Bhairawa (Rupandehi)	Rampur (Chitwan)	Parwanipur (Parsa)
1. HYV Seed Sales (MT)				
1969/70	661	101	42	60
1972/73	2083	186	107	255
1975/76	2328	48	184	182
1979/80	2919	76	126	314
2. Chemical Fertilizer Sales ('000 MT)				
1969/70	15861	259	263	1996
1972/73	32555	1311	1362	3111
1975/76	31131	1683	1562	391
1979/80	50168	2059	2466	5373

3. Production ('000 MT) c/

	P	W	M	P	W	M	P	W	M	P	W	M
1969/70	2151	265	795	117	14	5	48	5	50	106	13	5
1972/73	2010	312	822	106	29	5	47	7	50	81	81	7
1975/76	2605	387	748	129	21	5	54	12	41	116	25	3
1979/80	2060	440	554	76	26	4	45	16	11	106	25	-

Sources: Agricultural Inputs Corporation as cited in the World Bank, 1979. Nepal Agricultural Sector Review, pp. 72 and 85, and in World Bank, 1981. District data compiled from official statistics by USAID/Nepal, 1980.

a/ Maize, paddy, and wheat seed combined. Wheat seeds are the most important. The years represented were randomly selected.
b/ Different mixes of fertilizers.
c/ P = Paddy; W = Wheat; M = Maize

Table F-4.

Agricultural Sector Export Earnings
Nepal, 1968 - 1979
(Millions of Rupees)

	Rice a/	Other b/	Total
1968/69	--	468.4	468.4
1969/70	--	436.7	436.7
1970/71	0.1	362.1	362.2
1971/72	--	467.6	467.6
1972/73	--	567.8	567.8
1973/74	29.4	619.3	648.7
1974/75	3.7	742.6	746.3
1975/76	19.2	1071.1	1090.3
1976/77	6.0	1026.9	1032.9
1977/78	71.4	905.7	977.1
1978/79	100.8	1090.6	1191.4
1979/80	54.3	894.1	948.4

Source: Nepal Rastra Bank, Quarterly Economic Bulletin, Vol. XV, No. 4, July, 1981, Table 37 and Vol. X, No. 2, Table 29.

a/ To countries other than India.
b/ "Other" includes food and live animals, tobacco and beverages, crude materials and inedibles except fuels, animal and vegetable oils and fats, and jute from the manufactured goods category. All forestry has been excluded.

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No. 3: Third Evaluation of the Thailand National Family Planning Program (February 1980) PN-AAH-006
No. 4: The Workshop on Pastoralism and African Livestock Development (June 1980) PN-AAH-238
No. 5: Rural Roads Evaluation Summary Report (March 1982) PN-AAJ-607

PROJECT IMPACT EVALUATIONS

No. 1: Colombia: Small Farmer Market Access (December 1979) PN-AAH-768
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