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NO EASY HARVEST

The Dilemma of Agriculture in Underdeveloped Countries

Max F. Millikan

David Hapgood

Little, Brown and Company · Boston

A study from the Center for
International Studies
Massachusetts Institute of Technology

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Introduction

The worsening food crisis of the underdeveloped nations is becoming evermore apparent. Much of our world is having difficulty feeding itself. Although the productivity of agriculture has advanced in many of the underdeveloped nations and there are a few instances of notable success like Mexico, Taiwan, and the Sudan, in the regions where most of humanity lives the ancient art of agriculture has been unable to keep pace with the swelling demands resulting from the twin pressures of the population explosion and rising industrial incomes. Agriculture has lagged behind industry, and in country after country it is now acting as a brake on economic growth. The gap in living standards between the underdeveloped and the developed nations is widening dangerously.

Two different groups of people with what initially seemed to be two largely unrelated concerns have come increasingly to recognize that the same phenomenon lies at the heart of both of their problems; this phenomenon is the inadequate rate of growth of agricultural productivity in the underdeveloped world. The first group are those statesmen and economists in both underdeveloped and developed countries who feel that a necessary condition for peace and the emergence of a reasonably stable, viable, and open international community is a more rapid rate of general economic growth in the underdeveloped world. This group feels that with population growing at 2 to 3 per cent per year, the national product of the underdeveloped countries must grow by at least 5 or 6 per cent per year to provide the per capita improvement in standards of living which is required for a sense of progress and for the expansion in capital needed to sustain this growth. This group has come increasingly to recognize that for reasons elaborated in Chapter 1 the failure of many of the underdeveloped countries to achieve these target growth rates is at least partly due to the inadequate performance of agriculture.

The second group are the nutritionists and food experts who have been increasingly concerned with the physiological and psychological consequences of the chronic malnutrition from which the majority of the world's people have been suffering for generations. The Food and Agriculture Organization of the United Nations in its report "The State of Food and Agriculture, 1966" found that per capita food pro-

duction in the developing regions was no better in 1965/66 than before World War II. While consumption was raised somewhat above the pre-war level by large imports from the developed countries, the surpluses likely to be available over the next decade will be inadequate to make more than a small dent in the nutritional gap. In any case, the nutritionists are coming increasingly to realize that nutrition cannot be markedly improved without a sharp acceleration in the per capita incomes of the peoples of the developing world. Thus, improved nutrition and faster general economic development are two sides of the same coin, and much higher agricultural productivity is a *sine qua non* for both.

How can this end be brought about, and why has it not already occurred? How can we explain the failure of agriculture to perform as well as industry, and what can we now do about it? A decade ago it seemed to many that the agricultural technology of the developed nations could be quickly transplanted to the underdeveloped world, where it would produce rapid increases in food production. But most such transplants have failed to take root, and the gap in per acre and per capita yields between developed and underdeveloped nations is not narrowing. Ten years ago it was widely believed that one or another single technique (community development is an example) could solve the organizational problem of bringing new technology to millions of individual farmers. Many promising techniques have been tried in many places, but the record of recent years is one of general failure and only rare successes. Industrialization, it was commonly said ten years ago, is the key to development. Industry has advanced in parts of the underdeveloped world, but agriculture in many nations is not providing the higher levels of nutrition that are the first-priority use of higher incomes.

A group of development economists at M.I.T.'s Center for International Studies began in 1963 to try to find answers to these questions. None of us were expert in agriculture, so we consulted many different kinds of experts to try to get some leads. They included various kinds of natural scientists such as agronomists, plant scientists, soil experts, specialists in fertilizer, water, and pesticides. We spoke with agricultural and general economists, students of farm costs and prices, credit and marketing experts, transportation economists, and men who had made careers out of the study of land tenure, land reform, and farm organization. We interviewed anthropologists, sociologists, and psychologists who had investigated social organization, social values and conditions of life in peasant villages on all three

major underdeveloped continents. Finally, we talked to political scientists versed in the strengths and weaknesses of government organizations designed to promote agriculture through extension services, community development agencies, and departments of agriculture at both national and local levels.

After we had conducted quite a number of these interviews we found we could pretty much predict the answer we would get from any particular specialist if we had enough information in advance about the nature of his specialty. Analysis of agricultural failures tended, we observed, to follow the discipline of the diagnostician. Each specialist would find that the factor familiar to him was crucial in the given situation, though he might also acknowledge the role of factors in fields other than his own. His prescription would then be likely to read: "Do something about my factor first – and the others will follow."

The plant scientists felt that inadequate attention had been paid to the development of plant varieties especially suited to each local environment, and recommended as a solution the multiplication throughout the underdeveloped world of research and experiment stations to engage in a massive program of plant breeding and adaptation. The fertilizer specialists pointed out that there is a high correlation between yields per acre and rates of application of the three principal types of fertilizer and concluded that top priority should be given to a dramatic increase in fertilizer production. The water management experts emphasized that the absence of year-round water holds productivity in many places to a fraction of its potential and that even where irrigation schemes have been installed at high cost, much of the water is wasted through bad distribution, wrong timing, or faulty drainage. In some cases, as in the Indus plain, irrigation has been managed so poorly that agricultural performance actually has been reduced. They tended to regard better water management as the principal key to immediate results. Similarly other natural science specialists, like the experts in control of pests, weeds, and plant diseases, each had his special diagnosis and his pet cure for the agricultural problem.

The economists all, of course, had economic interpretations of the situation, but they varied surprisingly in their emphasis depending on their special interests. Those who had looked at farm prices and costs could adduce convincing evidence that where commercial farming had prospered, as it did in Japan, it was profitable and returns were high. Where it was sluggish, they found, a farmer would have

to sell several times as much grain to buy a pound of fertilizer as he would where it was prosperous. They thought the indicated cure was a change in relative prices either through price supports on outputs, which had worked so well in the United States, or through subsidy to such inputs as fertilizer or pesticides. Others had studied credit, which is required for all commercial agricultural operations, and found it either not available or exorbitantly expensive through most of the underdeveloped world. Still others assembled the persuasive evidence that inefficient marketing, distribution and transport reduce the farmer's returns on the land to a discouraging level, and urged primary attention to one or another of these elements. Finally, there were the land reform enthusiasts who pointed out all the ways in which traditional land tenure systems (or the absence of any clear tenure system, as in Africa) interfere with incentives to farm improvement, and held high hopes for land reform as the key solution.

The behavioral scientists had their various special diagnoses, but were, after the habit of their kind, less positive as to solutions. They accused the first two groups of neglecting the special values held by the traditional peasant and over-rating the importance of technical knowledge and economic incentives. The rural villager, they said, is a prisoner of his culture and his history, suspicious of change or innovation, not accustomed to taking the risks involved in producing for a market, and is, therefore, differently motivated from the commercial farmer. They tended to take the gloomy view that there was not much hope until the whole structure of rural society was rather radically altered and its values changed through fundamental education, a breakup of the extended family, and the spread of mass communications.

Finally, the experts in public administration underlined the inadequacies of the civil service system as it affects agriculture in many underdeveloped countries. In some of the newer countries there is a severe shortage of managerial talent to run government programs of all kinds. In others the existing talent is much more drawn to the work of building the symbols of modernity like factories, power plants, and airlines, than to the low-status tasks of improving agriculture. Even where, as in India, a civil service of high integrity and good organization has been built up by the occupying colonial power and then sustained by the new national government, it is likely to be a group of men trained to transmit instructions in one direction only, down from the top of the hierarchy to the bottom. Agricultural conditions vary so much from place to place and even from farm to farm that what is

required is a bureaucracy much more flexible at the lower levels and much more responsive to communication upward from the bottom than one finds in even the best administrative systems of the developing world. For public administration experts the attractive solutions lie in better organization, better training of civil servants, higher status for government programs in agriculture, and the like.

When we had established to our own satisfaction the range and variety of explanations being offered for the sluggishness of agriculture, we decided the next step was to assemble a group of people representative of all these points of view under circumstances which would provide them with an opportunity not only for confrontation but for extended debate and consideration of all the issues involved. We persuaded the U.S. Agency for International Development to finance and to sponsor with the Center for International Studies a six-week study on the problems of agricultural productivity. We added to the list of expert invitees several men who had been intimately involved in running successful agricultural programs abroad and several government officials responsible for assisting foreign agriculture. The group met at Endicott House, a country estate managed by M.I.T., from June 29 to August 7, 1964. The participants and their affiliations are listed on page xiv. This book is in large part a product of that exercise.

As readers of the following chapters will see, we found our subject a peculiarly troublesome one. It presented two basic difficulties. First, at our conference we came to the not very surprising conclusion that each of our conferees was essentially right in both his diagnosis and his prescription, but that his solution was necessarily incomplete. Agriculture is, we decided, a "systems problem." It will perform effectively not if one or two or even several requirements are met, but only if a whole range of interacting conditions is satisfied. But with limited human and material resources it is particularly difficult for the governments of underdeveloped countries to act simultaneously on several fronts at once. It is urgently important to identify in each situation which of the parts of the system are most limiting in order to put limited efforts where they will do the most good.

But this brings us face to face with the second difficulty. It is easy to conclude from an examination of specific cases that the complexity of local conditions makes each situation unique, that the crucially limiting factors vary so from place to place that no general statement is possible, and no experience gained in one place is transferable to another. Acceptance of this proposition leads to intellectual anarchy,

and had we been fully persuaded of its validity this book would never have been written. Both at the conference and in this volume we have tried to steer a course between the Scylla of incomplete single factor solutions and the Charybdis of analytic chaos that results from overemphasizing the distinctive features of each situation.

In tackling our subject we found it necessary at the beginning to set some limits on the problems we would consider. Our horizon in time is, very roughly, the next ten or fifteen years, though often we have looked beyond that horizon. We have concentrated on small-scale peasant farming as opposed to plantation agriculture, though as we looked at the best techniques for settling sparsely settled land we found we had to consider the most efficient scale of the individual unit. We decided also to limit ourselves to annual food crops and not to examine tree crops and animal husbandry as dominant forms of agriculture. As it turned out, in considering two types of ecologies — rain forests and high-altitude regions — we could not avoid paying more attention to tree crops and animal husbandry than we had intended. Our subject remains vast enough, for, despite these limits, we are still dealing with the primary occupation of most of mankind.

The way in which this book was written is unusual and almost as difficult to describe accurately as the problem with which it deals. At the conference out of which it grew, the participants grouped and regrouped themselves in successively different ways producing subcommittee reports at each stage. There were sessions in which the representatives of each discipline attempted to summarize what their professional perspective could contribute. There were working groups focusing on the special problems of particular kinds of agriculture in particular geographic regions. Finally there were four teams which looked at groups of factors in an effort to draw up widely applicable generalizations.

The reports of all these working groups, themselves frequently collective products, were reviewed, elaborated and modified to reflect so far as possible the consensus of the entire conference. Finally we produced a conference report that was circulated to the participants for comment and revision, and published by the Center for International Studies. The present volume is a revision and extension of the conference report prepared by the authors without further consultation with the original conference participants. Thus while we accept sole responsibility for the text as it now stands, it is based in large part on the work of others. The identity of their separate contributions has been lost in the process of multiple revision and editing, but we ac-

knowledge our profound debt to all the people listed on page xiv who contributed everything from occasional ideas to complete drafts of whole chapters.

The structure of the present volume is as follows. The first two chapters, drafted by Dr. Millikan, set the stage, discussing the relations between agricultural and general economic development, outlining the special characteristics of agriculture, the preconditions for its growth, and some implications for public policy.

Chapters 3 through 6 deal with four major sets of factors involved in agriculture: physical requirements, the economic environment, research and education, and the organization of agricultural development. These chapters are based upon the reports of four of the subgroups at the conference. The chairmen of these groups were Eilif Miller (physical requirements), Raj Krishna (economic factors), M. B. Russell (research and education) and Karl D. Olsen (the organization of agriculture). Chapter 7 on land reform is based mainly on a paper produced for the conference by Wolf Ladejinsky. Chapter 8 on four success stories is based on reports given the conference by Akhter Hameed Khan (Comilla), Arthur Gaitskell (Gezira), Allan Holmberg (Vicos), and Yien-Si Tsiang (Taiwan). Chapters 9 through 12 concern ecological regions. The areas covered are the regions of wet-rice cultivation, the rainy tropics where rice is not the dominant crop, the monsoon and subtropical regions, and the high-altitude zones. These chapters are based on the reports of four regional groups of conference participants. The chairmen of these subgroups were Kenneth L. Bachman (wet rice), Will M. Myers (rainy tropics). Arthur T. Mosher (monsoon and subtropics), and Allan R. Holmberg (high altitudes).

The division of this book into chapters, like the division of our discussions at the conference, is bound to be arbitrary and to some degree misleading, for the burden of our message is precisely that the agricultural problem is not divisible. The reader must keep this in mind. Nothing can prevent the specialist from flipping the pages until he finds what we say about his specialty, nor the operational man from just seeking out those of our findings that concern his part of the world. We can only repeat that to read the book in this way is to miss our basic point. The book is a whole, not the sum of its parts.

We offer no panaceas here. Those looking for a blueprint to follow will be disappointed. We did not find a magic key to unlock the problems of agriculture, nor do we present a program likely, in ten years or a century, to assure the world's supply of food. We say this with

both regret and pride – regret, for the urgency of the world's food needs demands quick solutions, and we did not set out simply to solve an abstract puzzle; pride, on the other hand, for we are confident that we are on the right track. If we laid claim to solving problems that have baffled so many for so long, we could rightly be suspected of having failed to come to grips with those problems in their full complexity. That there are no panaceas is an integral part of what we have to say. We believe that statements on the order of, for example, "cooperatives are the best way to provide farmers with credit" are neither true nor false but are in fact meaningless. No policy can be evaluated except in the context of local conditions, and it is the study of those local conditions as they relate to alternative policies that will prove rewarding.

Yet we believe we have something worthwhile to say, and that it is the more useful for avoiding facile solutions. If we have uncovered no panaceas, we have not bogged down in what we earlier called intellectual anarchy and decided that we could say nothing at all. We set out to explore our subject, not to resolve it. If we have not mapped the trail, we have at least reconnoitered the ground.

What we present here is essentially a tool of analysis, a method of approaching agricultural policy. It is a handle by which one can grasp the "all-or-nothing" dilemma that confronts decision makers in the field of agriculture. We do not say: "This is what you should do in this situation. . . ." But we do say: "In this kind of situation these are the factors you must consider in planning your program; depending on your local conditions, these are some alternatives you may wish to experiment with; if you do thus and so, then you will soon have to resolve these other problems. . . ."

One more word of warning. We are convinced that the technology of agriculture, whether it be a plant variety or a type of extension service, cannot be successfully transplanted without careful experimentation and adaptation to local conditions. The same principle applies to this book. We believe we have provided a useful guide to thinking about agricultural policy in the underdeveloped world; but nothing said here is a substitute for painstaking and comprehensive analysis of local conditions that others know far better than we.

Finally, ours is not a cheerful report. Compared to the urgency of the need, what we offer here may seem meager indeed. Where giant strides are necessary, we have taken but a few tentative steps. The agricultural problem will not be solved in a laboratory or at a conference. To get the people of our world a decent supply of food – that

most basic of man's requirements – will require a gigantic effort. It will cost a lot of money, but money is probably the easiest need to fill. The goal will not be met unless many millions of people – technicians, officials, and, above all, farmers – are willing to initiate a radical and often painful process of social change.

One of the authors gave a talk in the summer of 1966 summarizing the conclusions of the conference on which this volume is based. Kenneth Boulding, who was in the audience, thereupon produced the following verse which admirably conveys the essence of our message.

The Old Agricultural Lag

by Kenneth Boulding

I

O why does agriculture lag?
The answers all are in the bag
But the bag in which the answer lies
Turns out to have enormous size.

II

The ardent fertilizer buff
Thinks fertilizer is enough
(Such buffs, it's interesting to know
Are much produced in Buffalo).

III

Then some there are who argue that
The major culprit is the rat,
And so encourage, far and wide,
The massive use of pesticide.

IV

Economists, it's plain to see
All think that *Prices* are the key
For no economy will grow
With inputs high and outputs low.

V

Markets and competition now
Must be the hand that speeds the plow
Making, in one Rostovian leap
Corn dear, and fertilizer cheap.

VI

Some think the answer lies in Risk
Others, that land reform's the whisk
To brush away the blocks that bar
Development's immobile car.

VII

Some say, when growth occurs, what fed it
Is careful grants of shaky credit,
With Government to underwrite
The debts of those who fly by night.

VIII

For Anthropologists, Tradition
Remains the major inhibition.
And peasants, oftener than we think,
When led to water, do not drink.

IX

With facts too many now to list 'em
The answer is a General System.
So what has got to be advised,
Is, "get the stuff computerized."

X

When scientists use common sense
They fall into mistakes immense.
It's better far to place reliance
Even on the softest social science.

XI

Hard work and saving à la Mill,
Is seen as far too bitter a pill
So comes the unimplemented plan –
What Mill cant, maybe Millikan.

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Following is a list of those who participated in the Conference on Productivity and Innovation in Agriculture in the Underdeveloped Countries held at Endicott House in Dedham, Massachusetts, from June 29 through August 7, 1964, under the joint auspices of the Center for International Studies of the Massachusetts Institute of Technology and the Agency for International Development of the U.S. Government. The affiliations of the participants here listed are as of the date of the conference.

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CHAPTER ONE

Agriculture and Development

A decade ago a fairly active debate was raging about whether first priority in the development efforts of the underdeveloped countries should be given to industry or to agriculture. There is now pretty wide consensus that the extremists on both sides of this debate were wrong, and that the complementarities between agriculture and industry are so pervasive that except in very unusual cases neither sector can progress without substantial growth in the other.

The early proponents of industry took the view that the essence of development was to be found in the process of industrialization. After surveying the countries of the world, they pointed out that there is a remarkably good inverse correlation between per capita levels of gross national product and the proportions of the labor force engaged in agriculture. Indeed one would not go far wrong if one were to define an underdeveloped country as one in which more than 40 per cent of the labor force is engaged in agricultural pursuits. There are some notable exceptions to this rule. Ironically, the countries with a larger agricultural labor force than one would expect from their income level are those in which the doctrine of the preeminence of industry has been followed most slavishly, notably the Soviet Union and some of the countries of Eastern Europe. There are also exceptions in the other direction, such as Puerto Rico and Chile, where incomes are not as high as the low proportion of workers in agriculture would lead one to expect. Nonetheless the undoubted association between development and industrialization appeared to some to justify the view that growth in agriculture was relatively unimportant.

This is, of course, a non-sequitur. The fact that countries, like people, as they grow richer spend a declining fraction of their incomes on food and devote a diminishing proportion of their man hours to agriculture, does not imply that improved productivity in agriculture is unnecessary for economic growth. Indeed, as we shall see, the statistical truth is more correctly explained by the opposite inference, namely that it is only because of increasing agricultural productivity

that man can be liberated from slavish dependence on rural drudgery. But the fallacious logic of the case against a priority for agriculture did not prevent it from having considerable influence on the thinking of newly independent countries in the decade following World War II.

On the other side of the argument was a group we may call the romantic ruralists. Many of this group emphasized rural development not for economic reasons but because they felt that the good life was to be found in the villages and on the soil. In part this was a reaction to an equally romantic approach to industrialization which saw in the acquisition of a steel mill the essential elements of national prestige and symbolic modernization, whether the mill could compete internationally or not. But the romantic ruralists have never been able to show how a country can develop by concentrating on agriculture alone. As we have learned more about the mutually supporting interrelationships among the different sectors of a developing economy, the pragmatic realists have come increasingly to recognize that whatever happens to the labor force, productivity must rise rapidly in both industry and agriculture if either is to realize its full potential.

The validity of this proposition is borne out by the history of the developed countries, all of which grew simultaneously in agriculture and industry. The United States, the United Kingdom, Western Europe, and Japan all underwent agricultural transformation along with their industrial expansion. In the initially relatively empty countries like the United States, this was accomplished mainly by bringing more land under cultivation. Technological improvements were focused on reducing labor requirements per unit of output, so that individuals were farming more land, rather than getting higher yields per acre. Dramatic increases in yields per acre did not take place until the 1940's. At the other extreme is Japan, which at the time of its take-off in the 19th century was already very short of land and had a relatively abundant supply of agricultural manpower. Here yields increased steadily from very early in the development process, though even in Japan the greatest increases in output per acre have occurred since World War II. The only important historical exception to the rule that industrial growth requires a simultaneous expansion in agricultural output is the Soviet Union. Before World War I, Russia was a major exporter of food grains. This export surplus, rather than any success with agricultural modernization, provided the cushion which permitted industrial expansion in

the inter-war period. The exhaustion of this export surplus has generated a major concern with agricultural productivity in the Soviet Union in recent years.

Population and Food

The reasons why development depends on agricultural growth are familiar, but in appraising the importance of agricultural modernization, it may be worthwhile to review these reasons briefly. The first and most familiar has to do with the population explosion. The world's population is now growing each year at approximately the rate at which it grew each century until about 1600, namely 2 to 3 per cent. This means that merely to maintain present per capita food consumption levels requires an expansion in world food supplies of 2 or 3 per cent per year. This expansion can no longer be achieved, as it has been earlier in history, by moving the new population onto new land. As population growth accelerates, the supply of cultivable but uncultivated land is shrinking to the vanishing point. Also, many parts of the underdeveloped world suffer from severe undernourishment. In some areas this takes the form of gross calorie intakes which are too low to supply the energy requirements of an active population. For example, India's caloric intake is only two-thirds that of the United States. It has been estimated that it would take an average increase of about 10 per cent in the per capita calories available to the underdeveloped countries to bring their energy supplies up to minimum acceptable levels.

Perhaps more important, the average diet in most of the underdeveloped world is grossly deficient in protein. Recent biological research has documented the fact that these protein deficiencies result not only in danger to health and physical well being but cause permanent impairment of mental capacity as well. The production of proteins in the conventional animal forms of milk, eggs and meat requires several times as much grain per calorie of human consumption as the direct use of grain for human food. Thus, to bring world nutrition up to minimally tolerable standards, food and feed grain availability in the underdeveloped countries must increase for some decades by substantially more than population.

The economic reflection of this nutritional requirement is to be found in the fact that in low income countries the population will spend the major part of any increase in incomes on additional purchases of food. The income elasticity of demand for food – the per-

centage increase in food purchases which can be expected to result from a 1 per cent increase in per capita income – is between 0.5 and 0.8 in the low income countries, with the higher figure generally associated with the lower incomes. Thus the higher the per capita rate of growth in gross national product to which the underdeveloped countries aspire, the higher the rate of growth in effective food demand which they must expect. In Japan during the decade of the 1950's when income was growing extraordinarily rapidly the increase in food demand per capita amounted to 4.4 per cent per year.

Even if population control is successfully promoted it is likely that the population of the underdeveloped countries will continue to grow at a minimum rate of 2 to 3 per cent per year for the next couple of decades. This implies an equal rate of growth in food consumption just to keep nutritional standards where they are now. If these countries aspire to a rate of growth of per capita incomes of 3 or 4 per cent per year, the additional food demand which this will generate will be another 2 or 3 per cent. Taking these factors together it is clear that the underdeveloped countries must achieve a minimum rate of growth of food availability of at least 5 per cent per year if they are to meet even the more modest of their targets of development expressed in terms of growth rates of GNP. This minimum target of a 5 per cent rate of growth in agricultural availabilities must be borne in mind when we come a little later to an appraisal of the adequacy of the performance of the underdeveloped countries in the agricultural sector over the last fifteen years.

So far we have concentrated on the role of agriculture in supplying the food which a population with incomes rising from expanded industrial activity will demand. There is another way of looking at the interdependence of agriculture and industry. An important sector of industry, representing a larger fraction of all industry in underdeveloped countries than in developed countries, is dependent for its operation on agricultural raw materials. This includes not only food processing but such industries as textiles, leather and rubber products, paper, tobacco, and beverages. The United Nations has estimated that in 1958 industries dependent on agricultural raw materials accounted for 51 per cent of the value added and 64 per cent of the employment in all manufacturing in the underdeveloped countries.[1] These industries and their associated raw material requirements grow at rates substantially higher than those of the gross

[1] United Nations. *The Growth of World Industry 1938–1961: International Analyses and Tables.* New York, 1965, p. 320–327.

national product as a whole. This reinforces our previous conclusion that the availability of agricultural commodities must grow faster the higher the targets are set for industrial growth.

That food and other agricultural availabilities must rise by at least 5 per cent each year to support an adequate rate of growth does not of course mean necessarily that agricultural output in each underdeveloped country must grow at this rate. For any particular country the growth in its agricultural requirements could be met in part by a rising level of imports. Developed countries as a group have very much higher levels of agricultural productivity than the underdeveloped countries and several of the big developed countries are now producing surpluses of agricultural commodities for export. But the surpluses likely to be available from the developed countries as a group could physically meet only a small fraction of the growing requirements for agricultural products of the underdeveloped world over the next couple of decades if the ambitions of the underdeveloped countries are to be even partially met. Take the United States as a case in point. The heavy shipments in recent years under the Food for Peace program have already sharply reduced our surplus availabilities. The President has announced that whereas until recently our agricultural surpluses were in large part a by-product of domestic price support programs, for the future these surpluses will be available for the underdeveloped countries only to the extent that we decide to use our resources to produce for this purpose.

Even if it were physically possible to meet the growing food requirements of the underdeveloped world through increased production in the developed countries, an attempt to solve the problem this way would be economically irrational and in all probability economically impossible. It would require either a wholly unrealistic expansion of foreign aid or the allocation to food imports of scarce foreign exchange resources which the underdeveloped countries desperately need to buy the plant and equipment for their industrialization. If the increase in food requirements of the underdeveloped countries is not met primarily by an increase in the output of these countries as a group, their development is very likely to be choked off by the diversion to food imports of the foreign exchange they so urgently require for other development purposes. In the long run some of them can hope to increase their export earnings from sales abroad of the products which industrialization makes possible, but the growth of these very industries requires in its early stages very large imports of capital goods and equipment. Some of the smaller underdeveloped countries particularly favored with exportable raw material

resources like oil may be able to meet their growing food requirements through imports, but this will certainly not be possible for the underdeveloped world as a whole or for the larger countries which hold the bulk of its people. We are left with the conclusion that on the average the underdeveloped countries require a sustained rate of growth of agricultural output of more than 5 per cent a year for some time to come if they are to have any chance of meeting their other development objectives.

This essentially economic argument is reinforced by social and political considerations. The majority of the population of the underdeveloped world is now dependent on agriculture, and however rapidly industry expands this will continue to be true for several decades. In spite of an energetic search for labor-intensive industrial activities, the employment potential of industry in most of the underdeveloped world is not promising. In India factory industry contributes 12 to 15 per cent of the national income but employs only 2 per cent of the labor force. Thus for some time to come the population of the underdeveloped countries will inevitably remain predominantly rural. If the benefits of development are to be extended equitably to all major sectors of the populations of these countries, increases in rural productivity will have to play an important part. With the spread of rural education and the rapid extension of the mass media into the countryside, the revolution of rising expectations is not confined to the cities. If rural incomes do not rise, these countries will be subjected to growing social and political strains which could bring progress and development to a halt.

THE RURAL MARKET FOR INDUSTRY

A final consideration is that the growth of domestic industry requires the expansion of markets for its product. This market will be limited if it is confined to the urban sector, which, however rapidly it grows, will remain for some time a small fraction of the population of these countries. But the market can extend into the countryside only if rural productivity and purchasing power expand. While it is as unlikely that the growing labor force can be absorbed in direct agricultural employment as it is that it can be taken up in urban industry, rising levels of agricultural productivity and incomes can lead to substantial increases in employment in rural activities supporting agriculture. Some of these, like marketing, distribution, packaging, and supplying of inputs and credit, will auto-

matically expand as rural production rises. Others, including such public-works activities as terracing, water control, construction and maintenance of local roads, must be organized by governments or local communities as part of an expanded program of rural investment. Finally, as the money incomes of farmers rise, other kinds of small scale service and commercial activities for which subsistence farmers cannot pay begin to be economically viable in the countryside.

Thus the performance of agriculture in at least the larger of the underdeveloped countries is of vital concern not only to those interested in rural development but also to anyone committed to the promotion of sustained national economic development.

To summarize this discussion of the dependence of national development on agricultural growth, we may review the various ways in which a laggard agriculture may slow the growth process. In the first place, since agricultural product is such a large fraction of total output, static agriculture exerts a powerful statistical drag in the averaging process by which overall growth rates are computed. More serious are the linkages through which deficiencies in agricultural output act to inhibit growth in the rest of the economy. If for a variety of reasons there are forces, governmental or private, stimulating a high rate of growth in the non-agricultural sector, there will be a rapidly swelling demand for agricultural products. This results both from the demands of industry for agricultural raw materials and from the demands of the non-agricultural population to spend their expanding incomes in considerable part to improve their diets. If domestic supplies are not forthcoming to meet these new demands one of a number of chain reactions will be set in motion, or some combination of all of them.

If foreign exchange for agricultural imports or some form of aid such as Food for Peace is not available to fill the gap there will be upward pressure on agricultural prices. If no policy measures are adopted to limit the resulting inflation, the rise in agricultural prices which are the main component in the cost of living in low-income countries will set in motion increases in wages, government expenditures, and other costs which will expand money incomes and thus the demand for agricultural products still further. The inflation will become cumulative and accelerate with all the resulting distortions in the economy until something is done to stop it.

If conventional monetary and fiscal measures are adopted to restrict the supply of credit and raise taxation to bring the inflation

under control, investment will be choked off and growth in the non-agricultural sector brought to a halt. Non-agricultural growth can continue under these circumstances only as long as the resulting income increases are heavily concentrated in the upper income segment of the population where the income elasticity of demand for food is very low. Few modern political systems can survive the inequities attendant upon this process.

Alternatively, if the government is determined to keep the cost of living to the urban and rural masses low, it may resort to price control and rationing of foodstuffs. This cannot, of course, solve the problem of an overall shortage of food, but it is likely in addition to have secondary effects which will slow non-agricultural growth still further. The scarcest resource in most underdeveloped countries is managerial and administrative talent. Price control and rationing schemes are very expensive in this critical resource. They divert the skills and energies of competent administrators from production-promoting activities to the sterile task of attempting to spread an inadequate food supply more equitably. In the process, growth in industry and social overhead suffers.

If policy makers attempt to escape this dilemma by meeting the gap between the demand for and the supply of agricultural products by expanded imports, another chain reaction is set in motion which binds non-agricultural growth from another direction. Under the best of circumstances foreign exchange is chronically short in developing countries at the take-off stage. If significant amounts of whatever is available are diverted to the purchase of food and fibre from abroad, industrial expansion will be brought to a halt by shortages of raw materials, spare parts, and capital equipment. Precisely how this occurs will depend on the nature of the foreign trade and exchange mechanism, but if more of the available foreign exchange must go for food, that available for essential industrial purposes will be restricted whether by rising costs, low availability of licenses, or some other way.

There is an escape from this dilemma which has fortunately been available to many underdeveloped countries over the past few years and has made possible continued industrial growth in spite of lagging agriculture. The United States and some other developed countries have made available agricultural products on concessional terms in a fashion which has been essentially non-competitive with other sources of foreign exchange from either trade or aid. This has permitted food and fibre availabilities to expand in the underdevel-

oped world more rapidly than agricultural production. But this method of meeting the gap is not an acceptable long-term solution from the point of view of either donors or recipients. As the surpluses in the donor countries disappear, they will be decreasingly willing to supply food aid in growing volume. The recipients are already showing signs of distress at being dependent for anything as critical as food on what amounts to international charity, which may have political strings tied to it and which in any case is subject to interruption at the whim of the donor. We are left with the conclusion that unless the growth rates in agriculture in the underdeveloped world can be markedly accelerated, recent trends of growth in gross national products cannot be maintained, let alone stepped up.

The Need for Industrial Growth

The other aspect of the mutual interdependence of agricultural and industrial development is of course that adequate growth in agricultural productivity is in most cases impossible without a simultaneous growth in industrial output. There are many reasons why this is so. In the first place, as we shall see later in this volume, rapid agricultural growth in the more crowded of the underdeveloped countries can be achieved only if per acre yields can be multiplied severalfold from their present levels. This in turn requires transforming traditional agriculture which uses very limited inputs purchased from industry into a more modern commercial form in which the typical farm becomes a business enterprise purchasing large quantities of fertilizer, pesticides, tools, pumps, and other inputs, and utilizing much larger quantities of transport, power, water, and other public utilities. Some of these industrial inputs into modern agriculture can be imported, but at least for the larger underdeveloped countries foreign exchange limitations require that a major part of the new commercial requirements of agriculture be supplied from domestic sources.

Second, the fact that to raise yields the farmer must buy much larger quantities of purchased inputs means that he must sell his products for cash. This in turn means that there must be a rapidly expanding money demand for agricultural output which is most likely to be sparked by urban-industrial development. Unless nonagricultural incomes are rising rapidly, the expanded trade between agriculture and industry required for agricultural modernization cannot take place.

Third, powerful economic incentives are needed to induce the predominantly subsistence farmer to plunge into the risky business of commercial farming. An expanded money income will be attractive to him only if he can use that income to buy the manufactured goods he wants on favorable terms. This will be possible only if the economy contains a flourishing industrial sector able to take advantage of substantial economies of scale in both manufacture and marketing. One of the problems in some underdeveloped countries is that government efforts to keep the urban costs of living down through price control on agricultural products combined with tariff protection for domestic industry have turned the terms of trade between agriculture and industry rather sharply against the former and thus discouraged the development of commercial agriculture. If a farmer sees that the prices of the industrial products are rising, while the price he can get for a cash crop remains low, he has less incentive to go into commercial farming. The remedy for this situation is to pay more attention to industrial development. In Chapter 4 we discuss a number of the ways in which farming can be made more profitable. Since this is a book about agriculture this is not the place to go into industrial promotion in detail, but it is important for national planners to recognize the pervasive interdependencies between these two sectors and to be aware that rapid growth in either cannot take place without productivity increases in both.

Finally, it is important to bear in mind that increases in per capita incomes in agriculture, which are necessary to permit marginal savings rates to rise, cannot be easily brought about without a significant expansion of non-agricultural employment opportunities to drain off some of the surplus population now dependent on the land in many parts of the underdeveloped world. Agriculture can escape from the low-income trap characterized by low saving and investment and consequent stagnant productivity only if the rest of the economy is moving forward vigorously.

THE RECENT RECORD OF AGRICULTURE

The burden of this chapter is that agriculture must do significantly better if development is not to be stopped in its tracks. Before looking more deeply at what this involves, which is the subject of the rest of this book, we should set the stage with a brief review of how it has been doing over the past fifteen or twenty years. For a number of reasons generalizations about the post-war

record of agriculture in the underdeveloped countries are exceedingly dangerous. In the first place variations from year to year due to weather are so large that one's conclusions depend on which years one is comparing. For the principal grains, performance through 1963 or 1964 looks much better than it does if 1965 and 1966 are included, since bad weather in Asia and elsewhere has produced a setback in the last two years. Secondly, the range of performance is very wide among countries, with Israel sustaining a fantastic 10 per cent annual growth rate for fifteen years while Jordan's crop output has actually fallen over the same period. Finally the differences are great among different commodities in each region, with sugar more than doubling in non-communist Asia since the war, while jute and soybeans have hardly increased at all in the same region.

A careful study of 26 developing countries has been conducted by the Economic Research Service of the U.S. Department of Agriculture.[2] With the above qualifications in mind we can summarize their principal findings. In terms of aggregate output the record is much better than is frequently assumed. Of the 26 countries, 12 with a population about one quarter of the total had compounded rates of increase in crop output of more than 4 per cent per year. These rates surpassed those ever achieved by the now economically advanced countries during comparable periods of time. Within countries there have been districts or regions which have turned in outstanding records. We examine four of these success stories and the reasons for them in Chapter 8. On the other hand, the Food and Agricultural Organization (FAO) reports that for the underdeveloped countries as a whole per capita food production through 1965/66 has stayed about constant.[3] This gives the impression that agriculture has barely held its own. The reconciliation of these two superficially contradictory notions of agricultural performance is to be found in the wholly unprecedented population surge of the last two decades. The growth of agricultural output has averaged for the whole underdeveloped world a little less than 3 per cent per year for the past twenty years. This is a very respectable performance. Unfortunately population has been growing at about the same rate leaving the

[2] *Changes in Agriculture in 26 Developing Nations 1948 to 1963.* Foreign Agricultural Economic Report No. 27, Economic Research Service U.S. Department of Agriculture. Washington, D.C., 1965.

[3] *The State of Food and Agriculture 1966.* Food and Agriculture Organization of the United Nations, Rome, 1966.

world, like the Red Queen in *Alice in Wonderland,* running quite fast to stay in the same place.

The point is not that on the whole the underdeveloped world has done badly in agriculture, nor, as some prophets of doom have been asserting, that we face mass starvation if present trends continue. What is true is that the underdeveloped world can neither improve its nutrition nor achieve its general economic goals unless agricultural performance can be improved about twice as fast as it has been in recent years. How this could be done will be the topic of the balance of this volume.

CHAPTER TWO

The Nature of the Problem

Anyone wishing to devise a program for increasing agricultural productivity in the underdeveloped countries must bear in mind some general characteristics of agricultural enterprise wherever it is conducted, some preconditions to be met by the society at large if any such program is to succeed, and some policy implications of these characteristics and preconditions.

It is our purpose in this chapter to review briefly these characteristics, preconditions, and policy issues of agricultural programs in order to highlight the context of more specific functional and geographic discussions in later chapters. Little here will be new or unfamiliar to students of agriculture. But truths regarded as too simple or obvious to need restatement are often among the most neglected propositions in the development of policy proposals.

Characteristics of Agriculture

In spite of its diversity, small-scale annual crop agriculture has several common features throughout the underdeveloped world. Our first task is to find a satisfactory classification or checklist of the principal factors affecting agricultural productivity that we can use to ensure that in both diagnosis and prescription for any particular situation attention will be paid to all its relevant aspects. Since there is an extraordinary degree of interdependence and interaction among all the factors affecting agriculture, any classification is bound to cut across some important relationships. Moreover, any classification of continuous and interdependent phenomena must to some degree be arbitrary. Nevertheless some systematic division of the problem is necessary, and for this purpose we use the classification outlined in Table 1. It divides the factors affecting agricultural development into five major categories—physical input factors, economic factors, organizational factors, cultural and motivational factors, and knowledge factors—each of which is divided into a series of subcategories. We hold no special brief for the virtues of this as opposed to any alternative classification, but we are reason-

ably satisfied that it is comprehensive in the sense that everything that has a significant impact on agricultural productivity finds a place somewhere in the system.

Within each major category of factors affecting agriculture some limited generalization is possible. It is the function of the succeeding chapters to elaborate these middle-level generalizations more fully, but a few examples will illustrate the point. For instance for all types of agriculture, unlike industry, the major physical inputs are similar. Agriculture everywhere needs water, and in many parts of the world an improvement in water control over what nature provides – including added amounts, better timing, better distribution, and the removal of excess through proper drainage – offers major opportunities for productivity increases. Similarly the big problems in increasing the supply of plant nutrients come down primarily to three major factors – nitrogen, potash, and phosphorous – whatever the crop and its location. With respect to the economic environment, all commercial farming, whatever is grown and wherever it takes place, must be profitable; there must be markets for both inputs and outputs reachable by the farmer; all farming is time-consuming and requires some credit; and, in most types of farming, innovation is inhibited by the high risks associated with the adoption of new practices, some of which can be reduced by appropriate governmental policies. All modern farming requires higher levels of knowledge, education, and training than those required by traditional agriculture. Common elements among the organizational, cultural and motivational factors cut across the endless variety of particular agricultural situations.

Nonetheless, right down the list of factors, agriculture is characterized by an extraordinary degree of variation in its specific requirements for efficient production from crop to crop, from country to country, and from locality to locality within larger regions. Variations in agriculture are much greater than the place-to-place variations in the processes for steel making, textile manufacture, machine tools, and the like. The planner's task would be easier if it were possible to lay down some powerful general rules about priorities, sequences, policy emphases, and organizational structures that could be applied without much modification to any agricultural region. Unfortunately we are convinced that this cannot be done. Agriculture is practiced in the underdeveloped world under an enormous range of climatic conditions, from the rainy tropics of Africa to the arid lands of the Middle East. Associated with these variations in climate are variations in soils that enormously influence optimal

TABLE 1. CLASSIFICATION OF FACTORS AFFECTING AGRICULTURAL DEVELOPMENT

Physical Input Factors

1. Nonhuman physical inputs
   a. Land
   b. Climate
   c. Seeds
   d. Water
   e. Fertilizer
   f. Pesticides
   g. Structures
   h. Work animals
   i. Other animals
   j. Tools and machinery
   k. Fuel and power other than animal power
2. Labor

Economic Factors

1. Transport, storage, processing, and marketing facilities for products
2. Facilities for the supply and distribution of inputs, including credit
3. Input prices, including interest rates
4. Product prices, including prices of consumer goods
5. Taxes, subsidies, quotas

Organizational Factors

1. Land tenure
2. Farm size and legal form
3. General government services and policies
4. Voluntary and statutory farmers' organizations for:
   a. Coordinating physical input use, e.g., irrigation associations, tractor stations
   b. Economic services, e.g., purchase, sale, credit associations and cooperatives
   c. Social services, e.g., health centers, schools, family planning centers
   d. Local government
   e. Diffusion of knowledge, e.g., adult education classes, youth clubs

Cultural and Motivational Factors

1. Integration of agricultural institutions, practices, and values within the culture and society of the nation
2. Public administration factors, structure, values, mode of operation of the bureaucracy
3. Social structure, cultural values, and dynamics of peasant communities
4. Processes of sociocultural change, barriers, and motivations in the innovative sequence, functional harmony or disharmony in society as its constituent parts change

Knowledge Factors

1. Organization of basic and applied research
2. Diffusion of knowledge relating to:
   a. Technical knowledge, e.g., agronomy, plant genetics, soil science, water management, agricultural engineering, pest control, home technology
   b. Economic knowledge, e.g., land economics, general economics, farm management
   c. Policy, e.g., politics, public administration, planning
   d. General education, e.g., literacy, adult education, mass communication

water management, nutrient requirements, needed crop varieties, and a host of other factors. In some places a modification of land tenure seems a first prerequisite to any advance along other fronts, while in other areas land is reasonably widely and securely held by owner-cultivators in plots of a size that can be efficient. Although the organizational management of agriculture is a critical limitation in a great many places, there are areas, like Malaysia, where the organizational problem is less urgent than many others. In large parts of the underdeveloped world the problem can be described as one of improved management of existing farms, while in considerable sections of Africa, for instance, units that can be described as farms scarcely exist. More basic knowledge of plant science is needed everywhere, but in some areas existing knowledge is so far ahead of average practice that further research is a long-term goal, and in other areas we scarcely have the biological knowledge to know what to do to get any agricultural program started.

Taking all five of our major categories of factors into account, the range of diversity is so great that even though some general principles apply very widely, their application in particular situations cannot be by blanket rule but must be based upon the tailoring of a program to meet the detailed diagnosis of each particular locality. A program even for a single crop like rice requires fundamental adaptation to the circumstances of the place where it is to be applied.

THE INTERACTIONS AMONG DIFFERENT FACTORS

We cannot appraise the consequences of a number of factors in our classification by looking at each one separately and then summing the results. The interdependencies among the factors are so strong that the effects of a package of factors are likely to be very different from the sum of the effects of each one applied by itself. This is true within a broad category such as physical inputs. Additional fertilizer without water control may have little result, and the consequences of more water may be very modest if additional nutrients are not supplied. If both are supplied together, existing crop varieties that do as well as any others in the absence of water and fertilizer may not benefit as much from these new inputs as new varieties specifically tailored to water and nutrient availability; yield on existing varieties may even be reduced by added water or fertilizer. Insects and diseases that are unimportant under existing practices may multiply dangerously under irrigated and fertilized conditions and require new measures of control.

Even a single physical input involves many nonphysical factors. The effective use of fertilizer, for example, requires economic incentives, better distribution, and extension services to instruct the farmers in its use. Similarly, the best organization of marketing may depend on what kinds of farmers' organizations are to be set up for water control; or effective credit institutions may be most usefully linked to arrangements for the supply of fertilizer and seed. Not only the kind but the depth of education and training of farmers, extension workers, experiment station personnel, and the like will depend upon the complexity of the farming operations implied by cropping patterns, input utilization, and improvement of plant varieties. As we shall see later in this book, the interdependence of the factors affecting the farm enterprise has profound and general implications for the organization of programs for the promotion of agricultural productivity.

Another characteristic of agriculture that conditions what we can do to improve it is the extraordinary number and dispersion of decision-making units whose behavior must be changed if this sector is to be modernized. Unless agriculture is industrialized on a massive scale – and with isolated exceptions this seems to us neither feasible nor desirable – any program of change must affect the knowledge, motivations, and voluntary behavior of many millions of independent entrepreneurs. Farm decision makers are widely scattered geographically, they vary enormously in economic status and potential, they cover a wide political spectrum, they are subject even within one country to a considerable variety of institutional connections, and they exhibit a widely varying pattern of attitudes and motivations. By contrast, managerial control in industry and social overhead facilities are highly concentrated, and the development of a reasonably effective industrial labor force is infinitely simpler and more manageable than the building of a modern community of farmers. The characteristic agricultural need for unusually complex and extensive organizational and administrative arrangements poses an acute dilemma for societies whose scarcest resource is often organizational and administrative talent.

This last characteristic of widely dispersed decision making, taken together with the enormous variability of local conditions, implies another requirement for the organization of governmental services to agriculture that in practice is very seldom adequately met. This requirement is effective two-way communication in the administrative process, with information passing efficiently from the farmer up

through the bureaucratic hierarchy as well as down to him from ministries, research stations, and the like. It is now standard doctrine that such two-way communication is necessary for the effective operation of any administrative system, but it is both much more important and much more difficult to achieve in agriculture than in industry because of the decentralization and variability of local circumstances of farming.

Another complication arises from the fact that the modernization of agriculture in many countries requires shifting each small farm unit from a relatively simple pattern of producing a few traditional crops with few if any purchased inputs to a multiple enterprise with many interrelated products and inputs. At a later stage, commercialization may lead the individual farmer to specialize in one product, but initially multicropping, rotation, and the introduction of fertilizer, water, new seed, and pest control enormously increase the complexity of farm management and multiply many times the problems of education, training, extension, and organization.

THE NEED FOR SOCIAL CONTROLS

The traditional method on which many societies have relied to achieve some consistency and complementarity in the decisions of large numbers of independent units which characterize agriculture has been through the operation of a price and market mechanism. In most of the underdeveloped world the traditional farmer, even when he has some commercial operations, engages in a minimum of socially organized collaborative activities beyond the family. But some aspects of modernized agriculture, such as water management and control, effective insect and disease control, the use of equipment too large for ownership by a small farmer, and some aspects of marketing require the coordination of farm decisions through more explicitly social mechanisms supplementing the atomistic processes of the market.

Several of these characteristics have a further implication: Sustained growth in agricultural output requires technical, economic, attitudinal, and political transformations of the whole structure of rural society that cannot be brought about quickly. A single decision can, with appropriate outside help, lead quite rapidly to the building of a dam, railway, factory, or sewage plant. But the transformation of traditional agriculture requires a series of interlocking changes in so many different aspects of rural life that a perspective of decades is

required. This does not mean that some things cannot be done quickly. We cite later in this book numerous instances of measures with potentially rapid payoff. But the introduction into the rural economy of innovations that will ensure sustained growth requires patience and very steady purpose.

Finally, in most underdeveloped countries an intangible characteristic of agriculture that poses barriers to its modernization is that it is conceived of as a low-status occupation. If agriculture is to be effectively modernized, it must attract the attention of a significant number of the brightest, most imaginative, most innovative, and most ambitious members of the rural community. This is true both in farming and in such farm-related activities as research, extension, cooperatives, and marketing. But these are precisely the individuals in underdeveloped societies who are most likely to identify farming with traditional drudgery and see their only potential for mobility, self-improvement, and exciting challenge in an escape from farming to industry and urban life. Even though in many underdeveloped countries the widely held view that there is a surplus population in the countryside is valid in the aggregate, there is no surplus of the energetic and innovative types who alone can take the lead in the modernization of agriculture. Development programs must deal with this problem of raising the status and challenge of agriculture.

Preconditions for Agricultural Development

A large number of conditions outside the realm of agricultural policy itself, even when that policy is very broadly defined to include research, education, marketing and price policy, rural organizations and administration, and the like, must be at least minimally met if any program to expand agricultural productivity is to have even a marginal chance of success. Perhaps the first and least tangible of these conditions is that a will to develop agriculture must be present in the minds of at least some of the national and local leadership. There must be more than merely a verbal recognition of the importance of this sector. Because of the characteristics outlined in the preceding section, the amount of administrative time and attention that must be given to agriculture is out of all proportion to its relative financial requirements. Yet its low status inhibits the leadership in many countries from devoting to it the energies required. Effective programs of development once begun can reinforce this

will, but there is a substantial lower threshold of leadership motivation without which no program, however skillfully designed in detail, has much chance of taking hold.

A second requirement is at least some modicum of political stability and continuity in a country undertaking agricultural development programs. This is of course required for the effectiveness of development programs of any sort, but is perhaps peculiarly necessary for agriculture because of two of the characteristics of agriculture outlined in the previous section, namely that it involves the participation of very large numbers of people in decision making and that modernizing traditional agriculture requires time horizons not of months or years but of decades. One should not exaggerate the minimal degree of political stability and continuity required for at least some progress in the rural sector. A good many underdeveloped countries probably exhibit this minimum, but there are certainly a number where its absence makes the prospects bleak, however fully the other requirements are satisfied.

A third requirement is at least a minimal corps of administrative and organizational talent and competence. (We say a good deal in Chapter 6 about how to expand this resource to meet the very large needs of agricultural programs.) In agriculture, unlike some branches of industry and social overhead, an indigenous administrative and organizational base of at least a limited sort is absolutely essential. A steel plant, a railway system, a mining enterprise can be launched in an underdeveloped country largely or entirely with expatriate administration and management, with the breeding of an indigenous corps of managers postponed to a later date. The same can be done in isolated instances with industrialized plantation-type agriculture, but for the bulk of peasant-type agriculture it is impossible.

This implies a fourth requirement: the existence of at least a few nationals trained in agriculture before an effective program can be launched. One of their first tasks will be a training program to expand this corps at an adequate rate, but without the seed corn of at least a small group of indigenous professionals, an action program cannot even be started. Again, most underdeveloped countries probably meet these minimal initial requirements in getting started, but in some countries the numbers are so small as hardly to provide a viable nucleus.

Fifth, as emphasized in Chapter 1, there must be expanding markets for the products of agriculture if an agricultural development

program is to have any chance of success. In specialized crops these may be export markets, but the basic demand for the foodstuffs emerging from increased farm production must come from the economies of the underdeveloped countries themselves. Rising urban demand plays a necessary catalytic role in the commercialization of agriculture, which means that incomes outside the agricultural sector must be expanding. Again, in much of the underdeveloped world, progress has recently been more promising in industry and social overhead than in agriculture. Although this condition does not appear impossible for many countries to meet, we state it to raise a warning flag that a diversion of resources into agriculture sufficiently massive to interrupt growth in other sectors of the economy could well be self-defeating.

CAPITAL NEEDS

A sixth condition related to the preceding and implying a similar conclusion is that both domestic and foreign resources must be available to supply the necessary capital inputs for agricultural modernization. Some underdeveloped countries like Ghana, Thailand, and Colombia have already developed a specialized foreign-exchange-earning export agriculture and may be able to finance the modernization of their food crop agriculture from the unstable earnings of the present export crops. And of course after modernization is well under way, a prosperous and rapidly growing diversified agriculture can readily supply its own capital requirements and even some excess for investment in other branches of activity. Agricultural development programs should be designed to promote self-sustaining growth in agriculture in this sense at the earliest possible date. Nonetheless in many countries, including some big ones like India, it is unlikely that traditional agriculture can transform and modernize itself in the early stages (including the supply of new inputs of fertilizer, water, and the like, the expansion of social overhead facilities for transportation and communication serving agriculture, and the establishment of educational facilities essential for agricultural advance) without an additional injection of resources from outside the agricultural sector.

The same conclusion holds in many cases when we turn our attention from overall capital requirements to the specific needs that can be met only from abroad. While agriculture seems at first blush to be less dependent for its success on adequate supplies of foreign exchange, the creation of an adequate supply of the inputs of water,

nutrients, pesticides, knowledge, and training, and the expansion of facilities for transporting, storing, and distributing agricultural products that modernization requires, place very heavy burdens on a country's foreign exchange resources. Again, those countries where traditional agriculture has been export-oriented may be able to meet these requirements from the foreign exchange that their own agriculture produces, but many will require either foreign aid or an industrial or extractive base with a high foreign-exchange-earning potential.

POLICY IMPLICATIONS

A number of policy implications follow from the above characteristics of agriculture and preconditions for its development. The first generalization concerns the application of generalizations to specific situations. The diversity of situations in which agriculture operates in the underdeveloped countries – physical, economic, institutional, and motivational – taken together with the pervasiveness of interdependence in any particular situation means that generalizations cannot be applied without adaptive research and experimentation. The biologists have taught us this with respect to crop varieties. The basic principles of breeding improved crop varieties are developed in the biological laboratory and are independent of their place of application. But few plant breeders would feel safe in recommending to a minister of agriculture that he should adopt for use throughout his country, or even in any particular region of it, a variety that has been highly successful elsewhere without an extensive series of field tests to determine its adaptation to local conditions of climate, soil, water and fertilizer availability, pest and weed prevalence, and so on.

This same principle of the need for adaptive research and experimentation under local conditions is fully as valid for manipulations of the economic environment, for organizational and institutional patterns, for the types and complexities of knowledge that can be absorbed by the local population, for education and training, and indeed for the whole package of interrelated activities that must constitute an agricultural program. The need for such adaptive research and experimentation outside the biological field is not yet well understood by those responsible for agricultural programs in the underdeveloped countries. They seek outside advice on what kinds of programs they should adopt, whereas the best advice that can be

given is that they should conduct pilot schemes and test the adaptability of ideas developed elsewhere for their own complex of local conditions. In what follows we cite a number of dilemmas without any clear indication of how to solve them. Viable solutions for a particular region can be found only by adaptive experiments in that region with careful evaluation to test the results. Examining such dilemmas, while producing no solutions, may direct attention to a series of hypotheses to be tested against local conditions.

ALLOCATING LIMITED RESOURCES

An important dilemma is that while on the one hand a great many things need to be done to make modern agriculture work, including the whole list of factors affecting productivity, and while many of these things require for their successful performance administrative and organizational attention from all levels of government, the human resources available to perform all these functions are exceedingly limited, and if too much is attempted at once, nothing will be done well. It is clear that the effective manipulation of all the variables that affect agricultural productivity in a way that would eliminate simultaneously over the whole country all the potential bottlenecks is beyond the capacity of most underdeveloped governments. Faced with this dilemma, what do they do?

One possible answer is to be found in a sequence of trial-and-error attempts. In a small region in which almost everything is missing, a quick diagnosis will suggest one or two critical bottlenecks or urgently felt needs, like the control of pest losses or the timing of water supplies. Administrative energies can initially be concentrated on breaking this bottleneck. As progress is made, complementary bottlenecks will appear, such for example as institutions to supply credit for the purchase of insecticides, or more extension agents to explain its proper use to the farmer. If the initial program is concentrated in a small district, and if at the start there exist administrative skills and resources to broaden the program as the need becomes apparent, diagnosis and remedy can proceed in sequence, adjusting the program in stages to the priority issues as they are revealed. The alternative procedure, more logical but perhaps less feasible, is to conduct a local survey attempting to diagnose in advance all the elements required, their interconnections, and their relative priorities and then to design a complete package program to deal with them.

Choice between these techniques will have to be made locally, and experiments with both are to be encouraged. The one thing of

which we are fairly confident is that organizational experiments of this sort should initially be on a small scale and not national in scope. It is clear from the interdependence of all the factors affecting agriculture that the nationwide manipulation of one variable, like price policy or ample fertilizer supplies or adequate water or a good credit system, is likely by itself in most cases to produce very limited results at best. Where the prospects are very promising for a high immediate payoff from such single-factor programs, they may be tried on a national scale, but in such cases, administrative resources should be kept available to follow up quickly with programs of complementary factors as they turn out to be needed. For the longer run it is probably wise to adopt the principle of attempting to install fairly complete packages in limited areas, either in sequence or all at once, rather than dealing nationwide with a few problems one at a time.

This leaves open a great many questions. How large should these packages be? Which elements in them deserve the most emphasis? How should they be designed and administered? How many should there be, and how rapidly can the number be expanded? Answers to all these questions will differ not only from country to country but also from region to region within countries. They can be found only by pilot study and experimentation. The early experiments will almost certainly involve much heavier inputs of manpower than could be quickly extended to whole regions, but if serious attention is paid to ways of reducing the manpower inputs in the future, such pilot programs can yield insights for national policy. Meanwhile more modest effects may be achievable by more widely diffused policies outside the package areas.

A further important question is how much diversification of crops and practices is desirable and feasible both nationally and in the individual farm unit. In many circumstances a higher degree of diversification, certainly nationally and frequently on the individual farm, will reduce risks and significantly increase the efficiency of farm operations. But to be done properly such diversification makes much heavier demands on the knowledge and education of the farmer and on the training and competence of the extension service that backs him up than do simpler types of agriculture. Again there is no general answer.

PRODUCTIVITY AND EQUITY

Another problem that characterizes many areas of development policy is rendered particularly acute in agriculture by some of the

conclusions we have already reached. It is the problem of balancing considerations of productivity and of equity. How far are the limited resources – economic, physical, and human – available to the government of an underdeveloped country to be used to promote the maximum possible increases in the output of its economy, and how far are they to be used to ensure an equitable distribution of the yields of that economy among its members and particularly among its underprivileged members? From what we have already said about the principle of concentration, it is clear that productivity will as a rule increase more rapidly if resources are concentrated on limited regions and within those regions possibly on limited numbers of people. Although this will not always be true, frequently those most likely successfully to adopt a package of inputs and practices yielding much higher returns will be those who have had some experience of success in the past and more than average resources to risk on innovations in the future. Concentrating resources on the more promising regions and individuals may therefore result in increasing rather than reducing the disparities between the more and the less fortunate.

Practical politicians faced with this dilemma tend to be pushed too far in the direction of sacrificing productivity for equity even though in the absence of significant increases in productivity more resources may never become available to improve the lot of the less fortunate. On the other hand, concentration on productivity at the expense of equity may violate deeply held social values and may also generate tensions within the society which make the continuation of the productivity-increasing programs difficult or impossible.

Fortunately the alternatives are not usually limited to an inequitable concentration on success by too few or an unproductive spreading of resources over too many. Concentration can be accompanied by measures to relieve inequities that may contribute to productivity rather than limit it. A notable example is the development of a rural public works program using primarily the abundant resource of unskilled rural labor for projects like feeder roads or water distributaries. Such a program would contribute to productivity and provide employment for the least favored of the rural population – the landless laborers and those displaced from farming. This possibility is discussed further in the last part of Chapter 4.

These alternatives illustrate a broader range of problems having to do with conflicts between economic goals and social and political goals that may be in competition with them. In a book on agricultural productivity it is not possible to analyze these conflicts exhaus-

tively or to suggest principles for their resolution, but one must be continuously aware that such conflicts may exist and must be taken into account. How far they exist in fact and how far they are only fears in the minds of politicians can frequently be tested effectively only by experiments on a small scale, where the potential threat to deeply held social and political goals is much less apparent than when the experiment is tried on a national scale.

Another dilemma that confronts any government attempting to organize an agricultural program to affect large numbers of cultivators is: how far to attempt by a variety of devices to generate voluntary and active participation by cultivators in the program and how far to rely on paternalistic and coercive measures to compel their performance. The former choice is much more desirable in human and political terms but may be much slower, much more costly, and at least in the short term somewhat less effective. Indeed in certain situations like complex water management or pest and disease control, coercion may be necessary, for a minority of non-cooperators may threaten the success of a whole program.

SHORT- AND LONG-TERM EFFORTS

A dilemma that underlies many of the points made earlier is the one posed by the desperate urgency in many countries for raising production as quickly as possible and the need in most areas for much further study and experiment (physical, economic, organizational, psychocultural, and intellectual) before launching major and time-consuming reorganizations of agriculture. In most situations, whatever is done in the short run, it is likely that the thorough transformation of agriculture required to produce radically improved performance will take decades to bring about. On the other hand, with population pressing and with industrialization being limited in its growth by the agricultural bottleneck in many places, political leaders who want to survive cannot wait decades. A statesmanlike posture is of course to pay attention to both short-term and long-term measures. We are convinced that in many cases significant if limited improvements in agricultural performance can be brought about with measures that can be taken fairly promptly. However, unless longer-term measures are initiated at once to expand our basic knowledge of the factors involved and unless experiments with more radical alterations in the whole structure and pattern of traditional agriculture are made, the short-term measures will very soon, in a matter of a few years, bump against ceilings of performance

that cannot then be broken through without a protracted delay in the pace of advance. We have tried in this book to divide our recommendations into short-term and long-term ones, but the balance between these must be determined in each case by weighing the immediate urgencies against longer-term needs.

A final generalization is that the fundamental problem confronting agriculture is not so much the adoption and spread of any particular set of physical inputs or of economic arrangements or of organizational patterns or of research institutions; rather it is to build into the whole agricultural process – from the farmer to the university research institute, from the field extension agent to the minister of agriculture – an attitude of experiment, trial and error, continued innovation, and adaptation of new ideas. Once this innovative and experimental spirit permeates the rural community, the farm supply and marketing industries, the bureaucracy, and the intellectual institutions concerned with agriculture, the gulf between city and country, between universities and farmers, between ministers and village officials will be bridged, and continuing development can be built into the system. Without this change in attitudes, improvements in performance, though they may occur, will be halting and transitory and thus will provide no lasting contribution to agricultural productivity.

CHAPTER THREE

The Physical Requirements

Five major physical inputs may be purchased by farmers either individually or collectively: chemical fertilizers – primarily nitrogen (N), phosphate (P_2O_5), and potash (K_2O);[1] water; improved plant varieties; tools and machines; and pesticides. Since the proper application of these inputs to what is now regarded as the world's supply of arable land could multiply agricultural yields by several fold, we shall not take up ways of farming land not now considered arable.

Since the effectiveness of one physical input depends on the presence of others, a combination or package of new inputs usually produces greater yields than the sum of those inputs applied singly. For example, in experiments performed in Indiana a doubling of water availability with no fertilizer raised corn yields by only about 16 per cent. The addition of 50 pounds of nitrogen per acre with no increase in water increased yields by 161 per cent. When the two new inputs were combined – a doubled supply of water and 50 pounds of nitrogen – the yield was increased by 242 per cent.

When economic yields are calculated, it may be that no single input will repay its cost, whereas a package of new inputs would be highly profitable. Or, even if profitable, the margin of gain on a single input may be too small, given the risks that characterize farming, to lead the farmer to adopt it. A theoretical (but not untypical) illustration would be: $1 invested in irrigation without other inputs might return $2 in added yield; the same return might be gained on each of the other inputs alone. But $1 invested in a package of those same inputs might return $5 or even $10.

Some physical inputs introduced singly, for instance pest control or fertilizer, may yield important gains. Yet though these are cases of single inputs, they are not single-factor programs, for each involves a wide range of nonphysical factors. Pest control may require a high

[1] Commonly referred to as N, P and K, rather than by their exact chemical formulae.

degree of social organization; and getting fertilizer on farmers' fields involves complex problems of administration, distribution, knowledge, and economic policy.

Thus even with a single physical input we are dealing with a package of factors. Since adding other physical inputs makes the package more complicated, the policymaker designing the package is confronted with a difficult series of choices between optimum feasibility and optimum return. The simplest package is the easiest to design and administer and the easiest for farmers to adopt. But, as we have seen, it usually offers the least return. The addition of new inputs places an increasing strain on both the farmer and the innovating agency. Thus, as the package becomes potentially more profitable, its chances of being successfully introduced are likely to diminish. The optimum package of physical inputs (varying of course from place to place) will be the one providing the best compromise between potential yield and likelihood of effective adoption.

Chemical Fertilizer

Among the physical inputs, chemical fertilizer, in the opinion of many, offers the best hope of a quick and major increase in agricultural production.[2] How great and how certain that gain may be are issues still under dispute. Some feel that fertilizer alone could produce great gains over the next decade, before other physical inputs become limiting, while another group believes that the evidence is still insufficient to justify concentration on fertilizer at present.

The policies proposed here are, on the whole, in line with the first school of thought: we favor a major effort on fertilizer. With present technology, it should be possible with fertilizer alone (among physical inputs) to raise food production enough to guarantee the food supply of the underdeveloped world for several years – remember-

[2] Organic fertilizer (manure, green manure, composting, etc.) in many places makes an important contribution to soil fertility and therefore to productivity. Since it is an on-farm product, it does not fall under the heading of purchasable or off-farm inputs. We do not take up organic fertilizer in this discussion because it is our belief that, despite the contribution it now makes, the increased yields we are seeking require a supply of soil nutrients far beyond the apparent potential of organic methods of fertilization. This of course does not mean that the potential of improved organic fertilization should be neglected.

ing always that this cannot be achieved without great advances in the non-physical inputs such as organization. At some point, and experts differ on how soon it would be, another ceiling would be reached; fertilizer would not be able to raise yields any further in the absence of other physical inputs. But precious time would have been bought. This time must be used to set in motion the complementary activities that eventually would make possible, through other inputs, further advances in production.

Fertilizer adds to the natural supply of plant nutrients in the soil. Crops have fairly definite nutrient needs. A 1,000 pound per acre crop of paddy rice, for example, needs 30 pounds of nitrogen, 10 of phosphate, and 25 of potash. To double the yield, the supply of nutrients available to the plant must be doubled. Most of the soils of the tropics and subtropics supply only about 30 pounds of nitrogen a year. This limits the yield of most cereals to 800–1,200 pounds per acre, compared to 2,500 pounds or more in many temperate zones. Lack of nutrients, rather than the nature of existing crop varieties, appears to be the limiting factor in areas that have enough water. The experience of a minority of farmers in underdeveloped areas indicates that, with sufficient nutrients, the existing varieties may produce much more than the present average yields.

The experience of the FAO indicates that substantial yield increases (at least 50 per cent) are often possible with the single input of fertilizer. Since 1961 the FAO has run extensive fertilizer trials and demonstrations in fifteen nations in the Middle East, West Africa, and northern Latin America. The trials were conducted mainly on food crops on farmers' fields and without other inputs. The most economic fertilizer treatments sometimes produced increases of 50–80 per cent; rarely was the increase less than 30 per cent or more than 100 per cent. A tentative conclusion is that fertilizer may be able to increase the production of the major food crops in important areas of the three continents by about 50 per cent where water is not a limiting factor.

Fertilizer is little used in the underdeveloped world. As Table 2 shows, Asia, Africa, and Latin America consume far less fertilizer than do the developed nations. Fertilizer consumption is closely correlated to per acre yields and to the general level of development. The range among nations is extremely wide. Denmark, for example, consumes 64 pounds of nitrogen per capita per year, India only 1.7 pounds, and China 1.2 pounds. The underdeveloped nations produce

TABLE 2. FERTILIZER CONSUMPTION 1964/65

	Total Consumption[1] *(1,000 Metric Tons)*	*Kilograms per hectare*[2]	*Kilograms per person*
Asia (except mainland China and Japan)	2,230	6.5	2.2
Africa	910	3.6	3.0
Latin America	1,658	17.3	7.1
Soviet Union	4,464	19.4	19.6
Japan	1,840	306.7	19.0
Europe	16,880	111.0	38.3
U.S. and Canada	10,602	46.7	50.3

[1] The sum of weights of nitrogen, phosphate, and potash.
[2] of arable land and land under permanent crops.
Source: Food and Agriculture Organization, *Production Yearbook 1965*, Rome, 1966.

even less fertilizer than the little they consume. As Table 3 shows, their production in 1964/65 supplied only about half of their own low consumption.

The use of fertilizer in the underdeveloped world is inhibited by many factors. The cost/yield ratio is in general less favorable to the farmer than in the developed nations. The farmer in underdeveloped nations typically pays more for fertilizer and gets a lower price for his crop. The result is that the same physical return – ten pounds of crop for one pound of fertilizer, let us say – may be economic for

TABLE 3. PRODUCTION, IMPORTS AND CONSUMPTION, OF FERTILIZER IN THE UNDERDEVELOPED WORLD, 1964/65
(in million metric tons of plant nutrients)

	Production	*Net Imports*	*Consumption*
Asia (except mainland China and Japan)	1.05	1.18	2.23
Africa	0.53	0.38	0.91
Latin America	0.76	0.90	1.66

Source: Food and Agriculture Organization, *Production Yearbook 1965*, Rome, 1966.

one farmer but not for the other. This is especially true of food crops; as a consequence, fertilizer is used more on higher-priced cash crops than on food crops.

The cost of producing fertilizer in the underdeveloped world is comparatively high. In India, for example, production costs are 50 per cent higher than in the United States. Capital costs, involving imported machinery, are high, the lowest cost methods of production are not always used, and inefficient management frequently increases operating costs.

Distribution is probably the most critical bottleneck. Getting the fertilizer from factory or dock to the farmer requires extensive planning and a complex infrastructure. The fertilizer must be transported to the region where it will be used and stockpiled well in advance, which requires adequate transportation facilities and local storage places. Timing is crucial; the fertilizer is of no use if it arrives after the time when it must be applied. The critical factors here are physical infrastructure and effective management, both of which are frequently lacking.

The farmer suffers from other inhibitions. If he is a tenant rather than an owner, he has, under most tenancy conditions, less to gain from fertilizer. A typical tenancy arrangement forces the farmer to pay for all inputs and deliver half the crop to the landlord; so the tenant who uses fertilizer loses half the return on his investment. Even when it is proven to be profitable, the farmer may be as slow to adopt fertilizer as he is to try any innovation requiring a cash outlay, for risks are reluctantly taken by people living close to the level of starvation. Subsistence farming without purchased inputs has the great virtue of being relatively safe. The farmer is largely independent of the outside world. Once he takes up fertilizer, he puts himself at the mercy of a distribution system that may supply him with the wrong fertilizer or none at all.

Knowledge also is lacking. In one sense this means that the farmer does not receive existing information – from salesmen or extension services – about the use of fertilizer. In another sense the information itself is lacking, particularly on the local level. Indiscriminately applied, fertilizer may actually reduce yields. The optimum dose and blend of fertilizer vary widely with soils and crops. The blend usually contains at least two of the three major ingredients – N, P, and K – but the proportions will differ according to local needs. Nor is crop response proportionate to the amount of fertilizer applied: that is, doubling the dose does not necessarily double the extra yield. Only a particular dose may be economic; less, or more, may not

pay off. Extensive local trials alone can determine how much to use of what mixture.

FUTURE FERTILIZER REQUIREMENTS OF DEVELOPING COUNTRIES

At present rates of growth, the populations of Africa, Latin America and Asia (excluding Japan and mainland China) will increase by 400 million in the decade 1960–70. By 1980, the population of those areas will be 900 million larger than it was in 1960.

Agricultural production has been approximately static in these areas during the past five years. Clearly a considerable rise in production will be needed to feed the added population even at the present low levels of nutrition. To continue to provide one pound of grain per person per day in 1980 will require a grain production of about 150,000,000 tons in addition to the 1960/61 production of 231,000,000 tons. This represents an increase of 65 per cent in only twenty years – a high target indeed, and six of those years have already passed with little or no progress.

Consumption of about 30 pounds of plant nutrients per capita per year in Asia, Africa, and Latin America is a necessity for attaining even minimal food production in 1980. Table 4 shows the tonnage of fertilizer required in each area in 1970 corresponding to 20 pounds per person per year and in 1980 corresponding to 30 pounds per person per year. Meeting the 1980 goal would require a consumption of 30.7 million tons of plant nutrients, compared with three million tons in 1960/61.

TABLE 4. FUTURE FERTILIZER NEEDS AND ADDITIONAL GRAIN PRODUCTION OF UNDERDEVELOPED WORLD, 1970 AND 1980
(*in millions of metric tons*)

	Asia[1]	*Africa*	*Latin America*	*Total*
Fertilizer Needs for 1970 at 20 pounds per person[2]	10.4	2.9	2.7	16.0
Fertilizer Needs for 1980 at 30 pounds per person[2]	19.9	5.6	5.2	30.7
Additional Grain Production Resulting in 1980[3]	143	38	34	215

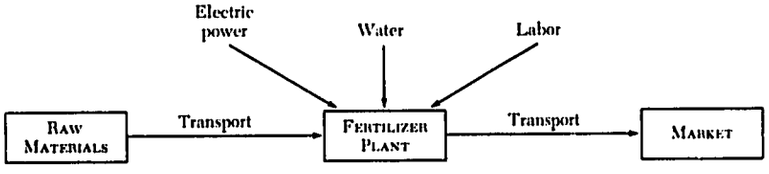
[1] Excluding mainland China and Japan.
[2] Projected population for 1970 and 1980 from UN Department of Economic and Social Affairs–Population Division, Future Population Estimates by Sex and Age. Nitrogen, phosphate, and potash are assumed to be supplied in a ratio of 16:8:6.
[3] Calculated as 10 tons of grain per ton of plant nutrient.

The projected 30.7 million tons of plant nutrients used in 1980 would correspond at best to 215 million tons of grain above 1962/63 production. This calculation assumes a return of ten pounds of grain for one pound of plant nutrient, a higher rate than is now being achieved in many nations. Thus the grain target will not be met unless other physical inputs, such as seeds and water, are supplied along with the nonphysical inputs of knowledge and organization. Additional grain production of 215 million tons would be somewhat more than enough to maintain grain consumption at one pound per capita per day in 1980, but part of the fertilizer would be needed for other foods and non-food crops. Therefore the fertilizer consumption goal of 30 pounds per capita per year is a minimum.

LONG-RANGE DEVELOPMENT OF FERTILIZER SUPPLIES

While the 1970 fertilizer requirements of Asia, Africa, and Latin America will have to be met largely by imports, the larger countries should plan to become self-sufficient in fertilizers by 1980. Smaller countries could establish a large fertilizer plant cooperatively on a regional basis. West Africa, Central America, and the Middle East seem to be areas where such an approach is clearly desirable. On the basis of 30 pounds of plant nutrients per person per year, a country of 5,000,000 population, the minimum for a basic factory, would need 75,000 tons of plant nutrients per year. Fertilizer plants become progressively cheaper in both capital and operating costs as they become larger, but the additional gain beyond 150,000 to 200,000 tons in annual capacity is slight.

The economic feasibility of a fertilizer plant is determined largely by, in addition to its size, its location with respect to raw materials, markets, and transportation. Secondary factors include electric power, water, and labor supply. These factors may be illustrated by the following diagram:



A plant may be located at the raw materials, at the market, or anywhere between the raw materials and the market. The delivered cost of the raw materials is the important criterion, and since water trans-

port is relatively cheap, coastal locations are preferable. Raw materials need not be available in the nation itself. For example, Japan has the third largest fertilizer industry in the world, after the United States and the Soviet Union, and yet Japan imports all her raw materials. Capital costs for fertilizer plants in terms of annual capacity are approximately:

Per 100,000 tons N	$15,000,000–$20,000,000
Per 100,000 tons P	$ 5,000,000–$10,000,000
Per 100,000 tons K	No processing required
Per 100,000 tons mixed fertilizer[a]	$ 1,000,000–$ 1,500,000

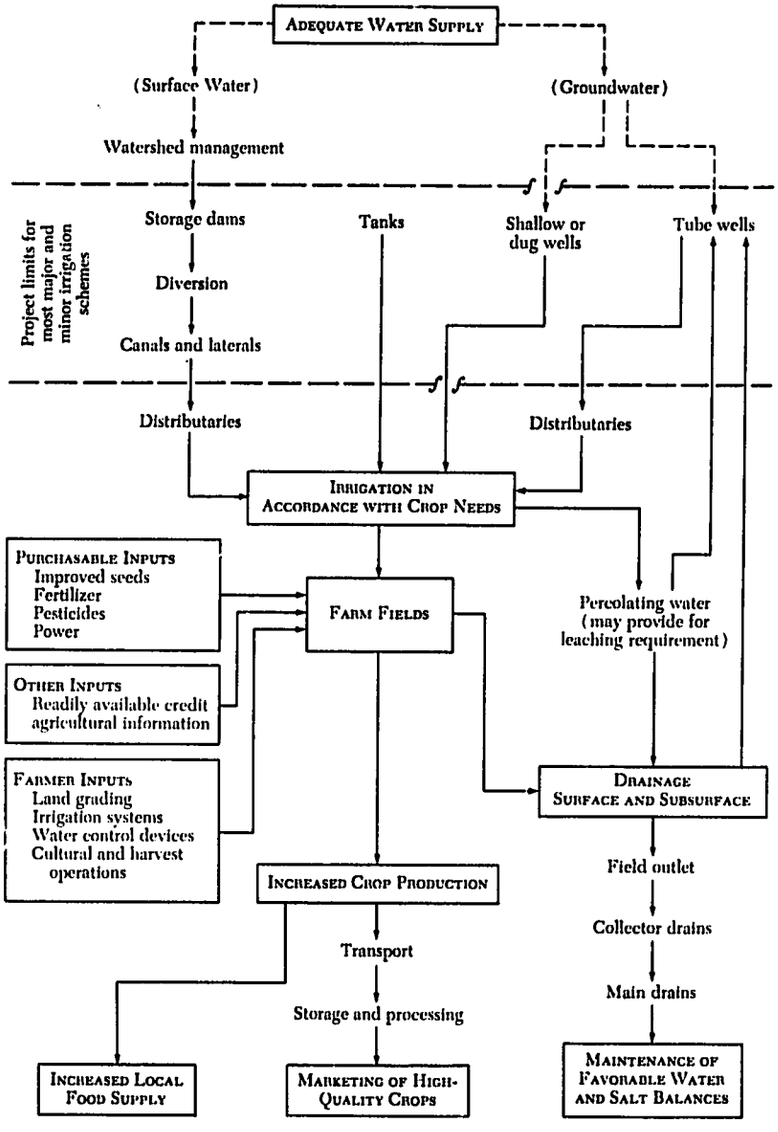
[a] Cost of blending plant in addition to cost of producing fertilizers.

Construction of factories with a capacity to produce 30,000,000 tons of plant nutrients (16:8:6 ratio among the three types) in Asia, Africa, and Latin America would cost about $4 billion – one tenth the cost of putting a man on the moon.

Cheaper fertilizer may be obtained from recently built nitrogen factories in areas with a plentiful supply of cheap natural gas, such as the Persian Gulf, North Africa, Venezuela, and Trinidad. Plants established there could ship liquid ammonia (made with gas, air and water) to the consuming countries for conversion to solid nitrogen fertilizer, or they could make and ship solid fertilizers directly. Typical of such a large low-cost nitrogen plant is a new factory in Trinidad with a capacity of 150,000 tons that uses the cheap natural gas available there.

Another approach to cheaper fertilizer is to ship liquefied natural gas from gas surplus areas such as the Persian Gulf to places with a large fertilizer demand, like India. Local blending can lessen the difficulty of distribution. Bulk blending at the local warehousing sites can be a cheap means of combining the three varieties of fertilizer in any proportion that local soils or crops require. Such blending plants are small, efficient, and low in capital costs (about $100,000). They function equally well with imported or locally made materials, as long as the particle sizes are roughly equal. The blended product can be sold in bulk or in bags. Bulk blending makes possible the decentralization of storage and the accumulation of stock in the agricultural regions well ahead of the rush season. The plant provides a local supply base upon which the farmer can rely and thereby increases the chances that he will get the mix he needs when he needs it.

CHART 1. PHYSICAL INPUTS AND PROCESSES FOR IRRIGATION AGRICULTURE



Irrigation Water

Irrigation agriculture is the most productive kind of farming devised by man. It is also the most expensive. The capital costs of providing irrigation water are commonly so large that they cannot be fully met by the farmers themselves but must be spread throughout the economy.

Because of its high capital and operating costs, irrigation agriculture must be intensive. The yields per unit of water must be high, which usually requires an intensive use of land. If the water is spread on too much land, a great part of it will be lost through seepage and useless evapotranspiration. To maintain the high yields required by the high cost of irrigation agriculture, all other factors of production – fertilizers, pest control, high-yield seeds, and effective farm practices – must be used to full advantage. The major factors in water supply through irrigation are illustrated in Chart 1 in this section. In many irrigation projects, attention has been concentrated too much on construction of central facilities (shown between the dotted lines on the chart) and too little on other aspects of water management.

WATER NEEDS OF CROPS

Four factors – the potential evapotranspiration during the growing season, the permeability of the soil, the quality of the water, and the salt tolerance of the crops – determine the amount of irrigation water that must be applied for maximum crop yields in a particular situation. Whether the supply of these amounts is economic in a given situation is of course a different question, depending on the cost of water supply, the value of the crops to be produced, and the consequences for yields of less than optimal water inputs.

Evapotranspiration depends largely on the length of the growing season and the amount of sunlight. The amount of water required by different crops varies widely. Winter wheat in West Pakistan, for example, needs about 14 inches of water to meet the evapotranspiration requirement, while sugar cane and cotton, because of their long growing season, which extends from early spring through the high water-demanding months of summer to late fall, may demand 50 or 60 inches.

In sandy soils much of the water will be lost by downward percolation, and hence for any particular crop the amount of water required will be far greater than the evapotranspiration requirement. In a tight silty or clayey soil little water will be lost by downward percolation.

Sufficient additional water must be supplied to prevent salt accumulation in the soil. The dissolved salts can be carried off in the return flows or leached into the underground. With salty irrigation water and crops of low salt tolerance, a great deal more water must be applied to the fields than is required to meet the evapotranspiration potential. For crops of medium salt tolerance, such as maize and sugar cane, irrigated with water containing 2,000 parts per million of salt, the excess of applied water must be about 70 per cent over the evapotranspiration requirement.

SOURCES OF IRRIGATION WATER

Water for irrigation can be gathered from a large or infertile area to be used on a relatively small fertile area, or water in excess during the wet season can be stored for use during dry parts of the year. It may be stored either on the surface behind dams or bunds, or underground, usually in porous alluvium or limestone.

Without storage the farmers are dependent for their irrigation water on variable and unpredictable river flows, which cannot be timed to coincide with crop growing seasons. If water can be stored, the farmers are able to use it when their crops require it; consequently they can plant crops whose growing season does not match the rhythm of the rivers. When the river flows are peaked during part of the growing season, a combined use of river flows and stored waters makes it possible to use more river water, and a larger area can be planted and harvested. Stored water can also be used during low river stages and thus double or triple cropping becomes possible on the same fields.

SHORT-TERM WATER DEVELOPMENT

Small-scale water improvements can be accomplished by the farmers themselves. Such improvements include the construction of earthen tanks and small hillside dams, the construction of water-spreading structures to increase recharge of the underground aquifer, digging and rigging shallow wells, the construction of water courses to carry the water from government canal systems and from wells to farm fields, building of terraces, bunds, and water guidance structures to conserve rain water, and digging drainage ditches to carry off irrigation return flows.

Larger structures require engineering design and special equipment and often help from the government. These include tube wells, which must be drilled and fitted with casing, pumps, and motors by

specialists; collector drains for return flows; underground drains, such as tile drains, ditches, and sumps for salt and water table control; and small deep wells for village drinking water. Reclamation of saline or sodium damaged soils by leaching with surplus irrigation waters may require government guidance. The farmers also need instruction in land leveling, in construction of water distribution systems in their fields, and in proper irrigation practices.

Tube wells can be privately constructed, owned, and operated, but the spacing, the depth, and the quantity of water pumped must be controlled by the government through licensing arrangements, and the quality of the pumped water must be continuously monitored to prevent salt damage. Tube wells on a large-scale pattern involving hundreds of thousands or even millions of acres must as a rule be government projects.

LARGE-SCALE WATER DEVELOPMENT

Large-scale water development, involving the construction of dams on major rivers, diversion structures, and canal systems, takes many years and often involves bringing new lands under cultivation. Planning farm villages and building roads, schools, marketing, storage, and other facilities must be part of the project, as well as the preparation of the new lands for cultivation. The costs are usually so high that only the national government can bear them.

Attention is often focused on the construction of major public works while other aspects are neglected. These include conservation of the watershed above the dam and provision for drainage to carry off canal leakage and irrigation return flows. Neglect of the watershed may mean that silt from rapid erosion will quickly fill up the reservoir behind the dam so that its life will be limited to a few decades. Erosion control can double or triple the life of the reservoir.

Many irrigation projects fail because of lack of drainage. Excess water, instead of draining off the irrigated fields, simply seeps underground and raises the water table. The water table may also be raised by canal leakage. When the underground water has risen sufficiently, water is sucked up by capillary action and evaporates at the surface, a residue of salt accumulates in the fields, and the productivity of the land gradually diminishes. Drainage of excess water to control salinity is as important in the long run as providing the water in the first place. This principle was neglected in the Indus plain in West Pakistan, the world's largest irrigation scheme, and as a result large areas have been lost to production.

Government pricing and distribution policies for irrigation water often are not designed to lead to optimum agricultural development. Instead of water being supplied on the demand of the farmer it is provided on a regular schedule to each farmer in sequence. The price he pays is based not on the amount of water used but on the area of land irrigated. Ideally water would be made available to the individual farmer in the quantities and at the time he needs it, and he would be charged for the amount of water he actually used. At a minimum the farmer needs better advance information than he often gets on the probable availability of water for the coming growing season.

ALREADY CULTIVATED LAND RATHER THAN NEW LAND

Greater benefit in relation to costs will be obtained in many cases from an increase in the productivity of already cultivated land than by attempting to bring new lands under cultivation. This is particularly true in monsoon tropical areas where one very wet season is succeeded by seven to nine months of dry season. In the Ganges-Brahmaputra Plain of India and East Pakistan, productivity could be increased several fold by developing irrigation water supplies so that two or three crops could be grown instead of the single monsoon crop.

The common assumption that agriculture is such a simple occupation that the farmer can easily move to new lands and start a wholly new productive economy is far from realistic. Pilot agricultural trials need to be undertaken where extensive development of new land is planned in order to gain the knowledge and the experience necessary for profitable operation. Such pilot trials can often be made with ground water available locally in the area or by diverting a portion of river flows through small inundation canals. These pilot trials of irrigation practices are an illustration of the principle of local experimentation.

VALUE OF SHORT-TERM, SMALL-SCALE PROJECTS

Water storage for irrigation is one of the principal justifications for such spectacular public works as great dams and aqueducts. These structures, though popular with local politicians and project-minded administrators of aid-giving agencies, and necessary to take full advantage of river flows, require a high degree of centralized operation and a uniform timing of water supplies over large areas. This seriously inhibits the flexibility and freedom of individual farmers to

vary their cropping patterns. Major irrigation works place a strain on both the villagers' social structure and the government apparatus that has at times proved unbearable. Villagers may refuse the new forms of social organization (in land tenure, for example) required by irrigation; the government may prove unable to devise and impose the necessary new patterns of behavior.

Underground storage of water and withdrawal by means of wells give far more freedom. The drama and impressiveness of large-scale projects should not blind policy-makers to the great potential of less conspicuous projects.

Improved Seed

Superior varieties of crops are fundamental to any program of supplying improved seeds. So long as only the common unimproved varieties are used, little profit is usually gained from giving special consideration to problems of seed supplies. Common seed for planting is available to the farmer within his own community, though exceptions are found among some of the vegetable and fodder crops whose seeds are not routinely harvested.

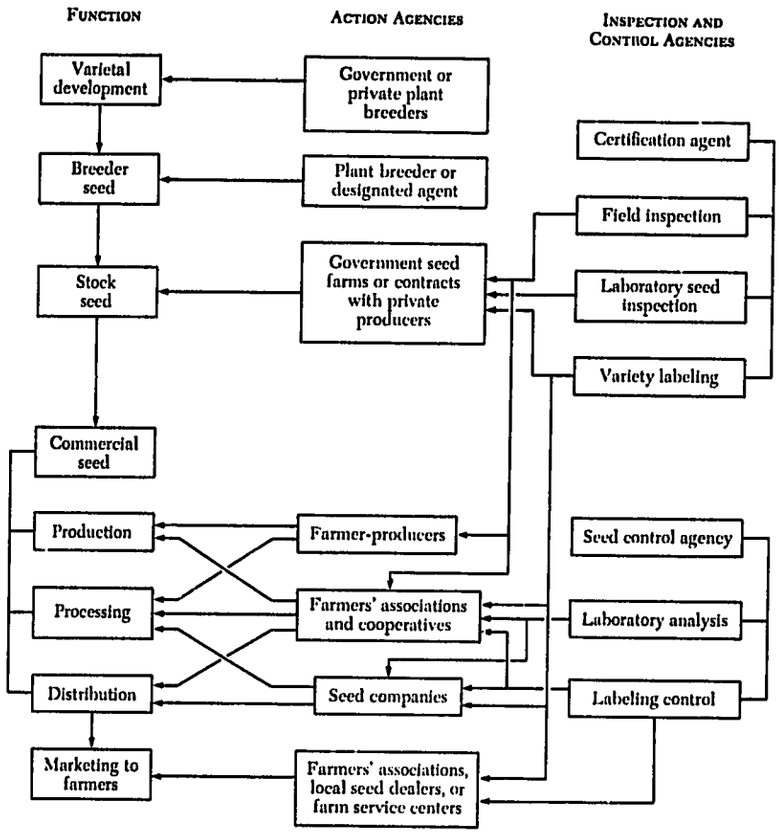
When a variety has been developed through selection or breeding and has proved superior, producing and distributing its seed become important factors. Improved varieties, however, are only superior with reference to a particular set of environmental circumstances. The best varieties for one region may be completely useless in another. A proven variety is superior because of genetic characteristics bred into it that give adaptation to specific conditions of soil and climate, high yielding capacity, resistance to drought or cold, resistance to diseases and insects, nutritive value, acceptability of taste and texture, desirable growth habit, and other characteristics that enable it to perform better than other varieties. However, highly improved varieties tend to be limited in their geographical adaptation and therefore limited in their potential distribution. The factors involved in the marketing of seeds are illustrated in Chart 2.

UNIQUE CHARACTERISTICS OF SEEDS

Because of the special characteristics of seeds, the requirements for their successful production and distribution are somewhat different from those of other purchasable inputs. Among these characteristics are the following:

1. The fundamental qualities of the variety can be maintained

CHART 2. THE CHAIN OF IMPROVED SEED MARKETING



only by the use of authentic planting stocks and careful production practices. Its characteristics cannot be assessed by research station tests, but only by the field performance of plants produced from the seed.

2. Seeds are living entities that require special procedures and handling in all steps of production, processing, storing, and distribution to ensure that the seed reaching the farmer will be viable.

3. Since the origin of farmer seed supplies is a small lot selected from existing seeds, it takes several generations to multiply the stocks from the original nucleus of breeder seed to the thousands or millions of pounds required by the farmers.

4. Seed-borne diseases and contaminants such as weed seeds will reduce the productivity of the crop.

METHODS OF REPRODUCTION

Crops vary widely in their methods of reproduction or seed multiplication.

Such crops as potatoes, sugar cane, and rubber are propagated by asexual or vegetative means, that is, by cuttings, budding, grafting, or tubers. Aside from mislabeling and mixing, the main precaution is to avoid contamination with systemic diseases such as viruses.

The naturally self-pollinated crops such as wheat, rice, and beans are relatively free from danger of contamination of the variety by natural cross-pollination. With sufficient care to prevent mixing, seed of varieties of this kind of crop can be easily reproduced through successive generations of the multiplication process.

The naturally cross-pollinated crops present special problems for seed production. To prevent genetic contamination from other varieties due to cross-pollination, seed fields of either open pollinated varieties or hybrids must be isolated by as much as one-fourth of a mile from other fields of the same crop. Furthermore, as the open-pollinated varieties are subject to genetic shift during reproduction, special precautions must be taken in selection and breeding to maintain the genetic integrity of the variety.

CLASSES OF SEED

Several classes of seed are generally recognized in the stages from the plant breeders' program to the farmers' fields. Breeder seed is maintained under rigidly exacting conditions and serves as a source for producing the stock seed. Stock seed in turn is used to produce the commercial seed that is distributed to farmers. Maintenance of an adequate supply of breeder seed is normally the task of the experiment station at which the variety was developed. In the case of proprietary varieties the company that owns the variety normally maintains the breeder seed. There must be an orderly program for multiplying the stock seed from the nucleus of breeder seed. This may be carried out by governmental seed farms, by individual farmer-producers under appropriate supervision, or by seed companies under contract with producers or in their own fields, also under supervision. Since any changes in genetic characteristics that occur during multiplication of the stock seed will be passed on to the

commercial seed produced from it, it is essential that great care be exercised during this stage.

SEED MARKETING

The major requirements for successful seed marketing procedures include:

1. Facilities for processing (including drying immediately after harvest), cleaning, grading, treating, and bagging.
2. Facilities for storage and distribution at the wholesale level.
3. Facilities within easy reach of individual farmers for the retail distribution of properly labeled seed of good quality. Because of the localized nature of varietal adaptation and of seed production, wholesale facilities may in some cases be less urgent. Individual farmers, cooperatives, or small seed firms may produce and sell to farmers in their areas.
4. A merchandizing and information program that takes the seed to the farmer.

Supervisory and control work should be carried out by establishing seed laws and seed quality standards with an enforcement agency, seed laboratories, and seed certification agencies.

TOOLS AND MACHINERY

Tools and machinery multiply the power of human muscle. They give the farmer greater control over his production environment and make possible new forms of cultivation and the farming of greater areas per farmer. Animal-drawn and motor-powered equipment are also used for transport. Improved hand tools are likely to be a useful input at the earliest stage of development; motor-powered machinery, with its much higher capital and operating costs, usually comes late in the process, though just when it should come is subject to debate.

TOOLS

Tools in most underdeveloped lands are few in number, crude, and seemingly inefficient. Since in some areas the only tools in use today are those used two thousand or more years ago, there would seem to be room for considerable improvement. Here again, however, technology is not easily transplanted. Many efforts to transplant tools have failed, often because the tool was designed for different conditions – metal plows that are effective on temperate-zone soils but not in the tropics are an example.

Yet opportunities exist for providing farmers with better tools. Adaptive research is needed, and it must take into account all the factors involved. The new tool must of course be tested by the farmers themselves. The innovating agency must determine whether the tool can be conveniently repaired in the village, whether its use clashes with the farmer's custom, and whether he has the skill needed to use it. Animal-drawn equipment must be adapted to the strength and bodily structure of the local animals. The most attractive innovations in tools would be cheap, simple to operate, and such that they could be maintained (and if possible made) in the village itself. These may be single inputs that can raise yields without forming part of a package.

The design and distribution of simple tools has not attracted much manufacturer interest. The long research time needed and the low profits to be gained make such tools commercially unattractive. Thus it is likely that at least the early stages of tool development will have to be carried out by the government. Once the tool has proved to be successful it may be desirable to interest private companies in its manufacture and distribution (including maintenance).

Some examples of promising areas of tool innovation are:

Plows. Bullock-drawn plows often fail to use the animal's potential power and do not prepare the soil as well as required for maximum yields. Different methods of hitching could increase the animal's effective power and therefore the depth of plowing, and in some cases it would then be possible to plow with one instead of two bullocks.

Harvesting implements. Sickles and scythes, little known in the tropics, are efficient for harvesting grains on small farms. They could replace straight-blade knives and the hand-picking of rice heads.

Threshing equipment. Machines operated by foot pedal (or motor), now used in Japan and Taiwan, are efficient for threshing on small farms. They could be useful in other countries where rice or wheat is grown.

Multipurpose equipment with rubber tires. A French-designed form of animal-drawn equipment called "tropiculture" has been successfully introduced in Senegal and Madagascar. It has a draw bar to which various implements – plows, disk, a lift – can be attached. Despite its many uses, the equipment has no nuts or bolts to be lost and is simple to maintain. It rides on rubber wheels. Rubber

wheels to replace traditional narrow wooden wheels are an attractive possibility in many areas. They greatly increase the range of the cart and the farmer's access to markets because they are easier for the animal to pull, and they avoid the damage done to roads by wooden wheels. Such rubber wheels can often be made from discarded automobile tires.

MACHINERY

When to introduce motor-powered machinery is a complex question. After a period of overhasty and often disastrous attempts to mechanize, the trend of thinking in many quarters has turned in the opposite direction, and it is often assumed that machines such as tractors have no place in most underdeveloped nations at the present stage. The argument is that these nations are short of capital but have abundant surplus labor (unemployed or underemployed); therefore an expensive labor-saving machine is not what they need.

This assumption needs to be re-examined. Machinery may sometimes be the only way to raise yields and, far from saving labor, such machines as tractors are often labor-complementary – that is, their use increases rather than decreases the demand for labor.

Two key factors here are planting dates and soil preparation. Multicropping may in some cases be possible only with powered machinery. This is true if planting dates are critically short or if the soil for the second crop cannot be prepared except by machine. Machinery often makes it possible for the farmer to prepare the soil better and to seed more precisely. Thus significant yield increases may require machinery even when surplus labor is available.

Often the time during which a crop must be planted for maximum yield is no more than a few days of the year. This time is the farmer's limiting factor; that he is underemployed much of the rest of the year is irrelevant, for he can plant only in those few days. This is a fairly common situation in the underdeveloped world. The use of a tractor at the planting season can break through that limiting factor. As to soil preparation, the ground may often be too hard to plow with animal-drawn equipment at the optimum time of year; only with machinery can planting dates be changed.

When machinery permits double cropping, or larger plantings of a crop such as rice that is labor intensive in other stages as well as planting, the effect is to increase the demand for labor. What happens is that the farmer's effective labor is increased at those key times when he is fully employed in any case. His larger crops then

require more labor at other times of the year. Another form of labor-complementary machinery is pumps for irrigation, which make possible more intensive cultivation and therefore raise the demand for labor.

Another consideration is that machines often replace draft animals. While many draft animals in underdeveloped countries now subsist largely on wastes or on the products of uncultivated land, land in some areas is used to grow feed for draft animals. If their tasks were mechanized, that land could be devoted to food crops or to grazing for meat animals. This consideration can be important in densely populated areas, where arable land is scarce and where people do not get enough protein in their diet.

Prestige is an important intangible. As noted earlier, one of the most subtle barriers to progress is the low status of agriculture. Farming is drudgery and it is "primitive"; the innovative people needed for its progress flee instead to the modern world of the city. Machines are a symbol of that modern world. The presence of tractors and other machines in rural areas may serve to demonstrate that being a farmer and being "modern" are not mutually exclusive, and thus the status of the farmer may be raised. Even if he does not have a tractor himself, he may see it as an eventual goal – his "horizon of the possible" is widened. A young farmer may stay and work for a tractor instead of emigrating to the city, and to get that tractor, with the status it symbolizes, he may be willing to innovate.

For all these reasons, mechanization must be examined in the light of the full range of issues involved, not summarily dismissed on the single and oversimplified issue of labor saving. However, the formidable problems it raises should not be underestimated, and a return to catastrophic policies of hasty mechanization would of course be foolish.

The question of status must be handled carefully, for if the proposed mechanization is uneconomic the return in status, and the effect on productive attitudes, may well prove illusory. Maintenance is a bottleneck that must be broken before any degree of mechanization becomes possible. Repair facilities usually do not exist; the supply of parts is erratic; mechanics are scarce; and, perhaps most important, farmers in underdeveloped nations have not grown up around machines and therefore do not understand such requirements as oiling that are familiar to people from mechanized cultures. Under these circumstances the life of the machine in the underdeveloped world will continue to be short, as it is today.

Nor are many individual small farmers going to be able to afford to own a tractor. Tractors may be provided by a government-operated station that gives custom service to the farmers, or they may be bought by farmer cooperatives (the latter being more likely to succeed if the cooperative is already a going concern). If the government station also provides drivers who perform the actual operations, maintenance is simplified since the station, not the farmer, is responsible for the care of the machines. Such tractor pools should be expected to run at a loss for one or more years until farmers become familiar with the potential uses of machinery.

The machines must also be adapted to local conditions. The innovating agency should be imaginative in choosing machines that are versatile in their potential use (tractors have proved useful for transport in East Pakistan, for example). Such secondary uses may make the difference between profit and loss. Machines developed only in temperate-zone climates, where ready maintenance is also available, are likely to break down quickly in tropical conditions. It may well be advisable to sacrifice some other assets, such as power, in order to produce a machine that is durable in the tropics.

PEST CONTROL

Pest control is the art of protecting crops and harvested farm products from being destroyed by disease or eaten by insects and rodents or choked by weeds.

Pest control in many situations could be valuable as a single physical input. Probably the best example is rat control. In India, one observer has estimated, there are about ten rats per person, and they eat an estimated 27,000,000 tons of food annually – one third of the country's production – either in the fields or in storage. Even if that estimate is far too high, the potential saving from rat control is enormous.

In West Africa an estimated 25 per cent of the food produced is lost to pests in storage. Cattle cannot be raised in large parts of Africa because of the tsetse fly, which carries sleeping sickness. These are cases for possible "early" uses of pesticides.

Pesticides interact strongly with other inputs in the later stages of agricultural development. The need for pesticides rises steeply as development proceeds, because the other inputs often create conditions that favor the growth of disease and pests.

Take, for example, an irrigation project to which fertilizer and improved crop varieties are added. Multicropping is now possible

where before only one annual crop was grown. This provides a year-round supply of plant life for disease and pests. Thicker foliage and solid stands of single varieties support more pests and make the entire wiping out of a crop more likely. In Egypt, in areas where multicropping has been achieved, army worms move from corn to sorghum and back again with the change in crops.

In these cases, pest control is a "late" input. The return on investment in pesticides is likely to rise rapidly after the other inputs are in use; and so does the potential danger of massive crop destruction. Pest control is likely to be an indispensable input in a package providing for intensive cultivation.

Since they are poisons, the use of some chemical pesticides involves dangers, which are likely to be much greater in underdeveloped nations where the rate of illiteracy is high, for the farmer cannot read the warnings attached to the package. Poisons designed, say, for rats may kill human beings or domestic animals; or pesticides applied to crops may upset a natural equilibrium by killing, along with the insects that feed on the crops, other insects that normally eat these pest insects. By destroying the second insect the pesticide application ensures that an increasing amount of pesticide will be needed. For some cotton crops the increasing need for pesticides has driven the cost of production beyond an economic return on the crop. The dangers involved in using poisons can be avoided where biological controls are possible. An example is the breeding and release of wasps that feed on the rhinoceros beetle that attacks coconuts in Africa and in the Pacific.

Pest control in many cases shares an important characteristic with major irrigation projects: the need for a high degree of social control. Many forms of pest control cannot be usefully adopted by a single farmer or even a majority within a community. This is true for combatting migratory insects and diseases that spread from one field to the next. In order for the pest to be successfully controlled, each farmer in the area must be convinced or coerced to join the program.

Widespread pest-control programs can be carried out by the government, and it can recover its costs fairly easily on export cash crops. When the cacao trees of Ghana were attacked by swollen shoot, the government carried out a compulsory control program, first by cutting down the stricken trees, later by spraying. The program was financed by an export tax on cacao. But with subsistence crops the government would be unable to recover its costs in this way.

A notable success in social mobilization was scored in the Taiwan-

ese campaign against rats. Before the campaign Taiwan lost between 150,000 and 200,000 metric tons of food annually to rats. The saving from the campaign is estimated at about 140,000 tons of food a year. The main problem was to secure popular cooperation in setting out rat poison and then to find out what had in fact been accomplished. The program was a voluntary one directed at communities rather than individuals. The government and the Joint Commission on Rural Reconstruction (JCRR) provided materials, and the community put up its labor. In 1956 the program was successfully tested in 14 communities. The following year 309 communities asked to participate. To find out if the rats were being killed, as well as to provide motivation for putting out the poison, the government offered a bounty for each rat tail turned in. In 1957 the farmers of Taiwan turned in 6.9 million rat tails. Since only about one in every four dead rats is found, this represented the extermination of about 27 million rats – more than half the island's rat population.

CHAPTER FOUR

The Economic Environment

In framing any policy for agricultural development, agricultural as well as industrial fundamentalism should be avoided. Some of the most chronic difficulties of agriculture can be effectively resolved only by developments in the nonagricultural sectors of the economy. On the other hand, the agricultural sector is too important to be left to itself while national planning concentrates on industrialization. Any plan for agriculture must, therefore, be designed and carried out as an integral part of planning for general economic development.

Measures to increase productivity may conflict with measures to realize other important objectives of policy, for example, equity in income distribution, self-sufficiency (independence from foreign aid at the very least, autarky at the very most), political stability, and fulfillment of wants such as education that are above the levels dictated by market tests. Economists need not restrict themselves to making productivity-oriented recommendations while only mentioning other objectives. They have to recognize the conflicts among objectives of public policy. In the area of agriculture the concentration of limited resources on a few regions that promise the greatest returns, or on large farms, may be desirable from the point of view of productivity but may also run counter to the objective of equity in the distribution of gains from growth. Economists should face such conflicts squarely and try to clarify and quantify the implications of feasible alternatives for various objectives. The allocation of funds should depend on both technology and tastes – on the technological possibilities that determine the rate at which gains in terms of one objective can be traded for gains in terms of the other, and the policymakers' tastes or value judgments that determine what sort of trades they are willing to make. Given a reasonable amount of data, economists can order alternatives according to their efficacy in realizing a number of objectives. In the discussion that follows both efficiency and nonefficiency objectives are kept in view.

This chapter focuses on the following aspects of agricultural policy: product and input price policy, credit policy, farm insurance

and market reform. We have also set out some considerations relevant to using surplus agricultural commodities imported under special arrangements, and to schemes for rural public works.

Current policies on all these subjects are in urgent need of review and revision. The relative importance, or priority, to be given to individual policy changes would depend on the particular situation of every country and on its political will and administrative capacity to make those changes. We believe it important to remember that, in order to obtain satisfactory rates of improvement in the living standard over the longer run, measures to increase food production must be coupled with measures to control population growth. The governments of poor countries should expand and improve the administrative efficiency of current population control programs, and they should also seriously consider such additional measures as legalization of abortion under specified conditions and the use of such newer cheap and effective techniques as the intrauterine devices.

PRICE POLICY

Not all farmers everywhere respond strongly to economic incentives. However, there is growing evidence that, with a minimum degree of monetization and the development of transport, a fairly large proportion of farmers do respond to these incentives in some aspects of their behavior. Thus, while all necessary technical and organizational measures should be taken to increase the physical outputs obtainable from given inputs, these measures should be combined with economic policies designed to take advantage of the price responsiveness of supply and factor demand wherever it is positive. In many situations the rate of absorption of new knowledge and inputs may depend critically on the price and risk milieu.

Any policy to improve the price milieu of developing agriculture should take into account and, if necessary, influence the following factors: the variability of agricultural prices, which affect the riskiness of farming; the relative prices of various crops, which affect the allocation of land and other inputs among crops; the ratio of the general level of agricultural product prices to the level of agricultural input prices; and the ratio of the general level of agricultural product prices to the general level of nonagricultural prices.

Although these price relationships are in theory distinct, any set of price regulation measures will simultaneously affect all of them to some extent. If, for example, the government succeeds in establish-

ing price floors for two or three major crops, downward price fluctuation will be restricted and relative prices, the output-input price ratio, and the terms of trade of agriculture will all be altered in some degree. Therefore price policies must be based on a consideration of their effects on all the key price relationships.

The desirability of price stability can hardly be disputed. Price fluctuations add immeasurably to the risks facing the cultivator and do not afford sufficient offsetting advantages to the community as a whole. A fall in the price of wheat between planting and harvesting or over a series of harvest years can render uneconomic an apparently profitable investment in fertilizer or pesticides. And the adverse effects of declines may not be balanced by gains from price increases of equal number and magnitude in later years because of the limited capital that most peasant farmers possess – hence the need for the administration of floor prices for a few selected crops. Price stability cannot, however, be willed by legislative fiat alone. An adequate warehouse and transportation network is required for stocking operations designed to reduce price fluctuation. Of course price stability need not, and should not, be absolute. Besides normal seasonal fluctuations which reflect carrying charges, flexibility should be allowed between fixed minima and maxima in order to remove some of the burdens of changes in demand and supply from the storage system.

An alternative to direct price stabilization from the viewpoint of reducing risk is a system of forward markets or "futures" markets (in which crops can be sold before harvest) that would enable the cultivator to ensure the price of at least a part of his crop prior to planting. But it should be remembered that futures markets in the more advanced countries have been of much more help to processors than to growers in reducing price risks. In any event the problems of making futures markets accessible to peasant farmers in the underdeveloped countries are so formidable that they rule out such markets in the immediate future.

Studies of the effects of changes in the relative prices of different agricultural products on the allocation of the existing stock of inputs among products show that farmers respond to changes in prices by redirecting their efforts in accordance with shifts in profitability. Therefore, insofar as it is desired to increase the output of a few important food and fiber crops by a transfer of inputs among competing crops, the objective can be realized through the manipulation of the relative prices of those competing crops. Today the shortages

of essential commodities like wheat, rice, and cotton are so acute in some countries that in addition to other measures it is essential to administer floor prices for these major crops both to stabilize their prices and to obtain some increases in output by improving their relative prices.

The fixing of floor prices requires technical studies and some experimental action. The floors at the very least should prevent price crashes in case significant output increases do materialize. Preferably they should cover the cultivating costs of at least the more efficient farmers using improved practices. If necessary they may include an incentive element over and above the cost of cultivation. The levels fixed will have to lie somewhere between the anticrash level and the cost of cultivation (with or without an incentive element), depending on the responsiveness of output. More investigation is needed to determine the magnitude of that response, either by examining reactions to price changes that in fact have taken place or by experimental manipulation in selected regions. Price floors should be held stable for several years – say, three – and should be adjustable or removable after each such period; and the government must make arrangements for direct purchase at the floor prices from farmers in a sufficient number of primary agricultural markets.

When we turn to the growth of the overall level of agricultural output rather than the output of individual crops, it is clear that the price ratio of outputs to inputs is as important as the relative prices of outputs, if not more so. Price ratios more favorable to cultivators can be brought about both by lowering the prices of inputs to the farmer and by raising output prices. Each course of action has its positive as well as its negative features.

The outstanding advantage of subsidizing purchasable inputs like fertilizers, pesticides, equipment, and livestock, rather than raising product prices, is that the cost of the subsidy program is directly related to the utilization of practices that increase productivity. The cost to the economy as a whole of increasing agricultural output is likely to be lower in the case of subsidies and can be borne through the tax system. More resources are available for development of the nonagricultural sectors of the economy and for other purposes; the government can avoid the political consequences of higher food and fiber prices to the nonfarm population; and, equally important, the cultivator must employ purchasable inputs to reap any advantage whatsoever from input subsidies. By contrast higher product prices add to the income of both noninnovators and innovators. This wind-

fall income may cancel out the incentive provided for increasing production by increasing the marginal preference for leisure relative to labor of at least some farmers.

The case for higher product prices can turn some of these same arguments to its advantage. The very fact that a program of input subsidies costs less than a program of product price supports means that the agricultural sector derives a smaller income from subsidies than from supports. This is an important consideration, for it can be argued that at current price relationships agriculture receives less than its "fair" share of the national income, and that a major obstacle to innovation in peasant agriculture is the lack of a capital cushion to absorb the added fluctuations in income produced by many innovations, such as fertilizer in areas dependent on variable weather. A second argument for higher product prices is that input subsidies are of no avail in situations in which increases in agricultural productivity come from additions of nonpurchasable inputs that are not complementary with purchasable inputs – for example, the farmer's labor in better cultivation, weeding, clearing, and local irrigation and drainage channels. Third, if the use of purchasable inputs is already widespread, the costs of input subsidies mount. In this case, since noninnovators (those already buying inputs) as well as innovators benefit, the argument for input subsidies on the ground that they do not increase the preference for leisure is weakened. If, on the other hand, the use of new inputs is not widespread, it is doubtful whether the mere cheapening of inputs will by itself induce more farmers to begin to use them.

No blanket preference can in our opinion be given either to general price supports or to input subsidies. The relative efficacy of the two means of improving the price ratio of outputs to inputs depends on the existing level of input use, the technological character of the measures necessary to increase productivity, the relative importance of low cost and provision of a cushion for risk-taking to the cultivator, and a value judgment about the distribution of incomes between the agricultural and nonagricultural sectors. All but the last can be resolved by specific empirical research in each country facing the choice between price supports and input subsidies, and even the question of rural-urban income distribution can be illuminated by such research.

A feasible price policy mix for the near future would, then, include floors for a few selected crops determined on the lines suggested; perhaps a program of subsidies for fixed as well as working capital

inputs; and an overall policy to prevent a serious deterioration of the rural sector's domestic terms of trade. As a part of such a policy it would be desirable to grant tariff protection to infant industries only when their output actually attains a certain proportion, say, 10 to 20 per cent, of the domestic demand. (Until that time subsidies might be granted.) This would prevent undue and premature increases in the prices of many industrial products.

Countries depending mainly on a single export crop would continue to need international commodity agreements for short-run price stability, but the provisions of these agreements must not jeopardize long-run price flexibility lest resources remain overcommitted to the crops even when demand conditions change.

Finally, the case for export subsidies on selected agricultural commodities exported by developing countries is as economically valid as that for industry protection. Properly designed subsidies should therefore not be frowned upon by international agencies.

CREDIT

Three kinds of production credit may be distinguished: short-term, for periods of a year or less; medium-term, for more than one but less than five years; and long-term credit, for five years or more. Any research on alternative means for providing agricultural credit should identify the three components of the gross interest charge – real interest, risk premium, and the cost of administration and collection. Quantitative comparisons of these elements will help improve the credit system.

To be most productive, short-term credit from official and cooperative sources should almost always be "supervised," that is, tied in with the farmer's performance. Loans should be granted on condition that the borrower agree to adopt a package of recommended inputs and practices. Loans should be made primarily on the basis of the increased production potential of the package rather than upon the security of land or other assets, so that credit will be accessible to tenants and small farmers as well as to larger farmers. As far as possible, loans should be made in kind, in the form of the actual inputs. Since official credit cannot possibly meet the full credit requirements of the agricultural sector, it should be channeled primarily to meet the financial needs of innovation.

In order to facilitate loan recoveries, the provision of credit may be linked with marketing. However, where marketing is undertaken

by a governmental or semiofficial cooperative agency, the services and conveniences provided by alternative private agencies, such as boarding and lodging for farmers coming to sell grain in the town, prompt payment, and emergency relief must also be provided. Otherwise new agencies will fail to attract farmers. Or the government may provide only a storage service to farmers at a nominal charge. Official warehouses may give them negotiable warehouse receipts so that farmers may market their produce whenever they can get a good price for it.

The possibility of revising the current practice of charging a uniform interest rate for all short-term official credit should be examined. The introduction of differential interest rates on loans for different purposes might improve the use of loan funds and recovery rates.

The actual role of traditional moneylenders deserves careful empirical study as part of a broader study of the relative efficiency of alternative systems for providing credit. Moneylenders have many operational advantages: intimate familiarity with borrowers, readiness to grant risky loans, quick and low-cost loan management, and a high rate of loan recovery. Since they provide such a large proportion of the total rural credit needs, the aim of eliminating them is utopian. Measures should therefore be devised to build upon the advantages of their system while eliminating any monopoly power or gains they may enjoy. One idea that might be tried is a system of rediscounting credit instruments between the farmer and the moneylender under specified conditions. This paper could be rediscounted by government agencies or commercial banks under governmental guarantees against a part of the losses. The rediscount system would increase the flow of funds through the traditional system, facilitate the entry of new moneylenders, break the islands of monopoly, and lower the level of interest rates. It might also induce commercial banks to enter the agricultural money market as wholesalers if not as retailers of credit.

As a rule, provision is made for a far greater proportion of the short-term credit needs of the rural sector than of the medium- and long-term needs – for land improvement, minor irrigation, equipment, and livestock – even though the longer-term needs are no less urgent and important. More research is needed to estimate the real degree of risk involved in medium- and long-term loans. On the whole they may be no more risky than short-term loans. Since the traditional and commercial banking sectors fail to meet medium- and

long-term credit needs adequately, special new credit agencies must be created.

The principle of linking loans with a package should be extended to medium- and long-term loans. Medium- and long-term packages as well as short-term packages should be supervised. The new agencies will need trained personnel to draft, evaluate, and supervise medium- and long-term projects. Again, commercial banks can be induced to participate in retailing or wholesaling of longer-term credit to farmers if they are guaranteed against a part of the loss, and if they are provided with technical help from the public sector. They may also need some guarantee against losses due to inflation.

The improvement of long-term land mortgage banking needs special study. Where land statutes, judicial decisions, or traditions have clouded land titles and thus adversely affected the volume of mortgage lending, tenure must be clarified for the purposes of lending.

INSURANCE[1]

The risks of farming in poor countries may be classified into the overlapping categories of weather risks, pest risks, price risks, risks of innovation, and administrative risks.

Although in theory almost all risks are insurable for the right premium, the cost of weather and pest insurance is likely to be prohibitive in developing countries until normal loss-preventing technological developments – irrigation, flood control, and widespread use of pesticides – have reduced these risks to manageable proportions. For a considerable time to come, therefore, development schemes themselves must be regarded as the main form of insurance. Some insurance against widespread crop losses due to drought, floods, and the like is and can continue to be provided through land-tax relief, water-rate relief, and famine and flood relief measures. At a subsequent stage of development direct weather and pest insurance might be undertaken at a reasonably low cost (which will be less if the insurance is compulsory than if it is voluntary). The remedy for price risk is guaranteed purchase at minimum prices. We have already suggested that if major food and fiber crops are in short sup-

[1] In this section, risk and uncertainty are not distinguished, and the word insurance is used to mean any scheme of reduction or sharing by public agencies of losses due to the uncertain behavior of natural, economic, or other factors. It is not restricted to mean only actuarially self-financing insurance.

ply, efficient systems of purchase at minimum prices should be established.

But the kind of insurance most urgently needed in developing countries is "innovation insurance," that is, insurance against loss following the use of new inputs requiring substantial additional outlay. Farmers who have little capital to fall back on are reluctant to incur this cost. Even if at the input and output prices prevailing in the market, or determined by the government, the expected additional return is many times the additional cost, as in the case of such innovations as hybrid corn seed, the rate of adoption may remain very low due to initial fears and uncertainties. Often the government experts recommending the innovations are themselves uncertain about the results that farmers may expect because the innovations have not been tested under local conditions.

In such circumstances it is necessary that any proposed new inputs and practices carry some insurance in the initial years of trial. Two alternative ways of providing the needed cover might be considered. One possibility is that imported surplus commodities might be delivered as compensation to farmers in the event that the net return from the package is less than an assured minimum. However, this scheme would entail many serious operational difficulties. Another possibility is that, since any innovation program ought to be linked with a supervised credit system that makes loans to farmers covering the bulk of the cost of the new inputs, risk coverage could be provided in the form of the promise of relief from a part of the total loan in case the additional yield per acre turns out to be less than the yield equivalent of the cost of the innovation. Only innovations with a high ratio of potential return to costs – say, not less than three to one – should carry this insurance, and the insurance fund should be distinct from the loan fund.

An insurance scheme of this kind has some obvious advantages. It will make the administration promoting the inputs a risk partner of the innovating farmer, instead of a mere adviser, and thereby stimulate its interest in the successful adoption of the innovation. Where loans are already being granted, the administration of the scheme would require only additional inspection and book adjustments. But the inspection system to check the actual application of inputs in the fields and to settle relief claims will have to be designed with care. Base yields of insured farmers will have to be fixed on the basis of average preinnovation yields estimated from revenue records and other evidence. The insured farmers should be responsible for notify-

ing the administration that their harvest may generate claims. The fields of notifying farmers will have to be inspected to determine their actual yields and settle their claims. The administration will have to have adequate technical staff and equipment for all these purposes.

What is being proposed, it should be emphasized, is insurance for the innovators rather than for the innovations. The insurance becomes operative in the event of a crop failure even though the failure – from unseasonal cold, lack of rain, closing of irrigation canals – may in no way be traceable to the innovation and even though the innovation may still be profitable compared to traditional methods. The only condition that the cultivator must meet is that he actually carry out the innovation with a minimum of competence.

The limited liability of the insurer – the limit being the cost of the new input – holds costs down to a manageable level. Only in the event of a general crop failure would the insurance become operative on a wide scale, and then some portion of the payments might be looked upon as a kind of famine relief. Limited liability also maintains the incentive for the cultivator to produce: He has relatively little to gain from collecting the insurance.

Although the administrative tasks involved are difficult, an existing supervised credit administration can be expanded to handle them. Innovation insurance is so crucial to the success of an agricultural program that the difficulties of administering it must be faced and resolved.

Still another class of risks are those that arise from the failure of the government machinery to render its services to the farmers in an efficient manner. When the seed, fertilizer, pesticide, and irrigation water deliveries, and the grant of loans and material permits and other permissions by the government agencies are slow, untimely, and uncertain, farmers depending on them suffer losses. These risks due to the poor performance of the administration are comparable in their incidence to the risks due to the poor performance of the monsoon. And, like the monsoon, they are so widespread that the main remedy must be preventive. Direct insurance against them will be prohibitive for a long time. However, the existence of these risks should underscore the dire need to expedite administrative reform. Also as far as possible farmers should have access to alternative sources of supply for their inputs. Reliance on monopolistic suppliers, official or nonofficial, can be extremely risky.

MARKETING

Market reform ought to be an integral part of any policy for agricultural development. Normal economic incentives for farmers to increase their productivity can operate only to the extent that the marketing system enlarges the market for their produce and brings them a reasonable price for it. Their desire to earn larger cash incomes can be stimulated by a marketing system that brings them cheap consumer goods, and their effort to increase productivity can succeed only if the system delivers the needed inputs. Marketing is as critical to better performance in agriculture as farming itself and should be treated with equal care.

The government is primarily responsible for providing the infrastructure required for an efficient marketing system: a good transport system, particularly a network of arterial and feeder roads; public storage to supplement private storage; a market information system; and a commodity grading system. The direct and indirect effects of transport development on agricultural productivity, through the expansion and activation of the markets serving farmers, cannot be overemphasized. Efficient storage can cut the current heavy losses due to bad storage. The government can build warehouses of its own and provide technical assistance to private stockers to improve their storage facilities. If produce brought by farmers is stored for a nominal charge in public warehouses as the farmers' property, for which they are given negotiable warehouse receipts, they can liquidate their stocks into cash when they like and thus obtain a better price for them. Better market information also enables farmers to realize a better price for their produce by removing market imperfections due to their ignorance of alternatives.

A public grading service enables the farmers producing higher-grade commodities to obtain correspondingly higher prices and induces others to improve the quality of their output.

It also enables consumers to know what they are getting and to get what they want. Often the expansion of commodity exports depends critically on grading. However, grading should be refined only as a demand is refined. The danger is that quality control intended to raise the technical quality of the product may have the effect of contracting the market if it makes the price rise beyond the reach of a sizable part of the market in an early stage of economic development.

Finding fault with existing distribution agencies is easy, but it is difficult to make new agencies perform all the necessary functions that the old agencies are performing at a lower cost per unit of sales. Therefore new marketing agencies promoted or run by the government should aim at supplementing rather than supplanting the existing agencies wherever the latter operate on an extensive scale. The concept of extension must be broadened to cover the further education of traders, particularly the small traders who abound in developing countries, and an information service should be set up to help them improve their operations. Traditional dealers should be educated and aided to operate on low-price and high-turnover rather than on high-price and low-turnover.

The relative efficiency of different kinds of marketing agencies (private, public, and cooperative) should not be ideologically prejudged. Empirical studies need to be undertaken to compare the efficiency of marketing under different arrangements. The efficiency of marketing can be measured by two magnitudes: the cost of marketing per unit of a given turnover, and the rate of growth of the turnover.

The existence of monopoly in agricultural marketing should not be assumed but empirically established. Prima facie, in many developing countries it seems that underemployment causes small-scale trade to be very overcrowded and hence competitive. But where monopoly is found, the government should either open its own agencies to increase competition or, preferably, take measures to facilitate entry by more traders.

In any marketing policy, special attention should be given to improving the processing of agricultural commodities, particularly the processing of perishable foods for city markets. Modern processing plants can in a short time create substantial additional income for farmers and stabilize, expand, and improve the food supply of cities. Governments should establish processing plants if they do not exist or help private agencies to establish them.

If marketing is deemed to be fully as "productive" as farming, the view of marketing margins current in some countries needs revision. It is often believed that "high" marketing margins always represent exploitation of the farmer. Although everything should be done to minimize the cost of marketing, often the new marketing agencies cannot really lower the cost of marketing if they perform all the operations performed by the traditional agencies. Moreover, the marketing margin and the return to the farmer for his resources or his total

revenue need not be negatively related. If the improvement of marketing (including processing) raises the marketing margin but expands the market, the farmer's revenue may simultaneously increase.

If in some countries adequate technical and managerial skill and financial resources are not available for large-scale processing and marketing operations, it may be desirable to allow foreign firms to collaborate with domestic firms under specified conditions. In addition to the conditions that are usually stipulated in contemporary collaboration agreements – providing for joint capital contributions, training of senior technical and managerial personnel, repatriation of funds, and so on – it may be useful to specify that foreign collaboration will be withdrawn after an agreed number of years. This provision would emphasize the strictly temporary, educative purpose of collaboration and allay suspicions of continuing domination by foreigners.

On the termination of a collaboration agreement a foreign concern might shift to another neglected field on the basis of a similar collaboration agreement. Thus foreign skill and finances can improve a number of marketing sectors in succession.

Use of Imported Surplus Food

Stocks of surplus food imported by developing countries under special arrangements, such as the U.S. PL 480 agreements,[2] can be used by them for a variety of purposes.

Basically, surplus food should be regarded as a subsistence fund (which is the original meaning of capital) – an addition to the other investible funds of the recipient country. It enables the government to reduce to some extent the pressure on food prices exerted by the additional effective demand generated by large-scale investments in development projects. Sales of the surplus stocks can prevent food prices from rising to intolerable levels. The effect of these sales may not necessarily be a lowering of the relative price of food, and hence discouragement to the growth of food production, but simply a partial relief of the hardship caused by developmental inflation to some

[2] Public Law 480 is the U.S. law under which surplus stocks of agricultural commodities held by the U.S. government are made available for importation by the underdeveloped countries, sometimes as grants, sometimes as loans with repayment in dollars, but usually in return for payment in the local currency of the importing country.

of the landless workers and city dwellers. This role of surpluses as a counterinflationary lever is crucial, for without it, the government might have to reduce non-agricultural investment or divert more foreign exchange for the import of food, thereby slowing the rate of growth. By and large, surplus food has performed the function of supporting expanded investment in many recipient countries.

Surpluses can also help reduce rural unemployment and accelerate rural capital formation if they are used to pay a part of the wages of workers employed in rural public works, as we propose in the next section. Although the possibility of undertaking such projects with surplus food is widely recognized, and has been tried in North Africa, it could be done on a much larger scale. It has, however, been difficult to organize the distribution of food as a part of wages in rural project areas. As an alternative, the imported surplus may be sold in regular food markets and the local currency proceeds used to pay the wages of workers on large-scale capital projects that would not have been financed otherwise. This avoids the technical and administrative difficulties of organizing a large number of small works projects with wages paid in kind. The availability of surplus food must not be allowed to cause any complacency among planners about the need to attain a satisfactory rate of growth of domestic food production. It should not underwrite the deficiencies of agricultural policy and administration. Neither should it permit a downgrading of plan allocations for the agricultural sector. Although surplus food may be used to reduce price instability and provide emergency relief, it should be treated primarily as a resource supplementing other resources committed to a comprehensive plan of investment.

RURAL PUBLIC WORKS

In overpopulated countries with an annual income of less than $100 per capita, the prospect of reducing the substantial volume of open and disguised unemployment within the next decade seems slim at best. Even if, for instance, all the objectives of the third five-year plan in India had been fulfilled, unemployment would not have been reduced and might even have increased slightly. Since the plan fell short of its targets, unemployment increased considerably. Nor can it be said that a thorough reshuffle and change in design of the five-year plans in India could markedly change the situation. The notion of labor-intensive methods producing more goods by handicraft and small industry remains a dream on the basis of

today's technology. The productivity per man-hour in handicrafts is so low that it cannot provide a rise in per capita income. It is true that there is a tremendous reservoir of manpower; but labor without capital can produce nothing – and capital is scarce. Under these circumstances there is – at least for the short period of the next two or three five-year plans – a conflict between the objectives of maximum output (income) and maximum employment.

One course might permit the creation of substantial additional employment without diverting considerable amounts of capital from more "productive" uses: a massive program of rural public works using labor with only minimal amounts of capital. These are activities like bunding, terracing, fencing, and building secondary roads (if they are not washed away by monsoons) with spades only, like the Burma Road.

Five million workers in India could, for instance, be organized in such rural public works for two hundred days a year. The works could "pay" if they increased agricultural productivity. Although they would not produce an immediate increase in the output of consumer goods, they would pave the way for higher production in the future. The wage bill[3] for such works – presumably one half would be spent on food that could be supplied from imports under aid agreements – is not a problem even for India.

The really scarce factor, once again, is organization. The academic approach of first studying how many people are in disguised unemployment (although one cannot hope to absorb more than a quarter or a third of them), then committee paper work on the design of pilot projects, and so on serves as an escape from the need to take real and energetic action.

An ample supply of rural labor would certainly be forthcoming for public works under the conditions stated. But digging is not enough; there must be people who will plan and supervise the digging. If only a half of India's villages (that is, 300 thousand) were to be covered, cadres of at least 100 thousand people would have to be formed to supervise and direct such public works. Although there is a host of problems relating to the payments (delayed or contingent

[3] The right wage will have to be determined by experimentation. It should be high enough to attract a sufficient number of the unemployed to the works program, but low enough not to divert labor from essential agricultural harvest operations. The works will have to be located within short walking distance of villages where the unemployed live; or transport will have to be organized for them.

liability payments) to be exacted from the owners of holdings on which public works are executed, these problems can be solved with a proper will and drive. The potential benefit is great: rural works seem to be the only way in India to reduce unemployment in the next five years from 20 to, perhaps, 15 million.

CHAPTER FIVE

Research and Education

To meet the needs of an expanding population and provide for some improvement in per capita food consumption, agricultural productivity must increase at the rate of 4 to 5 per cent annually. Few countries have sustained such a growth rate for any length of time, and, as we have seen, production in most of the underdeveloped world is stagnating. Only vastly improved technology developed by research and applied by a large part of the world's farmers will enable agriculture to meet this goal.

Research Planning

What kind of research will be most fruitful? Should the major effort be on short- or long-term projects? The underlying questions are: How much can agriculture advance by the diffusion and adaptation of existing knowledge, and how much is advance dependent on new knowledge that must be acquired by fundamental long-range research?

In many regions the existing knowledge is so limited that little if anything can be done. The soils of the tropical rain forests are an example; present knowledge does not seem to provide any alternative to the existing methods of cultivation.[1] Only much fuller understanding of rain-forest ecology, demanding a long-term research effort, would make possible a substantial advance in production.

In other areas enough basic knowledge exists so that, if adapted to local conditions, it can produce substantial yield increases in the near future. Two promising fields are the wider use of existing technology and the adaptation of technologies from the developed nations.

The more able and progressive farmers often produce far more than neighbors who have similar soil and climate and access to the same inputs and markets. Similar differences may exist in the firms that serve the rural sector. When the key factors producing such differences are understood, it should be possible to promote the better farmers' practices among their neighbors.

[1] The rain-forest area is described in Chapter 10.

Adapting technology from one nation and ecology to another is promising but tricky. When the technology and the yields of the developed nations are compared with those of the underdeveloped world, it would seem obvious that a transfer of methods would result in great advances in agriculture. But the long record of failure in such transplants is a warning that the process is not as easy as it appears. Time and again, crop varieties, cultural practices, credit schemes, and organizational patterns have failed to produce the expected results when introduced into a new environment.

The response of grains to fertilizer in India is one example among many. The grains do not respond as they do in the United States. Although the reasons are not fully understood, experience has provided some clues. In northern India, maize is grown mainly during the monsoon season. Methods of cultivation that were designed to conserve and store rainwater in the soil appear to have the effect of restricting the growth of the root system. This in turn affects where fertilizer must be placed if it is to be utilized by the plants. Thus fertilizer placement principles developed in the United States must be reexamined in India. It may be, also, that effective use of fertilizer in India will require new techniques of cultivation, of handling the soil surface, and of weed control.

The transfer of technology is, therefore, neither easy nor quick. Furthermore, the yield increases that can be expected from applying existing knowledge are limited. Almost everywhere, it seems, yields based on such adaptations will reach a ceiling in the relatively near future.

To pierce those ceilings, more fundamental knowledge is needed, and the gestation period of basic research is long. Developing plant varieties, for example, takes years. Yet only through such research can new advances in technology be ready when progress from short-run measures has been exhausted. A major effort in long-range research must, in our opinion, be gotten under way at once, and the underdeveloped nations must make a much greater commitment of money and trained manpower to agricultural research and education.

Nations doing little research may be discouraged by the cost of such a commitment, but it is not expensive compared to a steel mill or a major highway. Though it is costly in manpower, and many efforts will produce no return, and useful results will be years in coming, a basic research program is a necessary investment in the future of agricultural nations.

Planning a national research program should be preceded by a broadly interdisciplinary analysis of physical, biological, economic

and social conditions, and of the institutions serving agriculture. Only with such a diagnosis can government officials effectively plan the allocation of research and educational resources. With this information, foreign aid can be fitted into a coherent pattern rather than being scattered about, as often happens.

Research planners must always keep in mind the principle that agriculture is dominated by interactions. Too much research has been wasted, at least from the point of view of producing greater farm yields, because knowledge was pushed ahead on only a single front. If, for example, new crop varieties are being developed, the research plan must provide for studies of all the other inputs needed (cultural practices, marketing, extension, and so forth) for those new varieties actually to be put to productive use. If research is to follow these principles effectively, then one of the needs is for research on research itself: the study of alternative forms of research organization, and continuing evaluation of existing institutions.

Research will be necessary on each of the many factors that influence productivity. (See Table 1, page 15.) Priorities will of course vary according to the problems of each region; the kinds of bottlenecks that policymakers will find in different situations are suggested in other chapters of this book. The general lines of research in the physical and biological sciences are relatively well understood. This is not the case in the social sciences. Here, by way of illustration, are some areas of social science research that are likely to prove fruitful in many parts of the underdeveloped world.

Supply response. More wide-scale quantitative studies of the responsiveness of acreages and yields of crops to price movements and to nonprice factors are urgently needed to guide price policy decisions. Studies of the responsiveness of yields – particularly in areas where they have registered significant upward trends – will involve, first, the identification of input changes associated with yield variations, then the effects of price changes and other factors on the use of inputs. Studies of supply response will reveal how far the responsiveness of supply to price movements is related to the stage of development that different regions have reached. The comparative efficacy of input subsidies and product price guarantees and of alternative forms of "innovation insurance" – discussed in the previous chapter – also needs to be investigated.

Marketing. Empirical analyses of the cost of marketing (the so-called "spread" between the farm harvest prices and the wholesale market prices) of major staple crops and of the individual compo-

nents of total marketing cost are badly needed to indicate the type of marketing reform really required. Price variations from year to year, from month to month within a season, and from region to region need to be analyzed and accounted for in terms of the costs of processing, transportation, and storage, borrowing practices, interest rates, and public policies. Where alternative types of marketing agencies operate side by side, their respective marketing costs and efficiency should be compared. Such research will illuminate the marketing policy issues discussed in Chapter 4.

Fertilizer distribution. In many countries substantial quantities of chemical fertilizer have become available from imports or domestic production. But the distribution machinery is inadequate, and therefore, fertilizer supply cannot have its full effect on production: a crucial bottleneck in a factor that has, as we saw in Chapter 3, the potential for substantial yield increases. The cost and efficiency of fertilizer distribution by different kinds of agencies should be studied. Measures should be developed for coordinating sales, demonstrations, and the supply of credit, and for the improvement of mixing, storage, delivery, and application facilities.

Tenancy. Although there is a large body of literature on the evils of existing tenure systems and on the laws enacted to remedy these evils, very little empirical material is available about the actual tenancy arrangements that prevail in different areas and the particular schemes of sharing output, inputs, and managerial decisions implicit in them. (See Chapter 7.) If large numbers of actual tenancy contracts are empirically documented, their productive and distributive effects can be analyzed with a view to selecting the ones that are the least undesirable and at the same time are enforceable in practice in a given area.

Credit. The knowledge of loan contracts is not very much better than that of tenancy contracts. Therefore similar empirical studies of actual lending terms in large numbers of transactions are also needed.

Methods of program implementation. The timing, sequence, and combination of program elements must be studied. Various extension techniques, such as working with individual "farm cooperators" versus traditional groups, should be evaluated in the context of the local situation. Effective incentives for change – communication, health,

economic factors, and the like – should be identified. Experiments might be made on motivation and social effectiveness in innovation. In the analysis of agricultural information-transmitting agencies such as extension services, a key factor for study is the nature of the farmer's encounter with bureaucracy. The effectiveness of any program depends ultimately upon its facilitating the farmer's effort to innovate, enabling him to absorb more knowledge and resources. Research must articulate his experience with bureaucracy – his cost in time, money, energy, and self-respect in the effort to obtain permits, loans, supplies, water releases, and resolution of disputes.

Village planning. It would be extremely instructive to attempt some experimental planning for a single village. Such planning would reveal the changes in a given situation that should be made at the individual farm and those that can be made more effectively through group action at the village level. The spheres of efficient micro- and macro-activities can thus be demarcated clearly. Experimental planning would also indicate the resources that can be mobilized for development by individual farmers and village communities and the resources that have to come from outside the village. Finally, an institutional structure most suited to the needs of development can be designed as a part of village planning.

Farm research units. Experiments should be made with the development of owner-operated farm units in selected key communities that would put into practice the results obtained from small-scale research trials and combine them into a farming system. Such a unit, associated with agricultural research stations, would provide a larger-scale test of various new practices. It would make possible an economic analysis of the new system and serve as one proving ground for the development of program packages.

The studies proposed here will yield maximum value if they are carried out in farm communities whose social organization is well understood. Ideally, then, they should be made in communities representative of key types of farming (for example, subsistence and cash crop, or monocultural and diversified) where intensive community analyses have already been initiated. Any research leading to an action program must of course take into account the local social system with its interlocking of religious, political, economic, and cultural features. But this presumes the availability of ethnographic and sociological information about the community or about similar communities against which proposed new knowledge or new technique

inputs can be considered. In the many regions of the world where such data are scant or obsolete or non-existent, systematic studies will be necessary.

To derive conclusions that will be relevant to specific situations and will also have some general value, research projects with a common design might be undertaken in several regions whenever possible. What is already known must be collated and evaluated both to provide some guidance to actions that must be taken now and to limit research to the critical unknown factors.

On some of these topics experimental action research may be undertaken in addition to the usual survey-and-analysis studies. Thus, for example, the yields of different farms deliberately organized on different patterns and following different sets of practices can be analyzed; village plans with different priorities and institutional structures can be implemented and evaluated; alternative subsidy, price support, and insurance schemes can be administered and evaluated; alternative marketing agencies, fertilizer distribution agencies, and tenancy and loan contracts can be promoted and their performance evaluated.

THE ORGANIZATION OF RESEARCH

Like any other technology, a research organization transplanted from a developed to an underdeveloped society will not necessarily thrive and be productive. The stimulation that comes from contact with other educated people, the intellectual discipline imposed by dialogue with fellow scientists, the opportunity to see the results of one's research put into action, and the opportunity to work closely with and help train keen young minds are some of the features of the environment that will stimulate and make productive an agricultural research unit.

The basic organization should provide for one or more strong centers at which a substantial group of well-trained scientists from the various disciplines can be assembled. The main center or centers should be linked with a system of substations whose principal functions would be to test the applicability of materials or practices in various ecological situations and to discover problems peculiar to these various subareas. The number of such substations will vary with the size and resources of the nation and with the number of major ecological and farming areas to be served. These substations

should also form an important link with the extension officers in their respective areas.

In planning this research organization, the temptation to fragment and disperse scarce human resources should be avoided. Unless a sizable group of scientists – at least 15 to 20 – from the various disciplines can be assembled in one center it is doubtful whether a sustained flow of new technology can be expected. In institutions offering graduate programs in several disciplines the "critical mass" for the academic staff will be considerably higher; a minimum of 4–6 senior staff may be required for each subject-matter area. Where talent and resources are limited the principle of concentration must be kept in mind and, if necessary, only one main center should be developed initially. It should be possible to move progressively from a simple but productive research organization to a much larger and more complex organization as resources in funds and scientific manpower become available.

Some very small nations probably cannot support even one central station. They can, however, support a substation drawing information and materials from major stations in other countries. A somewhat larger nation might meet its requirements with one main research station plus a number of substations in its major ecological subdivisions. This pattern might be followed for individual states or regions within a large nation, with a complementary research organization at the center serving a coordinating function among the various states on problems and commodities of concern to more than one state and providing resources and staff that would add strength and flexibility. In a very large country such as India, which has a substantial body of trained agricultural scientists, it may sometimes be necessary and desirable to develop more than one main center per state, at least in the larger states. But the principle of concentrating the core staff in a limited number of locations should be kept clearly in mind.

The research program should have a strong training component. Research focused on significant problems is an effective vehicle for training the next generation of scientists. This suggests a close linkage between an agricultural college and the main research center. At the substations, if the staff is sufficient, the scientists should also teach and give short courses for extension workers or farmers.

The division of research activities among the various levels may be along the following lines:

Research at the central location. The emphasis should be on the kinds of research that (1) require concentrations of scientists with refined laboratory and field techniques, (2) are concerned with development of new knowledge, practices, and materials, and (3) have nationwide or interregional applications. Scientists at the central station should also provide leadership and coordination (but not direction) for research at the regional stations.

Research at the regional locations. Here the emphasis should be on trials and modifications of practices and materials developed at the central location and on their integration into enterprises adapted to the region. Development of new knowledge is secondary to the solution of problems particularly pertinent to the region that the station serves.

Research at the local fields. Simple trials should be conducted to determine or refine the adaptation to specific sets of local conditions of a few variables selected from regional trials. These trials should be under the supervision of the scientists at the regional or central location, and they should be designed to serve as both demonstrations and the final stage in adaptive research. Ideally local field trials would be within reach of each farm community, but in practice, such an extensive network would exceed the resources that are likely to be available in the early stages of agricultural development. The first local fields might be established in areas with the highest biological and physical potentials for improved productivity, and in communities in which local interest and hence likelihood of adoption are highest. The local trials may be in the cultivators' fields, village or other publicly owned lands, or stations specifically established for that purpose.

Research at the pilot farms. This research should emphasize the biological and economic aspects of an integrated enterprise evaluated on a farm scale. The farms should be under the control of staff members of the farm management unit of the central station or the regional station. Immediate operations should be in the hands of the most competent farmer available or of a technician who has had actual on-farm experience. The primary purpose is research. Ideally these pilot farms would serve as demonstrations, but experience to date does not give much cause to believe that they will be particularly effective in this role. The pilot farms could serve as centers for ing farm leaders, for in-service training of extension personnel, r farm experience for college and university students.

Research and the Demand for Human Capital

The role of new knowledge, or research findings, as a principal source of economic growth is coming to be better recognized. Research findings become a productive factor in the economy only when they are incorporated in capital goods or when people incorporate them into their work habits and procedures. Increases in productivity take place because improved processes reduce the unit costs of labor, or capital resources, and of natural resources.

In the agricultural sector new knowledge increases the demand for skilled manpower. New knowledge requires applied research to adapt it to particular sets of conditions, and development and design activities to incorporate it with more productive new inputs.

Take the example of a new plant variety produced by a research station. If capacity for seed multiplication does not exist, then plant breeders and other agricultural scientists will have to be allocated to this task. A great deal of research will be needed on the interaction of the new variety with water, fertilizer, pest-control measures, cultural practices, and other inputs. When the seed is available in volume, an organization will be needed to distribute it, along with other inputs that are complementary. An extension system is then necessary to disseminate all the relevant information to cultivators. A credit system is needed to facilitate the farmers' use of any new inputs. A marketing organization is also needed for the additional output. Also needed are educators to train the additional research workers, the managers and staff for seed multiplication and for marketing organizations, the extension workers, the credit supervisors, and the additional teachers.

In underdeveloped countries the initiation of a flow of useful research findings will increase the manpower needs greatly because many of the needed organizations do not exist at all or exist only on paper. They must be built from the ground up, and this process is not only slow and often painful but also requires a concentration of human resources that are very scarce. These manpower needs, it is important to note, occur long before the new variety or other innovation has begun to produce added yields.

It is likely that the demand for skilled personnel will grow much more rapidly at first than the flow of useful research findings. Failure to foresee skilled manpower needs will frustrate for a time the contribution that the new knowledge could make to agricultural productivity.

EDUCATION AND AGRICULTURAL DEVELOPMENT

Education is like a general-purpose investment that can be directed toward many essential needs when it matures. A society with a substantial number of high-school graduates can meet its needs for research, extension, credit, and other supporting workers much more rapidly than can a society with only elementary-school graduates. Many types of specialized training can be designed and grafted with little loss of time onto a good program of general education.

The advantages of general education extend far beyond the capacity to fill positions already known to be essential to development. Central to development is the idea of change; and education in its best sense is the cumulative impact of experience that leads to change in future patterns of behavior. Thus education, by increasing an individual's "perception of the possible," can condition and predispose him to change. It can create in him a new level of dynamic behavior that is essential for innovation.

Because much of the development process involves the transfer of knowledge from one person to another, the availability of diverse channels of communication is important. Illiteracy of course rules out the channel of the printed page. However, the modern technology of aural and visual mass communication offers many opportunities for transmitting information to those unable to read. Radio and television can be imaginatively used as complements to personal communication, demonstrations, and formal schooling.

Education for all through primary and preferably through secondary school is obviously a desirable objective. However, it may have to take second place to the needs for trained agricultural technicians and other workers if personnel shortages are seriously impeding agricultural development. In such cases vocational and technical agricultural schools will be more important than general secondary-school education of the classical kind. In-service training, short courses and on-the-job training are important supplements to formal classroom teaching, especially where large numbers of trained people are needed quickly and where many of the students in agriculture are from urban areas.

If the schools concerned with agricultural education are to be responsive to the needs of rural society, they will have to promote attitudes different from those that now prevail. As we shall see in the next chapter, the educated elites of the underdeveloped nations tend

to look down on farming and farmers and to fear the process of innovation. Schools can play a key role in combatting such attitudes and bridging the gap between educated elites and rural society.

The schools must, therefore, move away from the rote memorization and elite orientation that generally characterize education in underdeveloped nations. A spirit of inquiry, of problem-solving, is of course w lcome in any educational institution. But it is particularly relevant to agriculture, because of the multiple factors involved, because so much remains to be learned about the interaction of those factors, and because anyone working in agricultural development must always be ready to adapt principles learned in school to the unique requirements of a local situation.

The education of the farmers themselves is essential to increasing agricultural productivity in both the short- and long-run. But this does not mean just formal schooling that is often irrelevant to rural life; it means education designed to provide rural people of any age with the knowledge and the intellectual tools to resolve their problems. The phenomenon of interactions is brought into sharp focus by the decision-making ability and managerial skill required at the place where production occurs – the individual farm. To talk about production inputs and package programs in aggregative terms is useful in national planning, but their effects on production are determined by the way in which the individual farmer is able to put all the technologies together on his farm. On each farm the right "mix" may represent a unique combination of all the components of a complex mosaic. The ultimate effectiveness of any program depends on the ability of farmers to make sound decisions based on an understanding of the alternatives open to them and an appraisal of their consequences. It is for this reason that at all stages in the development process, whether with the villagers of highland Luzon, Dahomey, or Bolivia or the farmers of Taiwan, Israel, or Illinois, information and technology should be extended in such a manner that the farmer – the man who puts the information into the production machine – is himself educated by learning the "why," not merely the "what" or "how," of the innovation. Only in this way will he grow in his ability to adapt to changing circumstances.

CHAPTER SIX

Agricultural Programs

Let us assume that we now have a package of viable new inputs to offer the farmer, economic policies to make their adoption feasible, and a research system that steadily improves and adds to our supply of technology. The need remains for means to bring the package to the producer, from ministry and research station to the farm itself. Without this factor the package is incomplete and the other factors will remain barren. The factor of organization is perhaps the least tangible and least clearly understood of all the factors that go into the "systems problem" of agricultural development.

The key actors here are the farmer and the bureaucrat, for the state must play a major role in catalyzing agricultural development. Private firms and traders may play a greater or lesser role in different nations, but in this chapter we are concerned with those crucial responsibilities that fall on government. The profit in many agricultural enterprises cannot be recaptured by the private entrepreneur because it diffuses through society. We cannot expect private concerns to build farm-to-market roads, create and staff an extension system, or manipulate prices in the general social interest. The state may often aid the private sector so that it can better serve agriculture, notably in marketing. One example is the training of rural merchants, who can be a crucial force for change. Even when the state enters the marketing process it will usually be useful to preserve and stimulate the private sector in order that the farmer will benefit from the flexibility of competition rather than suffer from the rigidities of monopoly.

The bureaucrat must therefore be an agent of change. In the form of extension agent, cooperative organizer, or local official he must bring innovation to the farmer. The encounter between farmer and bureaucrat is a crucial point in the process of development. If that encounter does not appear fruitful to the farmer, then the most attractive of package programs will remain on the shelf, unsold.

The nature of the encounter between farmer and bureaucrat requires close study in the evaluation of any developmental program. All too little is known about what actually happens when the pro-

ducer meets the agent of change. Is the farmer approached in language he understands, in terms that are relevant to his experience and desires – and by people he trusts and respects? Are his customs and beliefs insulted? Is he subject to humiliation, red tape, and delay? How many people must the farmer see in order to get his new inputs and learn how to use them, and does he have reason to believe that his fertilizer, for example, will be delivered when he needs it? These are essential questions that cannot be answered by examining a table of organization in the ministry of agriculture.

The Innovation Package Program

In the encounter between the farmer and bureaucrat, the strain of innovation on the farmer is great. In adopting a package of innovations, he is required to master new physical skills (in cultivating a new crop, for example), to learn the use of credit, and often to accept unsettling changes in his social order, all in a limited space of time. Since such change is difficult at best, it follows that any further barriers in the relationship between farmer and bureaucrat-innovator will drastically reduce the chances that the package will be accepted.

The bureaucracy must design and implement its package of innovations to reduce as much as possible the barriers to its acceptance by the producers. Experience suggests the following as desirable characteristics to have in a first package of innovations:

1. *Profitability.*
2. *Complementarity.* Include all of the practices complementary to the key innovation(s).
3. *Appeal.* A strong motivation toward adoption should be induced both on the part of the farmer, whose felt needs it should tend to satisfy, and on the part of the agent of change, who should feel a personal challenge in promoting the package.
4. *Compatibility.* Collision with the culture must be avoided. Furthermore, it must be borne in mind that propensity to accept the package might be seriously hampered by previous failures.
5. *Simplicity.* Elements included in the package should be easy to manage, demanding as little as possible in skill prerequisites.
6. *Availability.* Knowledge, materials, and credit must be readily available.
7. *Immediate applicability.* Packages with long gestation periods should be saved for later phases.
8. *Inexpensiveness.* If possible, relatively little or no additional costs to

the farming operation should be involved; this consideration will be less important later.

9. *Low risks* should be involved for the farmer.
10. *Expandable.* Adjustable to operation on different scales.
11. *Spectacular impact.* Preferably on cash crops.
12. *Communicability.* Results should be easily visible to everybody.
13. *Residual effect.* Farmers should achieve self-reliance.

Such a package, including both tangible and intangible factors, can be designed in the ministry, but it can be implemented, particularly in its intangibles, only by agents of change who are fully aware of and committed to its requirements. Only their tactics in dealing with farmers can guarantee its success.

Thus bureaucracy faces a task as difficult and complex as that of the farmers themselves. The government's need for human resources to accomplish this task is acute. That need takes two forms. First, and most obvious, is the sheer need for large numbers of skilled people. As we saw in Chapter 5, agricultural development causes a steeply rising demand for people to man the structures serving the rural sector. The personnel requirements exist before the increased agricultural yields occur that are eventually to finance their costs; research and extension, for example, are needed before the farmers begin to innovate.

The organizational problems and therefore the personnel needs of agriculture are far greater than those of industrial development. The introduction and operation of modern industrial plants depend on the decisions of relatively few people. The large scale of operation can support the cost of personnel in the specialized functions of integrating production, supplying inputs, and marketing. By becoming employed in a factory, labor is taken into a new environment. The tasks to be learned are standardized, relatively simple, and not substantially different from production tasks in the same industry anywhere else in the world. Supervision of labor to achieve productivity is more a matter of achieving a well-integrated flow of materials and semifinished goods through the production process than a matter of incentives and sophisticated decision making on the part of the workers.

On the other hand, improving the efficiency of agricultural production depends on the decisions of millions of small producers. The tasks are not standardized, conditions vary from area to area and even between fields on the same farm, and weather and the occurrence of diseases have to be taken into account. Even the smallest

farms usually diversify their production. The supply of inputs and marketing of products have to be organized to serve the many producers spread over the land, and requirements are usually seasonal. Provision of credit is also complicated by the need to serve many producers and by the seasonal character of income and production expenses. The poverty of most rural people increases the risk of experimenting with new practices. Lack of transport and communications makes it difficult to reach the dispersed millions of the farming population. Roads are few. The sheer discomfort of traveling and living in the countryside, as compared to the amenities of urban life, tends to discourage decision-making officials from getting out in the field often enough to keep in touch with their programs. The multiplicity of languages impedes communication; cultural differences between educated elites and farmers hinder effective communication even when a common language exists.

Yet the skilled human resources of developing nations are typically scant. Almost by definition they do not have a pool of trained manpower available to staff new or vastly expanded organizations. The demand is many times greater than the supply. The issue then is: How can these scarce human resources be allocated – knowing they are far from adequate – to make the best possible use of them?

The second problem in the supply of human resources is less tangible than the mere lack of numbers. It is implicit in our earlier statement that the "bureaucrat must be the agent of change." What makes a successful extension agent? Obviously he must know the technical side of his job if his advice is to be worth hearing; much of that can be accomplished in his training. But his technical training will be of little value if he learned by rote, for the essence of agriculture is that general principles must be creatively adapted to an endless variety of local conditions. And he must also be deeply committed to innovation, which means that he must accept the painful personal adjustments (by himself as well as the farmer) that come with rapid social evolution. If he is not committed to change or is afraid of it, if he is content with the status quo, or if his primary commitment is to, say, his personal status, then the agent is hardly likely to be an effective promoter of innovation. Although easy to state, this principle in practice gets less attention than it deserves, perhaps simply because it is an intangible. We cannot measure the "innovation response" of an official as we can measure the fertilizer response of a plant. But the fact that we cannot assign numbers to this quality does not excuse us if we disregard it in our planning.

However, to draw up lists of the qualities desirable in an agent of change is of little help. We can say that an extension agent should seek farmers' opinions in order to understand the community in which he is working; or, to put it on the simplest level, we can say that the manager of a cooperative should not steal the funds. Such statements do not advance us far, for we are then dealing with agents of change as individuals rather than as a class. For example, an outstanding individual will often be cited with the wistful comment: "If only we had a hundred more like him our problems would soon be solved. . . ."

Whether there can be "a hundred more like him" depends on the values prevalent in the bureaucracy. Most officials, like most people, are conditioned in their behavior by their environment. Thus the human environment of the bureaucrat, like that of the farmer, must be conducive to innovation if development is to take place. Otherwise the exceptional individual remains just that – an exception. What is needed is a system of values in which the *unexceptional* individual can be an effective agent of change; only then can a society mobilize such agents in the numbers that agricultural development demands. Technical training in itself is not enough.

Put in other terms, the environment of the bureaucracy must encourage the growth of the "will to develop" that was listed in Chapter 2 as a precondition to agricultural development. The "will" must be distinguished from the mere "wish" to develop. The wish is evident in the public statements and development plans of the developing nations, yet it alone does not guarantee the will to overcome the barriers that often exist in the bureaucracy itself.

Values that are not conducive to innovation are generally prevalent in the bureaucracies of the developing nations. The bureaucracies are typically characterized by elitist and authoritarian attitudes; rigid adherence to rules is valued over accomplishment, and there is great concern with symbols of prestige and status; agriculture is seen as a despised occupation. These attitudes may be seen in terms of the bureaucrat's response to what he views as threats to himself or to the civil service as an institution. Even where some will to develop exists in the national leadership, these bureaucratic characteristics hinder effective implementation of any innovating program.

No organizational panaceas can be offered here, for no administrative technology can be transplanted whole from one society to another. It is useless to draw up an "ideal" extension or credit sys-

tem, for no bureaucratic shell would guarantee that the agent of change would perform to achieve the goal we have stated: to make fruitful the farmer's encounter with bureaucracy.

In the past, claims have been advanced for particular forms or methods of organization: cooperative credit and community development are examples. Our view is that – entirely aside from the issue of the will to develop – the variation in the factors involved is far too great to put forth any single technique as having general applicability or, for that matter, to reject a technique because it has failed in one situation. The priorities in the needs of agriculture vary from roads here to fertilizer there and to research in the third place; the variety of local cultures in which the innovations are to be introduced is almost infinite; different nations have different bureaucratic resources. If both problems and resources vary, it is normal that the best techniques for solving the problems should also vary. As we noted earlier, a statement like "cooperatives are the best way to supply credit" is meaningless as a generalization. Similarly, another often discussed question – whether to work primarily within existing organizations, or to set up new *ad hoc* structures – has no answer except in individual situations.

In deciding how best to group scarce human resources, planners face the question of diffusion or concentration: Should the available personnel be spread thinly in both geography and function in an attempt to bring benefits to as many farmers as possible? Or should they be concentrated in the hope that they can bring greater total benefits in a relatively small area? Whatever choice is made can only represent a compromise between great needs and scanty resources.

On the whole, however, we tend to favor concentration over diffusion. The reasoning is pragmatic. As stated in Chapter 2, only in rare cases can a single new physical input provide more than small or transient benefits. Most agricultural situations require a package that is typically complex. The package in turn requires considerable numbers of scarce human resources if it is to have any chance for success. Most developing nations can man such a package over only a relatively small area and often with benefit only to the better farmers (who may already have begun to innovate). On the other side, that of diffusion, the available manpower could at best staff a program attempting to bring a single simple input to great numbers of farmers. All the force of social justice of course sustains the case for diffusion of effort and benefits in desperately poor socie-

ties. The only possible counter-argument, and it is the one we have adopted, is that in most situations diffusion of effort will provide virtually no benefits for anyone. We do not argue that concentration is socially attractive or equitable – but that it is usually the only method that can hope to succeed. Also, while the package's immediate benefits may be concentrated, other measures, such as land reform or taxation of added income, can be taken to spread the gains more widely.

Examination of successful agricultural development programs, and they are all too few, confirms the view that no administrative panaceas exist. Chapter 8 describes the salient features of four successful schemes: the Comilla Academy for Rural Development in East Pakistan, the Joint Commission on Rural Reconstruction (JCRR) in Taiwan, the Gezira scheme in the Sudan, and the Vicos project in Peru. Even these four have few specifics in common. Comilla is primarily a farmer-training project that started with a single factor – cooperative credit – in a single district and has expanded very cautiously. The JCRR, on the other hand, operates nationwide and covers a broad spectrum of activities. Gezira is a capital-intensive irrigation scheme involving a high degree of paternalism and enforced change in land tenure and farming patterns. Vicos is a community project that grew out of a study by foreign anthropologists.

The lessons of such success stories do not lie in the form of the project or in any particular techniques. Many similar projects have failed; Gezira, for example, has been imitated unsuccessfully. Their forms are dependent on local conditions. But, if they provide no readily exportable panaceas, the success stories point to some underlying principles that may be generally valid. These general principles are closer to hypotheses than to dogma, yet we believe that they provide criteria by which the organization of agricultural development can be evaluated.

ORGANIZATIONAL PRINCIPLES

BUREAUCRATIC FEASIBILITY

This precondition is as essential as technical and economic feasibility. Before any program is approved, this question must be answered: Are the needed organizational resources likely to be available, and is this their optimum use? This principle has all too often been disregarded with the result that otherwise attractive projects

failed. Basic decisions may turn on the answers to these questions. The choice between large- and small-scale irrigation is an example. One may have the choice between one big dam serving large numbers and, on the other hand, many wells and small village dams, each serving at most a few fields. The big dam requires vast social change and a high degree of imposed discipline; for example, the Gezira scheme was paternalist not by choice but by necessity. Landholdings have to be reshuffled; all farmers must conform to rules governing the use of water; they may be required to grow specified crops by specified techniques. Thus the local culture, the farmers' patterns of living, is bound to be drastically remolded. The administration of the irrigation project must plan and enforce these far-reaching changes. This is precisely where so many irrigation schemes have failed in the past: the dam is well built but the farmers are not organized and the services are not provided to make efficient use of the water possible. The success of the project diminishes in proportion to the distance from the site of the dam. By raising the organizational question early in the planning stage the state may find that it does not have the needed human resources. It may then abandon a project that is feasible in every other dimension in favor of another project, perhaps with less potential yield, that is within the state's administrative capability. Other areas in which the organizational issue is especially important are pesticides and land settlement schemes, both of which often involve a high degree of social control.

PILOT PROJECTS

Any organizational scheme should be tested on a pilot basis before it is generally adopted. Like the concept of bureaucratic feasibility, the idea of field tests in bureaucracy needs far wider acceptance. As we pointed out in Chapter 2, the case for adaptive research in institutions is similar to that for adaptive research in crop varieties. Our knowledge of all the factors involved is not great enough to transplant crop varieties without testing. This statement applies even more to institutions. Our knowledge of the complexities of local cultures and how they may interact with any proposed innovation is far too limited to permit us to design in a bureaucratic laboratory an organizational structure that can be generalized without running unacceptable risks. Alternative ways of approaching the farmer with an innovation may be possible; he may, for example, be approached either as an individual or collectively through the village

leadership. Which alternative is more effective should be determined by field tests, not a priori in the ministry offices.

Pilot projects have other advantages. They accord well with concentrated regional packages. Pilots do not engage the prestige of the national bureaucracy. If one proves unworkable – and it should be stressed that a high proportion of such experiments will probably fail – it can be abandoned or drastically altered without serious loss of face. Thus inertia is less likely to force the continuation of a scheme that has failed but to which the nation's leadership has committed its prestige. In far too many cases, a scheme that is pronounced successful in the capital is barren on the farm, for the failure of an agricultural project to make changes – which are at best barely visible – on countless fields in remote areas is less likely to be widely noticed than, say, the failure of a steel mill to turn out steel. It is easier to find capable people to staff a pilot project because it is small. Finally, if the project involves radically new values or reforms, it is less likely, again because it is small, to arouse resistance from entrenched interests or bureaucracy than a large-scale project. This was the case in Comilla.

Yet the success of a pilot scheme does not necessarily mean that it can readily be generalized. Institutions grow more slowly than most plants. There is a difference in kind – not just in scale – between a pilot and a national scheme. The advantages we have just cited tend to vanish when the pilot scheme is generalized. Manpower needs multiply. When one examines existing pilot schemes, one typically finds a very high extension-farmer ratio: a relatively great number of skilled people are being used to provide new knowledge and services to relatively few farmers. Usually the manpower is not available to generalize the scheme at that ratio, and it may not work at a lower ratio of skilled people to farmers. (This problem underlines the need to devise and test schemes using a low ratio of skilled manpower.) Bureaucratic opposition, skirted at the pilot stage, may arise when the scheme becomes large enough to be perceived as a threat to the customs or status of the civil service. That it is possible to unite a small group of bureaucrats levoted to change in the special conditions of a pilot scheme does not prove that it is possible to animate a whole sector of the civil service.

A pilot scheme is by definition an exception to the rule. When it becomes the rule instead of the exception, then a whole new set of considerations emerges. Thus the expansion of a pilot scheme, no matter how successful, must proceed slowly and in full awareness

of the new problems to be faced. This also has been the experience of Comilla; it has gradually expanded as its techniques improved and opposition diminished.

FARMER-BUREAUCRACY COMMUNICATIONS

Two-way communication between farmer and bureaucracy is essential for bridging the present gap between the producer and the agent of change. The urgent need is for return communication from farmer to bureaucrat. Extension is often seen as a one-way process in which the educated person instructs the ignorant farmer, a view that accords all too well with the despised status in which agriculture is usually held, and with the rote learning typical of education in many underdeveloped nations. Communication is all one way and *down,* from research to extension to farmer. Research does not listen to the relatively "lowly" extension agent; nor does the agent listen to the "ignorant" farmer. The agents do not discuss; they instruct. New institutions, such as cooperatives, are imposed on the farmer without consulting him.

Lack of two-way communication undoubtedly is a major cause of the farmer's reluctance to listen to his advisers. It is often observed that the better farmers get yields on their fields that are higher than those at the research station, and that "the farmer knows more about local conditions than the extension agent." In such cases the farmer is unlikely to value the agent's advice.

Nor is the farmer likely to accept advice that – in its form if not its content – is either offensive or irrelevant to his own way of life. This may be particularly true of subsistence farmers, who do not respond to economic motives as much as farmers who are already in the market economy. To reach subsistence farmers, to convince them that a better life is in fact possible through innovation, the agent of change must thoroughly understand the workings of the local culture – the forces that motivate the farmers, and those that inhibit them. Such an understanding can be gained only by lengthy dialogue in which the agent of change listens more than he speaks.

We have emphasized the need for innovations that respond to the farmers' felt needs and for research directed to that end. It is clear also that the method of introducing an innovation that clashes least with local customs or values has the greatest chance of success. Finally, people of different cultures perceive words and ideas in different ways; it is therefore essential that communication with the farmer be in such terms that he, as well as the agent of change, per-

ceives the utility of what is being offered. If these criteria are to be satisfied, the agent of change must learn as well as teach, which means he must be willing to learn from "ignorant" farmers.

The process of two-way communication must be institutionalized. Again the agents of change must be viewed as a class rather than as individuals. Exhorting the agents to listen will not be enough, for if educated people as a class despise agriculture and farmers, then most extension agents will be reluctant to listen to those they consider ignorant and primitive no matter what they were told in their training. The channel of feedback must be built into the system as a function no less necessary than the instruction of the farmer. This is likely to require drastic change in the values prevalent in the educated class.

Once it is a part of the system, feedback can correct the mistakes of research and extension. Since so much is unknown and experimental, these mistakes are bound to be plentiful, so corrective feedback is urgently needed. When the gap between farmer and bureaucracy is effectively bridged, when information and opinions flow automatically from farmers to decision makers who must take them into account in their decisions, then the latters' policies are far more likely to be adapted to local physical conditions and to local social structures and to respond to the farmers' felt needs. Mistakes are more quickly identified and acted upon if there is pressure from below; any package of innovations must be varied to suit a multitude of local conditions. An example is the Package Program in India, which offers a complete package of new inputs in selected small areas. By experimenting with the ingredients of the package (more or less fertilizer, for example), farmers are constantly refining the package, producing new combinations better suited to their farms. Thus when two-way communication exists, the chances for a viable package of innovations — for a fruitful encounter between farmer and bureaucracy — are vastly increased.

LOCAL LEADERSHIP

The strain on scarce supplies of skilled manpower can be lessened by local leadership. This principle is a corollary to the bridging of the communication gap between farmer and bureaucracy. Often the question is befogged by ideological controversy over "statism" or "paternalism" as against "democracy." It is true that new programs require impulsion from a decision-making center. Static local cultures need a continuous input of outside initiative in addition to

technology. Such forms of development as major irrigation works require a high degree of regimentation since all farmers must adopt the new practices.

Yet the pragmatic arguments in favor of using or developing local leadership, combined with outside stimulus, are compelling. Since the human resources of bureaucracy are so scarce, any technique that stimulates local energy for development has the welcome effect of reducing the burden on the center. It can also reduce the financial burden by making it possible to raise capital locally. To the extent that village initiative can be aroused, overcoming apathy based on the pessimistic view that man is helpless before his environment, the responsibility for development passes in part to the local community. An excellent example, cited earlier, is that of marketing: providing rural merchants with technical assistance and training in innovation can make them powerful and continuing agents of change within the village community. In many places, however, existing local leadership may be a brake on development; this would be likely where land is held in latifundia. Finding useful community leadership may then require an overturn of the local power structure.

In an overly paternalist program in which all decisions are made for the farmer at the center, village apathy may persist, and any progress may be viewed as a gift from outside. Development then is a fragile plant that depends on the constant input of stimulus and decisions from the center. On the other hand, a village participating in decisions concerning the program may sooner become committed to development and innovation, and the process may eventually become self-sustaining in human if not in financial terms. The farmer participates in development as a partner of the elite, not as a client or dependent. Once this stage is reached, lapses on the part of the elite need not necessarily halt the process of development. A good example, described in Chapter 7, is the stimulus to rural Japan provided by farmer participation in administering land reform.

The use of local leadership combined with outside initiative characterizes three of the successful programs described in Chapter 8. The JCRR works through elected farmer associations. Farmers themselves choose fellow farmers to attend the Academy at Comilla; these farmers are key agents of change. At Vicos, where the Cornell team successfully stimulated a rise in farm yields on a former hacienda, opinion leaders among the Indian serfs were sought out and given a share of the responsibility for designing the program.

In all three projects, despite differences in technique, farmers are

given an essential role in deciding what is to be done and in carrying out the decisions. By using farm leaders as agents of change, the influence of the scarce supply of skilled manpower can be multiplied. As suggested earlier, any such technique that expands the effective supply of agents of change may help a developing nation break a particularly tight bottleneck. Moreover, any method that results in stimulating village decision making, in releasing human energies now bogged in apathy, is more than a technique of development. It is a goal itself, the goal of human development.

The principles stated here are not likely to be put into practice without profound and unsettling changes in attitudes. Successful innovation in agriculture, as suggested in Chapter 2, ultimately depends on diffusing through the society a spirit that welcomes innovation. Applying these principles will at times prove painful, for they run counter to attitudes that are now prevalent. Establishing two-way communication with farmers implies a respect for their opinions that is often lacking today; granting responsibility to local leadership means taking power away from the center; raising the status of agriculture implies lowering the prestige, at least in relative terms, of the elite. Such changes cut deep into a society. They will not be effected by technicians or researchers, and still less by foreigners. They can be accomplished only by a determined political leadership.

Thus our analysis has taken us from physical inputs to nation building. That this sequence is logical – that putting fertilizer on a remote farmer's field is intimately linked to the values of officials in an urban ministry – is an illustration of the extraordinary complexities of the agricultural problem. What makes it particularly difficult to grasp these complexities in a useful manner is that no common measures exist. One can calculate the relative value of two kinds of fertilizer, or fertilizer and pesticides, but on what scale can one weigh both pesticides and politics?

CHAPTER SEVEN

Land Reform

Land reform consists of changing the cultivator's relations to the land in a land tenure system. When the tenure system in predominantly agricultural countries provides the cultivator with a reasonable reward for his efforts, it is a force for economic, social, and political stability. In the main, with notable exceptions such as Taiwan, that reasonable reward is denied the cultivator in most parts of Asia, Latin America, and the Near East.[1] Today vast numbers of farmers work somebody else's land under adverse conditions. The principal features of the tenants' plight are stagnating agricultural economies; scarce land, yet concentrated in few hands; low yields but high rents; poor farmers but expensive farms; too many people living on too little land, and small holdings getting smaller as population rises with no alternative occupations; inadequate tools, indebtedness and usury, malnutrition and illiteracy; keen competition among the peasants seeking scarce land; absence of any chance for advancement within agriculture; little margin for risk-taking; and subsistence farming with little capacity for growth.

Many of these conditions are due to institutional land systems over which the peasant has no control. Exploitative forms of tenancy prevail in most countries of the underdeveloped world. Rack renting and insecurity of tenure are standard. Through the centuries governments and their judicial bodies have given official sanction to this type of tenant-landlord relationship. Farmers are obliged to pay exorbitant rentals because their compelling need for any kind of employment depresses wages and raises rents. In Asia, rents of up to 70 percent of the crop are common, even when the landlord provides only the land, while the tenant must provide all other inputs. Their contract of tenancy, which is supposed to ensure security of tenure for a specified period, is seldom worth the paper it is written on if it is written. In most cases the contracts are oral, but whether written or oral, they can be abrogated at the whim of the landlord. The

[1] The quite different land tenure problems of tropical Africa are discussed in Chapter 10. New settlements, which involve still other issues, are discussed in Chapters 11 and 12.

peasant has no incentive to improve the land and produce more, nor is there a place for creative technology on a wide scale. These conditions preclude equalization of opportunities, stifle progressive impulses and underwrite stagnation in agriculture.

No single land reform panacea will deal with all these issues effectively. In conditions of rural poverty even redistribution of the land will not suffice unless it is accompanied by the necessary means to work and improve that land. It follows that countries that carry out land redistribution programs must make great efforts to increase agricultural investment, particularly if their population is increasing rapidly. The economic opportunity and psychological incentives that come with possession of the land or security of tenure must be accompanied by a host of other developmental measures. Agrarian reform, therefore, encompasses all or most of the following elements: distribution of land to the landless; security of tenure and fair rents; better methods of cultivation through technological improvements, adequate credit, and marketing; and other measures.

ECONOMIC ASPECTS OF SIZE, TENURE, AND ORGANIZATION OF FARMS

In framing land reform, two major size-tenure situations should be distinguished. First is the *small-farm situation* that characterizes most densely settled regions. The overwhelming majority of operating units are small. The large owners have leased out most of their lands. There are relatively few large, owner-operated farms. In some areas, holdings have been so fragmented by inheritance that an individual may farm several tiny plots, often widely scattered.

Second is the *plantation situation.* There are many large-scale plantation units – some very efficient, some inefficient – each employing large numbers of hired workers. Some small-scale plantations are owner-operated. Some are "mixed" haciendas where a part of the land is cultivated for the absentee owners by laborers working under agents, and a part is let out to workers in small patches for rent in the form of cash, kind, or personal services.

With respect to the small-farm situation, where individual holdings are fragmented, a strong case can be made for consolidating the plots tilled by an individual into a single unit. However, fragmentation may serve an important purpose if the land in different loca-

tions in the same village receives varying amounts of water over the season (owing to the location of wells, canals, or seasonal flood water).

A quite different question is whether the size of the individual holding is too small to be efficient. In many small-farm and plantation situations one comes across a confused argument that calls for the liquidation of large estates on the ground that they are too large to be efficient, and at the same time calls for the consolidation of small farms into cooperative or collective farms on the ground that the farms are too small to be efficient. But evidence across nations as well as within individual countries, shows that in densely settled areas the enlargement of farm size is not an absolute precondition of increased agricultural productivity per acre. Farm management data for individual countries show that yield per acre does not increase and often diminishes with size over a considerable range. In countries like Japan and Taiwan, productivity per acre has been raised manyfold without any significant enlargement of farm size.[2] And it can be similarly raised in most small-farm situations.

The technological changes that are relevant in the immediate future as well as economically most efficient at current factor prices, such as improvement of varieties, better water management, and fertilizer use, do not necessarily require the enlargement of the farm. The mechanization of some operations – particularly timely plowing and irrigation – may be necessary to make multiple cropping possible but this can be done through cooperative ownership or rental without changing farm size.

The central principle is that the economies of scale do not obtain to the same extent in all operations that constitute farming. The economies may be significantly large in the case of some operations and unimportant in others. It follows that the farm may be enlarged in some dimensions while the dominant managerial unit remains small. Thus the scale of some of the land improvement, irrigation, input purchase, output sale, and fund-raising operations may be enlarged, while the plowing, tilling, and harvesting operations continue to be performed on a small family-farm scale.

[2] The conventional measurement of farm size in terms of a single input, the area of the farm, and the measurement of productivity as productivity per acre are questionable in theory and may be misleading in some situations. They are used in this discussion on the assumption that in labor-surplus, small-farm situations they are adequate for operational purposes.

Recognition of this principle of selective enlargement of scale will open up numerous possibilities of farm organization that are now blocked by bipolar ideological controversy. This principle is implicitly embodied in the farm reorganization patterns that have proved to be most successful in raising productivity in many countries. It is the core of every agricultural structure of small family farms served by large-scale cooperative and public agencies, but it needs to be enunciated and applied as an explicit principle. One of its great merits is that it makes it possible to leave untouched those family farm dimensions whose collectivization would have the most damaging effects on farmers' incentives.

Conversely, this same principle implies that inefficient large estates can be broken up in respect of the land unit of some operations without impairing productivity, provided that some large-scale common services are maintained intact. On the other hand, efficient plantations usually cannot be broken up without loss of production. These plantations should be treated like indivisible industrial enterprises, and the promotion of equity should take the form of income redistribution through wage bargaining, taxation, and social security rather than land property redistribution.

THE CONTENT OF AGRARIAN REFORM

Tenure reform takes two main forms: security of tenure and rent reduction, and redistribution of land among tenants. In Asia, except Japan and Taiwan, the emphasis is on security and rent reduction, while in the Middle East and Latin America it is on land redistribution and peasant proprietorship. No country approaches the content of either main measure in the same way, and the approach chosen depends upon the answer to this basic question: For whose benefit and for how large a group of beneficiaries is the reform designed? If the reform is indeed one for the benefit of the great majority of the tenants, its specific content and its enforcement will differ substantially from a reform attempting to satisfy both landlord and tenant in the difficult conditions of scarcity of land, land monopoly, high rentals, high land values, and subsistence farming. The Japanese and Taiwanese reforms reflect a thoroughly pro-tenant attitude. Hence they emphasized ownership of land for the majority of tenants through the abolition of absentee ownership altogether and a low land ceiling for resident landlords; genuine security of tenure and low rentals for the remaining tenants; arbi-

trary and low valuation of land prices; easy repayment terms; and a type of enforcement in which the tenants play a major role in order to ensure a minimum of evasion. These reforms involved drastic redistribution of property, income, political power, and social status at the expense of the landlords. This was the purpose of the reforms, the basic proposition being that half measures or attempts to satisfy both parties could not bring about conditions under which those who cultivate the land would enjoy the fruit of their labor.

Although the abolition or near-abolition of tenancy has been the ideal of many land reform movements, it is debatable whether tenancy can ever be entirely abolished even if the man-land ratio is favorable, for a variety of circumstances may cause it to continue to some extent in all situations. When the man-land ratio is extremely unfavorable, and is likely to remain so for a long time, the early abolition of tenancy may be a utopian hope. Even if a redistribution of land is carried out, every rural family cannot possibly be given a piece of land sufficient to provide subsistence; therefore the landless are bound to take, and the landowners bound to offer, land under tenancy arrangements of one kind or another. The argument can be made that in the short run, the realistic course of policy in some cases is to recognize the inevitability of some tenancy and to legalize and promote the most productivity-oriented form of tenancy, not to attempt to outlaw it (and thus promote the worst and most insecure forms of illegal tenancy). The long-run goal of redistribution can be pursued at the same time. The main problem of tenancy regulation is likely to be finding a form that is possible to enforce.

Almost all tenancy arrangements have some adverse effect on the incentives of the operator and cause him to employ fewer resources than he would if he did not have to give a substantial part of his output for the mere right to cultivate. But empirical research is urgently required to determine the precise manner in which alternative tenancy arrangements – money rent as opposed to crop-sharing – affect input use and productivity in developing countries. Some conditions of efficient tenancy, however, can be safely set out a priori. A money rent fixed for a long period is most likely to induce the tenant to intensify cultivation, but the reason for the widespread prevalence of crop-sharing tenancies is that this system reduces the tenant's burden in the event of crop failure. Thus, although a shift to fixed money rent contracts would be highly desirable, and is a feature of most attempted rent reforms, it is not likely to come about on a large scale unless the risks of cultivation are reduced.

Crop-sharing tenancy can itself be improved in many ways. The law should require that all tenancy contracts be written and registered. The landlord should be required to share a part of the cost of cultivation, varying with the proportion of crop received as rent. Managerial decisions should lie with the tenant operator, but the landlord might give informal advice. Tenancy should usually be secured neither for very long periods nor for very short periods, such as one or two harvest years. An intermediate tenure of five to ten years, subject to renewal, might be desirable so that the inefficiency of tenants is not perpetuated. In the event of a shift of tenancy, outgoing tenants should be entitled to compensation for enduring improvements made on the land.

Taiwan, more than any other country concerned with the problem, provides the strongest tenant occupancy rights. The Taiwanese law provides that farm lease contracts (of six years' duration) shall not be terminated before their expiration except if the tenant dies without an heir, or waives his right of cultivation by migrating elsewhere or changing his occupation, or if he fails to pay a total of two years' rent.

Such safeguards extend to tenants even after the expiration of the lease. The law provides that the landlord cannot take back the leased land for his own cultivation on the expiration of the contract if any one of the following conditions exists: the landlord cannot till the land himself; the landlord's income is sufficient to support his family; or the landlord's action in taking back the land deprives the tenant's family of its subsistence.

For all practical purposes this means that tenants can remain on the land undisturbed even after the expiration of the contract. This helped ensure the enforcement of the rental provision. Less carefully worded stipulations might have undermined this part of the reform program. In India, for example, the provision that a landlord can take back land for "personal cultivation" has proved to be a serious drawback in enforcing security of tenure and rent provisions.

Rent reduction has been attempted in several Asian countries, without revealing any common standard upon which reasonable rentals may be based. Some maximum rentals are 25 per cent of the crop in Japan, 37.5 per cent in Taiwan, 50 per cent in Nepal, and, in India, from 16 to 50 per cent. The reasons for these varying rents have virtually nothing to do with the apportionment of rent among the various factors that go into the growing of a crop.

There is a case for legislating such maxima, but in general it is nearly impossible to enforce them where, as in India and Indonesia,

the pressure of excess demand for land is intense. The maintenance of unrealistic legal rent maxima on paper only causes widespread evasion and brings law into ridicule. It would therefore be desirable to impose rent maxima only after considerable empirical evidence is collected about actual rents and enforceable rents. Ultimately the only way to make rent maxima as well as other provisions of tenancy legislation effective is to organize strong tenants' associations in all areas where tenancy is widespread. The case for such associations is analogous to that for trade unions.

Land Redistribution

The arguments are strong for the diffusion of ownership among the tenants as the ultimate purpose of agrarian reform even if tenancy regulation is also attempted. Though enforcement of redistribution in Asian conditions is no easy task, it is no harder to administer than regulated tenancies. Ownership is important in relation to investment credit because agricultural practices on new-owner farms need improvement, and this means new investments. Financial institutions, even if they are public, make a distinction between owned land and leased land in making loans. In the first case land is the security for obtaining investment, but this is not so in regulated tenancies with their continuous shifting of rights and duties between landlord and tenant.

The redistribution programs discussed here are all compulsory. An alternative, however, is fiscally induced voluntary redistribution through a scheme of progressive taxation of land holdings that rises steeply with the land's estimated potential yield. The tax on large farms of low productivity can be made so heavy that the owners are forced either to attain high yields or sell part of their holdings. If many large farmers are forced to sell, prices are likely to fall very low. This scheme, it must be emphasized, is no better than direct redistribution. The political will required to implement it is no less, the administrative difficulties and danger of evasion equally great. But policy makers can choose the alternative that seems to them to have the better chance of success in the given situation.

The Land Ceiling

In a program of direct redistribution, the immediate problem of reformers is to secure enough land to endow a given number of tenants with their own holdings. The central issue is the

"ceiling." The landlord is permitted to retain a certain amount of land (ceiling), the remainder being earmarked for redistribution among the landless. The amount provided by the ceiling (always assuming it is enforced) determines how far-reaching the program will be.

Since countries have varying amounts of land available and varying scales of tenancy, the ceiling is bound to differ from country to country. The basic difference, however, is that in some countries the ceiling is made to serve the objective of widespread ownership, whereas in others the ceiling can become a device for evasion. In Japan and Taiwan the ceiling encompassed all the land of absentee owners and in Japan permitted the resident landowner to retain only 2.5 acres. The landlord's holding is cut less deeply in South Vietnam with a ceiling of 250 acres and apparently deeply in Iran where a landlord is permitted to retain only one village out of many. In India the intent of a great variety of ceilings was defeated by lack of enforcement and widespread evasion.

Clearly what matters is not only at what level the ceiling is set but also that it not be evaded. The low, well-enforced ceilings in Japan and Taiwan made it possible to extract a great deal of surplus land for redistribution. Before reform 54 per cent of Japan's land had been owner operated, while after the reform the figure was 92 per cent; the respective figures for Taiwan were 60 and 85 per cent. In West Pakistan, on the other hand, the ceiling of 500 irrigated acres and 1,000 unirrigated acres – in a country where the holdings of two-thirds of the farmers averaged five acres each – was not really a measure for land redistribution. Moreover, subdivisions of large holdings among members of a family were permitted on the eve of the reform. This, combined with the high ceiling, meant that the land distribution program was meaningless. If a ceiling is to provide the landless with land it must be set at a low level; the acreage retained by the landlord must be fixed retroactively, or on a date well in advance of the reform; and, finally, the ceiling must be set on the basis of land owned by a household rather than an individual. With a low ceiling, no evasions, and effective implementation, large numbers of tenants can become farmer-proprietors.

THE LANDLORD'S COMPENSATION

Unless a reform is confiscatory, and the ones considered here are not, the question arises of how much to pay for the land obtained from landlords for redistribution. Usually the value of

the land for compensation purposes has been derived from one or a combination of factors such as valuations shown in land tax records, recorded land revenues, rent collected, landlord's net income, or value of produce.

Land prices in underdeveloped and densely populated areas are commonly very high, bearing no relation to the productive value of the land. Low assessments of agricultural land, comparatively low land taxes, and negligence in tax collections are among the main reasons for high market values. Added to this are the social and political prestige and influence that go with the possession of land, and a favored tax position compared with that of investors in commerce or industry. The combination of all these elements, plus population pressure, has made land values unrealistically high, a fact that must be faced by reformers in deciding what to pay for the land.

In Japan the price of land was fixed by capitalizing the annual rent in a manner to ensure a fair profit for the farmer buying the land (taking into consideration that all rice beyond what he consumed was collected by the government at fixed prices). In practice this meant 40 times the rental value of a rice field and 48 times the rental value of an upland field. These figures were well below the price level, which had been augmented by inflation. In Taiwan the government decided that the landlord would get 2.5 times the annual value of all crops on a given piece of land. In Italy, assessed valuations shown in the land tax records served as a basis of pricing. A number of Indian states used annual tax revenue or net income from the land as a base.

But whatever the method, with rare exceptions the price fixed has been below the market price. Land purchase under a reform is not an ordinary real estate transaction where seller, broker, and buyer meet in a free market. If it were, and if tenants were able to pay the going price, there would be no need for reform. Thus the price fixed by the government is an arbitrary one, and its level depends once again on the answer to the question: "For whose benefit is the reform designed?"

Methods of Purchase and Repayment

The government must as a rule buy the land and resell it to the tenant rather than institute direct landlord-tenant negotiations. Where land is at a premium and the economic and political power of the landlords is strong, the bargaining power of the tenant is so slight that an agreement can be reached only on the

landlord's terms. The two decades of Japanese paper reforms before World War II demonstrate this point. This is true in other countries in Asia where purchase transactions are left in the hands of landlord and tenant. In the long run this means prohibitive prices and no sales.

How a government pays for the distributed land is of great importance to government, landlord, and tenant alike. Most governments, no matter what the price, are not in a position to pay for the land in cash in one lump sum; Colombia and Venezuela are perhaps the only exceptions to the rule. Payments to the landlord are made mostly in interest-bearing bonds spread over a period of years, with cash seldom exceeding 10 per cent of the fixed price of the land. In the Philippines 50 per cent of the compensation may be paid in cash and the remainder in land certificates; however, very little land has been thus acquired, especially since prices are based on "fair market value." Payment through bonds, extended over periods of twenty years or more and bearing an interest rate of 3.5 to 5 per cent, has eased budgetary difficulties and has served to avoid the inflationary impact of large cash disbursements. In some countries the bonds are negotiable and redeemable in equal annual installments, or the bonds can be used for industrial and commercial investment or for the payment of taxes.

Taiwan's case is unique. To avoid the effects of inflation, which resulted in virtual confiscation in Japan, Taiwan tied the price of land to the prices of two principal products of the land and to shares of stock in government-owned industrial undertakings. Seventy per cent of the compensation was in the form of commodity bonds payable in twenty semiannual installments over ten years, and 30 per cent was paid outright in stocks. This method worked well for all parties concerned. The commodity bonds preserved the value of the sale price against fluctuations in the value of the currency for a ten-year period. And an estimated 40 per cent of the total compensation found its way into industrial and business investments. This is perhaps the only known case of an agrarian reform that has successfully used a land procurement program as a device for financing general development.

Methods of repayment to the government by the former tenants vary from country to country, but the underlying principle is that the payments must not constitute an excessive burden on the new owner. The government's annual recovery from the new owner must be less than his former rent. Usually repayments by tenants and

payments by governments for the acquired land are extended over a similar period of years. The government often aims to strike an annual balance between what it pays out and what it takes in. This does not necessarily work in practice for a number of reasons; most importantly because some governments have realized that, if land redistribution is to be viable, heavy investments are needed to improve the land and to create infrastructure to help the new owners during the formative years of the reform. The recovery of these extra costs is seldom charged directly to the new owners.

The record of repayments is on the whole good, because relatively easy terms have been set. In Italy, for example, a new owner pays an annual sum equivalent to $19 per acre, on the average, as against $40–$50 per acre on similar, nonreform land. In Venezuela the new owners amortize in twenty to thirty yearly installments a predetermined proportion of the cost of the land; improvements and the first year's working capital are provided by the government as a gift. In Egypt repayment is in forty annual installments, and, though the farmers are also charged 1.5 per cent interest and 10 per cent for administrative costs of the reform, the total they pay is considerably below the level of prereform rent.

Even with good recovery, reform imposes budgetary strains on the government. However, agrarian reform is not an ordinary commercial enterprise but one involving social justice and political stability, an investment in the future of the nation's people. If that agrarian reform leads to an increase in agricultural productivity, then eventually the government and the nation as a whole will more than recoup the investments called for by the initiation of a reform and its support during the early years.

Implementation and the Political Climate

Effective enforcement rather than legislation, however well drawn, makes the difference between real land reform and reform on paper. Paper reform is all too common in the underdeveloped world, and, with the exception of Japan and Taiwan, the situation in Asia leaves much to be desired. The landlords' property in South Korea has come into the hands of the tenants, but the government failed to provide financial assistance to the new owners, and the results have been unimpressive. The war in South Vietnam caused that reform to be short-lived. The Burmese tenants are owner-farmers now, but one government after another has failed to

take the other measures needed to develop Burma's rich land resources. The Philippines has four reform failures on its record and is trying for the fifth time with no better prospects than heretofore. West Pakistan and Indonesia have proclaimed reform but with hardly any implementation, while Nepal, after a dozen years of cogitation, is just barely taking the first step. India's record is mixed.

Ignorance of the tenantry's conditions or inability to draft legislation did not cause these results. Even Nepal, a closed and remote society only yesterday, is skilled enough to write good measures – if it wants to, and the same can be said of every country where reform has failed. Administrative and technical skills to mount a reform may be lacking, but this is not a crucial issue, and failure to implement a reform cannot be attributed to it. More important are inadequate measures or measures deliberately drafted so as to retard, if not obstruct altogether, the implementation of a reform; lack of peasant leadership to propagate the reform idea and exert pressure on legislative bodies; and disinterestedness, or overt opposition, on the part of intellectuals and other molders of public opinion. Most important, of course, is the opposition to reform by the landlords, whose role in politics is out of all proportion to their numbers. Land redistribution under agrarian reform is a compulsory measure imposed by a government upon the landowners on economic and legal terms unpalatable to them. It is a drastic redistribution of property and income at the expense of the landlords. It is revolutionary to the extent that it shifts political power and social status from one group in the society to another. This is the real meaning of an agrarian reform with land redistribution as its central objective. Thus land reform, despite its economic goals, is essentially a political question, a fundamental conflict of interest between the "haves" and the "have-nots."

Technical expertise in preparing and administering the necessary legislation is indispensable, but experts do not and cannot make reforms. Politicians, and only politicians, make good or poor reforms or none at all. They control the political climate, which determines the will or lack of will to proceed with reforms; the specific measures with which the reform is or is not endowed; the care or lack of care with which the enabling legislation is framed; the preparation or lack of preparation of the administrative services; the presence or absence of technical services; and, above all, the drive or lack of drive behind the enforcement of the provisions of the law.

The makers of reform must represent strong political leadership deeply concerned with the land and its cultivators and capable of

translating those concerns into action. There is no substitute for this leadership at the crucial stage of determining a reform's main goal and initiating it. The financial, technical, and administrative needs of reform can prove to be formidable obstacles, but experience shows – and India provides a number of illustrations – that these obstacles are not insurmountable if the concerted will of political leadership is brought to bear. The built-in landlord opposition, abetted by public servants, can be overcome if the political leadership is determined to carry out its goals. This leadership is especially needed because the peasantry has not developed a popular political movement capable of effectively advocating its own cause.

The Case of India

India, which has done both much and little, demonstrates how much can be accomplished when will and determination are present and how little can be attained if they are absent. India's reform objectives were twofold: first, the abolition of the zamindari system;[3] second, security of tenure, reduction of rent, and distribution of land to the landless. The zamindari tenures have been virtually abolished. Not all the 20 million cultivators affected have received permanent, heritable, and transferable rights, yet a major step was taken toward a reconstruction of Indian agriculture. The measure succeeded because it was politically popular to abolish a system whose abuses were imposed by a foreign power. With the British gone, the government went about drafting the necessary legislation; the zamindars were disestablished despite their opposition, the government's lack of financial means, and insufficient administrative and technical staff.

But in dealing with its indigenous landlord system India faltered, and very often badly, both in the content of the reform measures and in their implementation. Security of tenure, rent reduction, and landlord ceiling provisions have not been successfully implemented on the greater part of India's 80 million acres of tenanted land. In fact, perhaps as many tenants have lost their tenancies as have been made secure on the land. Such states as Maharastra and Uttar Pradesh have shown that, given strong leadership, many reform prob-

[3] The zamindari system was a product of early British rule. The zamindar was given the right to collect land taxes and undertook to pay the British administration a fixed revenue. In return he was permitted to keep a portion of the revenue and was also recognized as the proprietor of the revenue-bearing land.

lems can be dealt with successfully. But where antireform sentiment prevails, as it often does in Indian state legislatures, vague and complicated measures generously studded with loopholes, delays in legislative enactment, failure to inform the peasants about the law, enforcement officers who behave as if reforms are not meant to be enforced, and refusal to enlist the support of the farmer in helping carry out the program are the rule rather than the exception. With variations the same is true of a great many other nations.

THE CASE OF JAPAN

Japan and Taiwan, on the other hand, proceeded with their reforms whole-heartedly. They developed their own techniques of initiating and enforcing reform. The American occupation of Japan and the loss of mainland China for Taiwan were important elements in promoting reforms, but it remains true that a favorable political climate is the precondition of a sound reform and its implementation. In such an atmosphere even the would-be nonenforcers become enforcers, and technical difficulties are not excuses but challenges to be resolved. Since reform has an element of coercion, the key to its implementation is the willingness of the controlling political forces to use *all* instruments of government to attain their goals.

Even well-drafted measures in a pro-reform atmosphere cannot be easily enforced if the task is left solely to the bureaucracy. As we have seen, skilled manpower is scarce, and the attitudes that prevail in most bureaucracies are not conducive to social change. There are never enough bureaucrats and reform experts to go around; the experts become experts only in the process of applying the reform. If a reform is to be carried out successfully, it must win the active participation of the people directly affected by the reform, the farmers, who best know the conditions of their rural community; the principle of local involvement applies to land reform just as it does to the other aspects of agricultural development. This has not been recognized by most countries currently engaged in reform activities.

Japan is the pioneer in entrusting the villagers with the major share in implementing reform, and the Japanese experience is one that other countries might well ponder. The device created by Japan for the administration of the reform at the village level is the local land commission made up of five tenants, three landlords, and two owner-cultivators – all elected by their respective groups. The number of tenants means that if only one owner-cultivator sides with

them a working majority is ensured in the commission. The commissions were entrusted with the actual purchase and sale of land. They had broad powers that they could exercise with a minimum of governmental interference. These included: drafting the purchase plan for each village, determining the suitability of the land to be purchased, establishing the eligibility of purchasers, deciding cases requiring unusual or special treatment, and appraising cases of exemption from the purchase provisions. The Japanese reformers knew that no staff could have been gathered to deal quickly with the transfer of 30–40 million plots of land and that only the local people knew at a glance who was who in the village, who owned what land, who leased land and how much, and so forth.

The work of the local commissions, coupled with the successful effort to bring to the attention of the farmers the basic points of the reform, justified expectations. Without them the reform probably could not have been carried out so speedily and in such orderly fashion. Most important in the long run, the duties they performed served to stimulate new local leadership. Tenant members who started out ill at ease and insecure were seasoned performers a year or two later. The process of creating the commissions involved the adult farm population in voting on a matter of utmost concern to all groups in the village. The makeup of the commissions proclaimed that the tenants' interests were to be protected by the tenants themselves rather than by someone acting on their behalf within the traditional paternalistic pattern of rural Japan. At the height of the reform approximately 150,000 commissioners had received this special leadership experience and half of them were tenants. The absence of paternalism, of outside dictation, promoted the local responsibility and initiative that, as we have argued elsewhere, is a vital underpinning to sustained agricultural as well as social progress.

The case of Japan shows how reform can narrow traditional class differences in the village. The tenants step up, the landlords step down. As the landlord loses affluence, he loses influence, even though he is not eliminated altogether. What is taking place now in the Japanese village is the sharing of power between the old and the new leadership. Both are meeting now on the agricultural committees, cooperative and school boards, and in village offices. They rub elbows dealing with common problems. This new leadership and the idea of citizenship rights were foreign to prereform Japan. The passing of second-class citizenship for peasants is a symptom of a new social order and of greater political maturity and independence. This

is expressed in the attitude of the citizen toward government and political parties of power Unlike prereform days, voters pick and choose according to the candidate's own proven concern with farm conditions and the record of his party's agricultural policies. The actions a government in power takes with respect to the price of agricultural product or fertilizer, land improvement work, and short- or long-term credit funds now affects the distribution of the vote.

When an agrarian reform is carried out along these lines, changes in social status and political attitudes in the countryside are inevitable if remaining in power requires popular support of the peasantry. What Japan did with a literate farm population need not be ruled out in other countries where farmers are not literate. Even illiterate farmers know their own condition and that of others in their community. A judge in court may dispute a farmer's occupancy right because he lacks a written contract, but there is hardly a village where the tenants, like the Japanese tenants, do not know the details of the existing pattern of tenure. This knowledge, if enlisted through some organization, not necessarily the Japanese type, could greatly aid any reform effort. So long as the would-be beneficiaries are treated as mere onlookers – the case in most reforms – the reform has little hope of success. The paternalist assumption that only white-collar officials can administer a reform reflects elitist attitudes that are a handicap to agricultural growth in general.

REFORM AND PRODUCTIVITY

Since insecure and difficult tenure depresses production, it is often assumed that agrarian reform with ownership as its objective makes for higher productivity. This assumption may or may not be correct depending upon the circumstances surrounding the fact of ownership. In Latin America, for example, many a private owner of a hacienda has not proved to be a good producer – and many a small owner has done no better.

Measuring the productive effect of ownership is extremely difficult. While assessment of output is comparatively simple, the contribution of a land distribution program to productivity cannot be separated with any degree of accuracy from that of other factors affecting output. But a close interrelationship between agrarian reform and productivity does exist if the reform includes in addition to ownership of the land or secure tenure, the supporting elements of irrigation and other inputs, credit, marketing, and so on. Without

these added factors agrarian reform does not necessarily lead to increased output.

If the anticipations of the beneficiaries of agrarian reform are not to be thwarted, the government must be prepared at least in the initial stages to invest in a variety of other measures that promote agricultural productivity. On the other hand, efforts to promote productivity where tenancy reforms are needed are likely to be adversely affected by the existing tenure system. Unless new inputs come to overburdened tenants as a gift or under exceptionally favorable terms, the chances are that they cannot afford to innovate. Thus the agencies concerned with building a technical and organizational base for raising productivity must be equally concerned with reforming existing tenures when these constitute a handicap.

In overpopulated rural areas an agrarian reform, even with all the supporting services, cannot solve all the problems standing in the way of a better livelihood and greater production. Reform can do nothing to change the land-man ratio. With no alternative occupation outside of the village, the rise in the farm population is bound to reduce the size of holdings that are already small and to increase the number of farms as sons and grandsons take over. This is obvious even in prosperous Japan. While in the United States between 1920 and 1957 the number of farm units was reduced by 22 per cent and the working farm population by nearly 40 per cent, in Japan during the same period both categories increased by 10 per cent despite the country's striking industrial upsurge. Japan's nonagricultural economy has served as a safety valve by providing the farmers with 40 to 50 per cent of their income. Clearly this is not possible in nations without substantial nonagricultural economies.

Agrarian reform in such conditions is not a solution of all the farmer's problems. But it can do away with the worst features of a system that is economically, socially, and politically outmoded. Reform is a means of elevating the human condition. Even with all the material inputs of water, seeds, fertilizers, implements, and credit, the peasant needs the psychological incentive that comes with being secure on the land, particularly on land that belongs to him, for this uncertainty is one of the great disincentives under which a farmer labors. In any attempt to provide a better material and organizational base for the rural sector, the solution of the land tenure problem is the clearing of the ground, the preparatory step for all else, the sum total of which raises agricultural productivity.

CHAPTER EIGHT

Four Success Stories and Their Lessons

Success stories in agricultural development carry with them the danger that they will be imitated rather than understood. Blind emulation of what has worked in another context usually leads to failure. If it is true that temperate zone farming methods cannot be transplanted wholesale to the tropics, it is equally true, though far less obvious to many planners, that an institution that works in one underdeveloped area cannot be transplanted to another without adaptation. The lesson of the four projects described in this chapter lies not in specific techniques but in the approach they have taken to development.

The Comilla project, for example, has worked out a promising method of organizing farmer cooperatives in East Pakistan. The immediate impulse of planners in other nations is likely to be: "Let's do it the Comilla way." Yet the lesson of Comilla is precisely the opposite. Pakistan had tried cooperatives long before Comilla; these attempts, based on European models, had failed. Comilla's method was based on the understanding that European models could not be imitated, that a model must be worked out in the Pakistani setting. Thus, the planner who blindly adopts Comilla's cooperative structure is not doing it "the Comilla way," but is doing the contrary of what Comilla did.

The nature of these four projects varies greatly. Gezira in the Sudan is an irrigation scheme with a high degree of central control. Vicos in Peru is a small community development project created by United States anthropologists. The Joint Commission on Rural Reconstruction in Taiwan is an autonomous organization that has found working outside the state bureaucracy to be an asset; while working within the bureaucracy is a basic principle at Comilla. In addition to varying techniques and philosophies, one often finds in these programs a unique political or personal element that has made a crucial contribution to its success. In the case of Vicos, the intervention of Senator Edward Kennedy, then passing through Peru, swung a key decision. The relatively free hand that the Comilla innovators have enjoyed was largely due, certainly at the beginning, to the status that

the project's guiding spirit, Akhter Hameed Khan, a senior civil servant, held in the Pakistani power structure.

Despite their differences, these four programs have one characteristic in common: their designers took into account all the major factors involved as they applied to their conditions and resources. A project might begin with a single apparent input, such as cooperatives at Comilla, but the other factors involved were well enough understood so that bottlenecks could be foreseen and overcome as they appeared. This sort of planning is the only "secret" to these successes, and it is perhaps the most difficult lesson to emulate. If this principle were understood and applied, much more productive use could be made of the existing resources of the underdeveloped nations.

East Pakistan: Comilla

The Academy for Rural Development was founded in 1959 under the leadership of Akhter Hameed Khan. Khan's aim was to apply social science to rural development in a pilot program combining action and research. At Khan's request, the Academy was given the Comilla area as its staging ground.

Comilla is a thana (an administrative unit) with a rural population of about 150,000 in some 300 villages. It lies in the monsoon region and its agriculture consists mainly of an annual crop of rice. The area suffers from desperate poverty and overcrowding.

The typical village in Comilla Thana includes 50 to 125 families with 200 to 250 acres. Of those families, about one-fifth are landless laborers who are at the bottom of the ladder; 5 to 10 per cent are relatively well-off farmers who own 10 to 15 or more acres. The majority of the villagers are small farmers who own 1.5 to 3 acres. Their condition appeared to be getting steadily worse when the Academy was founded. With population growth, their holdings were diminishing in size, and an increasing proportion of small farmers could no longer own bullocks for draft. Caught in a credit squeeze, small farmers were forced to rent bullocks from the larger farmers and to borrow at 60 to 80 per cent interest.

In 1959 the formal structures for development existed in Comilla, but they did not function effectively. Cooperatives and extension services existed on paper but did not produce results. Research had developed and tested improved practices, but the farmers did not adopt these practices even when they knew about them. Little co-

ordination existed among the various units of government and the technical services. An ambitious development program known as Village-AID was in process of failing. A general hopelessness, a feeling that "nothing can be done," seemed to pervade both farmers and bureaucrats.

The Academy's social scientists began by studying village social structures and attempting to analyze past failures in cooperatives and extension. The basic cooperative unit then included 10 to 15 villages with a government-appointed manager. Loan recovery ran under 50 per cent, and many of the loans were going to the richer farmers who loaned the money out again at usurious rates. The cooperative's managing committee was typically dominated by the richer farmers. The immediate flaw, the Academy decided, lay in the size of the cooperative unit: it was impossible to develop any bonds of trust among the inhabitants of several villages.

Extension included the usual gamut of technical services. The point of contact with the farmer was the village-level worker, a government employee — usually a young man with a secondary education — assigned to live in the village. The Academy found three major flaws in the existing system. First, there was virtually no coordination among the technical services, so that innovations could not be presented as a package and inputs were not delivered when needed. Second, the Village-AID program had bypassed the regular civil administration, and was therefore cut off from the main source of bureaucratic power. The third flaw lay in the role of the village-level worker. No effective communication took place between him and the farmers. Because of his education, he disliked living in the village. For their part, the villagers viewed him as an outsider, an agent of a government which they mistrusted. Nor did they respect him as a source of advice, for they knew far more about local farming conditions than he. Thus the encounter between farmer and agent of change was a failure on both sides. The Academy reached the conclusion that educated people could not be successfully sent into the villages.

The Academy's effort to overcome these barriers centered on new channels of communication. The headquarters of Comilla Thana's civil administration and technical services were moved to the Academy itself. This involved no formal change in the existing power structure. The existing services, not the Academy, continued to hold the decision-making power. However, the decision makers were brought together in a new environment. The Academy setting made

possible a continuous interchange of information among the services and with the Academy's staff of social scientists. Thus the decision-makers were continuously exposed to the results of the Academy's research on their operations.

Comilla's new cooperative and extension systems were designed to place the primary responsibility for diffusion of innovations on viable village-level organizations. The basic cooperative unit now is the village cooperative, which typically has around 50 members. (These units are joined in a thana-wide Federation, which provides central banking services.) In this group, everyone knows each other and bonds of trust can be established. The outside manager was eliminated. Instead, the members themselves choose an "organizer." In the extension system, the outside village-level agent was replaced by a "model farmer," again chosen by the villagers.

These men chosen by the villagers are the agents of change. They spend one day a week at the Academy, attending classes and discussing their local problems with the staff and the technical services. They also attend a weekly meeting of the cooperative in their village. The cooperative rules require this weekly meeting and require also that each member contribute a sum, no matter how small, at each meeting. The weekly meeting serves to diffuse information from the Academy. It also serves to assure that the small farmers will be well enough informed on the workings of the organization to keep control of the cooperative. The physical inputs themselves are also available at the Academy: a model farmer who has learned to use fertilizer can at the same time obtain the actual fertilizer. The weekly visit to the Academy, in addition to providing information and inputs, provides the agents with continuing support from outside the village.

Comilla has also started pilot schemes in mechanization, providing pumps for irrigation and tractors, and in education and family planning. Despite its promising record, Comilla has been cautious about expanding too fast. Khan has refused to plan for other regions; instead, he has suggested that young officials be assigned to Comilla for a year or two, after which they can draw plans for their own districts.

Comilla remains a pilot scheme, rather than a widespread development program. Its distinctive features are the joining of action and research, so that the results of its self-evaluation are fed back into the decision-making process; the new channels of communication between bureaucracy and farmers, and among the bureaucratic serv-

ices; and the development of innovating leadership within the village. These general principles, as opposed to Comilla's specific techniques, may be applicable in other parts of the underdeveloped world. What is not transferable, however, is the key factor of Akhter Hameed Khan himself, with his rare combination of innovating drive, personal charisma and high status within the Pakistani power structure. Whether Comilla could have been started without him remains a crucial unanswered question.

SUDAN: GEZIRA

The Gezira scheme is an intensive irrigation project in the Sudan between the Blue and White Niles just south of Khartoum. Planned early in this century, the dam and canalization for 300,000 acres were completed in 1925. Gezira now has some 70,000 settlers and covers 1,800,000 acres.

Gezira has succeeded where all too many irrigation schemes have failed. Its benefits have gone to most of the people in its area, rather than being restricted to the most skilled farmers. It has brought the benefits of large-scale estate management to peasant communities without sacrificing individual motivation. The settlers' income is considerably higher than that of other Sudanese farmers. The scheme has repaid its costs and is now a major source of foreign exchange and development capital for the Sudanese government. Thus it benefits the nation as a whole, not merely the settlers.

When Britain gained de facto control of the Sudan at the turn of the century, it found government revenue inadequate to administer, far less develop, a vast land with virtually no communication system. The Gezira scheme was intended to provide that revenue. While damming the Blue Nile to irrigate the neighboring plains was feasible from an engineer's standpoint, the idea faced imposing obstacles. The capital needs were far beyond the apparently available means. A new cash crop would be needed to pay off the capital investment, and no transport existed to get that crop to a foreign market. Nor was the Sudan government equipped to manage such a large-scale enterprise. The government wanted the project to benefit both itself and the Sudanese farmers. To ensure profitable production, the scheme's planners felt, they must do more than simply provide water and let farmers fend for themselves, as was then happening in the Indus Valley in India. If the farmers were to benefit, the land itself must be kept out of the control of resident or alien landlords, as was then the case in Egypt and Rhodesia.

The cash crop selected was cotton, then in demand in Britain. A railroad was built to the Red Sea coast, financed by an interest-free loan from the British-controlled government of Egypt, granted on the ground that the railroad would serve the defense of Egypt. The management and part of the capital was provided by bringing into the scheme a private company, the Sudan Plantations Syndicate, which was already growing cotton under irrigation. The company was to manage the scheme under policies laid down by the government. Its participation was limited to 25 years.

The farmers were to be profit-sharing tenants, not owners or employees. The annually-renewed tenancy contract was designed to ensure that the farmers followed a prescribed rotation of cotton, food and fodder crops and fallow. Tenancy limited to 30 acres per family protected the farmers against landlord control. Profit-sharing gave each partner a stake in the success of the scheme. It applied only to the cash crop, cotton; the food and fodder crops belonged to the tenants. The division was 40 per cent for the tenants (later raised to 45 per cent), 40 per cent for the government, 20 per cent for the company. Much of the management has gradually been transferred from the bureaucracy to farmers' associations.

Some of the policies that seem to have contributed to Gezira's success, though once again the important fact is that all the factors were taken into account, are the following:

1. The scheme found what proved to be a happy balance between paternalism and farmer participation. The social controls imposed at Gezira were intended to protect the settlers against exploitation and to maximize production without, however, stifling individual initiative. The organized services provided to the farmer made him better able to cope with his environment, but his returns nonetheless depended on his own effort. For example, the cropping system was laid out in such a way that modern machinery could be used, though the individual farmers could not afford to own the machines themselves. Thus the motivation of the family farm was retained, but the farmer also benefited from the economies of scale in the supporting services. This is an illustration of the selective extension of farm size advocated in Chapter 4. The Moshav system in Israel is another example of the same principle.

2. The scheme concentrated on the area of the Sudan that had the greatest potential, and the economic objective was uppermost. The scheme was designed to make money for all three partners (government, company, and farmer), and the profit for each was directly related to yield. Gezira may well have benefited from the poverty in which it was conceived. Because capital and management were so scarce, the scheme had to be carefully planned, had to be as simple as possible, and costs had to be held down.

3. The inclusion of experienced private management filled a gap in capital needs and provided an element of drive and efficiency often lacking in a bureaucracy to whose members loss or gain is less immediately important. The company's participation supplied the factor of organizational feasibility. At the same time, the 25-year limit on its participation allayed the fear that Gezira would remain under the control of foreign private capital.

4. Long research and experimentation preceded the actual construction. The first pilot scheme was started in 1912, thirteen years before the dam was completed. This work provided extensive experience with production methods and made it possible to determine the optimum farm size of 30 acres. The pilots also had the important effect of converting the peasants to the scheme. When it was first proposed, peasant opposition was almost unanimous. A pilot scheme, using pumped water, was then conducted on 600 acres. This demonstration brought a shift in community opinion in favor of Gezira.

5. The combination of subsistence and cash crops cushioned the settlers against the effects of a fall in the price of cotton.

6. The scheme's simplicity reduced the burden of change on both farmers and management. Change was imposed on the farmers, but no more change than was necessary to the success of the scheme. Most of the settlers already lived in the area; Gezira brought the water to the farmer, not the farmer to the water. Of the three crops, two – the food and fodder crops – were already grown in the area. An assured supply of water for familiar crops met a strongly-felt farmer need. The division of profits on cotton followed existing custom in the Nile Valley, whereby the landlord supplied all inputs except labor, and took 60 per cent of the crop.

Gezira's simplicity also made extension easier. Since the new inputs were relatively simple, the extension personnel did not have to be highly trained. Several functions could be combined in one person. A single man in an office, no farmer being more than eight miles from an office, could provide technical advice and inputs, credit and any other information needed by the farmer. Since there was no need for specialists, who tend to be transients, Gezira was able to build up a permanent staff that could gain the farmers' confidence.

PERU: VICOS

The Vicos project, smallest of the four described here, had its origin with Cornell University anthropologists interested in the interaction between technological and social change.

The project took place on an 18,940-acre hacienda at Vicos in the highlands of Peru. Cornell rented the hacienda in 1952. It had about

1,800 inhabitants who were Indian serfs and it was being operated under the traditional feudal system that required the serfs to give three days of labor weekly to the land of the patron, 3,850 acres of the best land in the hacienda. The Indians also had their own small plots of poorer land.

In effect Cornell became the patron of the hacienda. The aim of the Cornell group was to set in motion the general process of modernization keyed to an increase in agricultural productivity. Before launching any development projects, the Cornell group spent a year studying the Indian community's needs, motivations and social structure, and attempting to gain rapport with its members. Projects were to be determined only in collaboration with the community.

Contrary to expectations, the Cornell group found that the Indians did not resent the three weekly days of labor they had to give the patron, but they did object, and bitterly, to the extra services he often exacted. Cornell's first move therefore was to abolish all extra unpaid duties, an act which gained support for the new patron.

The three days of labor were used to introduce innovations on the hacienda's land, the production from which was to provide capital for other development projects. Potatoes, the staple food, were being badly damaged by blight. Research had already shown that the blight could be controlled, and pest control was successfully introduced on the supervised patron's fields. Diffusing this and other innovations to the Indians' individual plots was more difficult. The Cornell group had found a vacuum of community leadership. Eventually the leaders for innovation were found among the younger, disaffected Indians, not in the existing leadership.

Potato production rose rapidly. With the capital it provided, the hacienda was able to buy a truck to take its produce to market (which increased hacienda revenue from the potatoes) and to invest in such social projects as education. In purely economic terms, the project was highly successful. In ten years, per capita annual income at Vicos rose from $40 to $250; the average for Peru is $179.

Cornell's ultimate aim was to develop local initiative and self-reliance toward the day when the Indians could replace the foreign patron. After the five-year rental period was up, Cornell felt that this point had been reached. One sign of this was that the Indians, once obsequious, were now willing to challenge the decisions of the Cornell group. A striking example occurred later on when the Indian council at Vicos voted to expel its Peace Corps contingent – an act that would have been inconceivable only a few years before.

Cornell suggested that the Peruvian government expropriate the

hacienda from its absentee owner and sell it to the Indians. Because of opposition from interests that disliked land reform, this process took five years; the sale was finally brought about when Senator Edward Kennedy, visiting in Peru, intervened with the government. During those years it was observed that production at Vicos rose and fell according to the Indians' expectations of getting title to the land. When at last it became theirs, production almost doubled in a single year.

The patron's land is now held communally and managed by an elected Indian council. Cornell plays only a consulting role. Labor productivity has increased so that it has been possible to reduce the time spent on the patron's land from 152 to 35–40 days a year. (One reason is that the Indians' unmotivated labor under the old system had been extremely inefficient.) The success of Vicos has even reversed the trend toward migration to the cities: some 30 families have returned to the community. However, Vicos as yet has had little demonstration effect: few of its innovations have spread to other communities.

The most distinctive feature of Vicos is that the agents of change were foreign to the nation as well as the community, and were therefore relatively free from the constraints imposed by the Peruvian power structure. If, as seems likely, this was a controlling factor in the success of Vicos, then clearly this project is at best of limited relevance in other situations. Other features of Vicos worth noting are: community attitudes were carefully researched before any project was launched; the development of self-government was a primary goal; community structures such as the hacienda system were not destroyed but adapted to development purposes.

TAIWAN: JCRR

The Joint Commission on Rural Reconstruction was created in 1948 by the governments of the Republic of China and the United States. Three of its five commissioners were Chinese and two American.

The JCRR is distinctive among these four programs. It is the only program that is diffuse – covering virtually the entire island of Taiwan – rather than concentrated in a relatively small area. It is by far the largest of the four; its staff includes 89 specialists. The joint creation of two governments, the JCRR is a separate organization that does not form part of either the Chinese or U.S. bureaucracies. This

has given it a large measure of freedom from political pressures and bureaucratic regulation.

The JCRR views itself as a catalyst to stimulate rural development and agricultural growth. It helps those who help themselves. It seeks to promote the Confucian ideal of social justice by means of Western science and techniques. Agriculture is the main focus of the JCRR's activities, but it also operates in such related fields as marketing and rural public health. Agriculture has progressed rapidly in the years that JCRR has been in existence; production doubled between 1952 and 1964. (One of JCRR's most noted successes, the campaign against rats, is described in Chapter Three.) The JCRR has dealt with all the factors affecting agricultural productivity – and, unlike the three other programs, it has dealt with them on a national scale.

Like Comilla and Vicos, the JCRR has brought the farmers themselves increasingly into the process of development. The JCRR relies heavily on farmers' associations. Though the agricultural four-year plans are drafted at the center, they are revised in consultation with farmers' associations and local governments.

Many activities launched at the center by the JCRR have been turned over to the farmers to manage. The typical pattern is this: a period of study is followed by an action program managed by the JCRR or the central government; then the farmers take over full or partial management. The rat program, for example, was studied for three years (1950 through 1952), launched in 1953, managed from the center until 1959, and is now managed locally. Other examples are programs for renewing rice seed, rice nursery improvement, introduction of machinery and implements, all of which are partly managed by farmers. All public health, including family planning, is conducted in partnership with local institutions. The prime burden of extension work has been assumed by the farmers themselves. Extension agents are hired by the farmers' associations, which bear two-thirds of the cost; the rest is paid by the government and the JCRR. The extensive farmer cooperatives employ some 13,000 persons, many trained by the JCRR.

The JCRR was able to operate as it did because Taiwan is an exceptional case among underdeveloped countries – if indeed the island can still be classed in the underdeveloped world. The island itself is small (12 million people and 14,000 square miles); what is "nation-wide" on Taiwan would, in India, be a small regional program. The central government had both the will and the means to reach its people – one example of this is land reform, which suc-

ceeded on Taiwan while it has failed in most Asian nations. (See Chapter 7.) The special relationship of Taiwan to the United States meant that the island enjoyed large amounts of American aid; it also made possible the joint Chinese-American operation of the JCRR, which would have been politically unacceptable in many nations. When the JCRR began, the farmers of Taiwan already were relatively highly skilled, used to working throughout the year, and open to innovation. Perhaps most important, Taiwan had an abundant supply of trained manpower – so abundant, in fact, that Taiwan is sending technicians to other nations.

Thus there is little in the experience of Taiwan that underdeveloped nations can easily emulate. It serves little purpose, for example, to dwell on the crops saved by rat control if the nation in question lacks the resources to carry out such a program. The lesson of Taiwan and the JCRR is that agriculture is capable of rapid growth, but only if all the necessary factors are present. This underlines the importance, to governments of underdeveloped and aid-giving nations alike, of investing in the physical and human infrastructure that made Taiwan's success possible.

CHAPTER NINE

The Rice Regions

The Region and Its Problems

Wet rice culture predominates in the rainy tropics and subtropics of East and Southeast Asia where the rainfall is adequate for paddy cultivation. Here we consider the rice growing regions of Japan, Taiwan, the Philippines, Thailand, Indonesia, Vietnam, Laos, Cambodia, Burma, East Pakistan, and Southeast India.

Projections of the demand for food in most of these countries indicate that, assuming the present population growth rate of about 2.5 per cent and the present degree of self-sufficiency, an annual increase in food production of from 4 to more than 5 per cent is necessary to meet the demand associated with a modest rate of economic growth. But the actual rates of increase have averaged only about half this required rate, and in parts of the region per capita production has declined. Little additional land is available, and yield increases are slow and spotty.

We therefore set ourselves the task of identifying the "package" of measures – of technological improvement as well as socioeconomic policy – that could increase production per acre more rapidly over the next few years and at the same time provide the foundation for sustained growth over the longer run.

Although the focus here is on means to increase productivity per acre, measures to promote equity should receive special attention. Beyond its intrinsic value, social equity contributes to and provides incentives for increasing production. Raising the level of living over the longer run will also require that measures to control population growth accompany measures to increase food production.

Diversification of the human diet should be an important objective for the wet rice region. The need for proteins and vitamins is acute in these areas. This means a progressive shift from rice monoculture to diversified agriculture as well as an increase in rice production. Such a shift is also essential to any substantial long-run growth of output in these areas.

The region's major problems fall into five categories: economic

incentives, the use of fertilizer and other improved practices, multiple cropping and water, organization for agricultural development, and land tenure. The wet rice countries differ greatly in the effectiveness with which they have handled their problems, differences that are reflected in different levels of productivity.

ECONOMIC INCENTIVES

The ratio between the market price of rice and the cost of fertilizer and other purchasable inputs is much less favorable to the farmer in most of these countries than in, say, Japan or the United States. The price-cost ratio is particularly unfavorable in the export countries of Thailand and Burma, where domestic rice prices are held substantially below world export prices. In India the spread between the prices in producing and consuming regions is high, and price fluctuations are wide because of regulations hampering grain movements and the lack until recently of effective price guarantees. Rice prices fluctuate widely in several other countries, whereas supports have stabilized rice prices in Taiwan and Japan.

In contrast to the relatively low price of rice, fertilizer prices are substantially higher in most of these countries than in the United States or Japan. In several countries the price reflects import regulations or higher-cost domestic production. High distribution costs are another important factor.

Measures to improve economic incentives may include raising rice prices, price supports, reducing input prices, or innovation insurance schemes, depending on the situation in the various countries.

In exporting nations where domestic rice prices are well below the export price, and in importing countries where the price is low relative to other imported goods, a case can be made for raising prices. Higher prices promote the use of yield-increasing practices and are simpler to administer than input subsidies. The general association of prices with yields and fertilizer consumption is shown in Table 5.

FERTILIZER

Much more fertilizer is used on rice in Japan and Taiwan than in the rest of the region. The importance of fertilizer and improved practices is widely recognized, however, and in several countries fertilizer production is being rapidly expanded. Substantial results can be obtained with known fertilizer and technology. For example, the Indian Council of Agricultural Research has summarized the results of an extensive series of fertilizer trials on farmers' fields. For rice they indicate returns of roughly 200, 120, and 20 pounds of

TABLE 5. RICE: PRICE, YIELD, AND FERTILIZER CONSUMPTION

Country	*Price of Rough Rice (U.S. Cents Per Kg.) 1960–61*	*Kgs. of Rough Rice Equivalent in Price to 1 Kg. of N 1960–61*	*Total Consumption of N,P,K, (Kg. Per Hectare) 1962–63*	*Yield (Kg. Per Hectare) 1961–63*
Japan	15.6	1.78	270.1	5050
Taiwan	10.0[1]	4.10[1]	190.0	3210
India	6.6	5.58	3.4	1480
Philippines	7.8	4.13	9.4	1220
Thailand	5.5	4.36	2.1	1430
Pakistan	11.0	1.27	5.7	1590

[1] Estimated. Not given in source.

Source: *Changes in Agriculture in 26 Developing Nations, 1948 to 1962.* Foreign Agricultural Economic Report No. 27, U.S. Department of Agriculture, Tables 41 and 42, pp. 56 and 57.

milled rice, respectively, for 20-pound inputs of N, P, and K. Comparing these figures with those in Table 5 shows that this 10 to 1 return on N provides an attractive economic incentive in some countries but not in others.

MULTIPLE CROPPING AND WATER MANAGEMENT

This factor deserves special emphasis in the wet rice region. Most rice is still grown under uncontrolled annual flooding that limits production to a single crop a year. Multiple cropping of rice and other changes in the cropping pattern can be introduced only if water management is improved; this would give much wider scope for increased fertilizer use and improved varieties. However, water management also increases the needs for research, extension and credit.

The extent of irrigation and multiple cropping varies greatly in the region. Most of the riceland in Taiwan is irrigated and multiple cropped; India and East Pakistan have substantial areas serviced by improved canal irrigation, drainage, and tube wells. In most other wet rice areas, some irrigation development is under way, but the portion of the land benefiting from the controlled use of water remains small.

RESEARCH AND ORGANIZATION

In contrast to the rain-forest tropics, considerable basic research has been done on the wet-rice region, particularly in Japan, Taiwan,

Thailand, India, and the Philippines. This effort has been bolstered by the establishment of the International Rice Research Institute. The major gap in the research program appears to be that it does not provide an adequate continuum from basic research to applied research and to development use. Much more applied research is needed on crop rotations, high-yielding varieties that will respond to fertilizer and water management, the use of high-analysis fertilizer, and pest control.

Research is needed in economics and rural social organization as well as in agricultural technology. Moreover, studies in these different fields must be closely integrated if the knowledge gained is to be put to effective use. For example, if locally-adapted varieties of rice are being developed, the local varieties of rural culture should be investigated at the same time. Only in this way will the social techniques – extension, stimulating of local leadership – be available to introduce those new varieties of rice.

Government services in the wet-rice countries display three general characteristics: multiple ministries and departments servicing agriculture; commodity-oriented research and extension; little involvement at the local level. Increased governmental responsibility in agriculture has led to several experiments with ways of improving coordination and making assistance to farmers more effective. Two of these innovating organizations, the JCRR organization in Taiwan and the Comilla project in East Pakistan, were described in Chapter 8. Among others are the Indian Package Program, which is attempting, but often with considerable difficulty, to work through the existing agencies in promoting a package of improved practices in selected regions; and the community development programs in the Philippines and India, which have attempted to coordinate a broad spectrum of programs for rural populations.

The experience of these programs underlines the importance of organization at the local and the national levels. In most countries further improvements in administrative machinery and in training workers are prerequisites to rapid agricultural development.

LAND TENURE

The agricultural population is dense, small farms prevail, and in most of the area a substantial land-tenure problem exists. However, as we argued in Chapter 7, the two questions of size and tenure are decidedly different in character.

A change in farm size is not of priority importance. The available

evidence suggests that small farms now make more intensive use of the land than larger farms. The relevant inputs for increasing productivity, such as new varieties and improved water and crop practices, involve no substantial direct economies of scale in terms of land. Much of the mechanization needed – irrigation pumps and transportation, for example – will not involve change in farm size. Increased use of tractors is desirable in places, but group ownership and custom rental can effectively provide power for the critical operations on small farms.

The existing structure of land tenure, on the other hand, is an important barrier in many wet-rice areas. Japan, Taiwan, Thailand, and Burma, nations where the percentage of tenancy is low, are the major exceptions. In the other countries the prevalent tenancy practices, such as share-cropping without any sharing of the cost of purchased inputs, clearly deter increased productivity.

GENERAL CONSIDERATIONS

This review of the current situation suggests the need to alter the physical, economic, organizational, and knowledge environment of the wet rice region. Any action program must take account of a great variety of local cultural and communications problems. The differences in cultural values, village attitudes, and family and social organizations are great, and these variations directly influence the means that should be chosen to attack the problems we have discussed.

The major question, then, is not what in general should be done in the wet rice region; rather, it is how a more effective program can be mounted in specific countries and areas. What this means is that any action program must be tailored to the limitations of human, financial, and other resources, and the nature of existing organizations. Within these limits, a minimum effective package should be designed fixing the priority and complementarity of different measures, setting the timing sequence for study and action, and identifying specific methods that will be both effective and feasible.

AN ILLUSTRATIVE CASE: THAILAND'S CENTRAL PLAIN[1]

The Central Plain of Thailand provides an arena for an attempt to outline the relevant variables and priorities in a

[1] The material in this section relates to the situation that existed in 1964.

"systems" approach to agricultural development. The program presented here is not a blueprint to be applied in other situations. It is neither the only nor perhaps even the best possible program for Thailand. It does, however, illustrate the factors that go into the package: that is its purpose.

Most of the rice cultivation in the Central Plain depends on annual flooding. The total area under rice in Thailand is about 15 million acres; despite an extensive network of irrigation, dams, and canals serving about 4.3 million acres, a second crop of rice is raised on no more than 100,000 acres. However, irrigation projects under way with aid from the World Bank are likely to make multicropping possible in the near future on over 1.5 million acres of paddyland in the Central Plain and to provide or improve wet-season irrigation on almost 4 million acres.

Traditional farming methods persist. Many farmers hesitate to use fertilizers both because water control is lacking and because they believe the fertilizer they apply will flow over to other farms. The marketing and milling of rice also continue to be traditional. Rice exported from Thailand has the reputation of being poor in quality. The government levies an export "premium" tax of about $50 on each ton of rice, which, by depressing the price received by the farmer, discourages an increase in fertilizer consumption.

Diffuseness characterizes the ministries and technical departments that would be involved in irrigation development. The Coordination Committee for Rural Development is concerned only with the northeast. Some liaison and coordination of technical services is provided by governors at the provincial level and by the district officers at the district level.

Water in Thailand is free to the cultivator by tradition. Other than a few land development cooperatives of limited effectiveness, there are no devices to elicit self-help from farmers for constructing or maintaining small local works.

Many credit cooperatives have been organized by the government, but they are small and do not adequately provide production credit. The Rice Department of the government has also organized farmers' clubs in some villages. They help spread the knowledge of better farming practices, and in some places they engage in informal lending and group marketing.

We have outlined two package programs, the first short run and the second long run. The proposed measures are classified under five headings: physical, economic, organizational, knowledge, and psy-

chocultural. Most of these measures are highly complementary. They can increase productivity in combination, while in isolation they will prove limited in effect or fruitless.

The program is based on general assumptions that are essentially political. These are: the national leadership will be committed to agricultural development; the administrative system will be reorganized to meet the program's requirements, and the need to create local structures to secure the maximum participation of the people will be recognized. These commitments can of course be made only by the national political leadership, not by technicians or foreigners.

The following criteria have been used in selecting and timing the proposals: Priority is given to measures that can bring about immediate increases in crop yields and that will provide strong economic incentives to farmers to increase productivity. Immediate action should include measures that may have enduring long-range effects, such as research to prepare the ground for measures to be taken on a large scale at a later date. Any plan that involves group action at the village level should be developed in consultation with the farmers and local officials that will be involved in its execution.

SHORT-TERM MEASURES

Rice production could be substantially and economically increased by purchased inputs and other improved practices. Short-run measures directed toward the farmer's environment must promote the use of these inputs. Other steps taken now should be aimed at the longer-term goal of an intensive irrigated agriculture.

PHYSICAL

Fertilizer. The principal physical input to be promoted is fertilizer. Since this input depends largely on the ratio of the price of fertilizer to the price of rice, the main action to be taken is economic and is discussed below under the "Economic" heading. However, studies should be undertaken immediately to extend the knowledge of responses to fertilizers.

Seed. Supplies of the presently known improved rice varieties should be multiplied and distributed more extensively. These varieties may be expected to increase yields by about 10 per cent. Outstanding farmers in the farmers' clubs should also be enlisted to produce approved seed.

Fish and livestock. The raising of fish in rice paddies, now preva-

lent in some areas, should be expanded, and farmers should be helped to expand home poultry flocks.

Pest control. Research and regional pest-control services should be strengthened, and additional pest specialists trained for the rice areas.

Water management. In anticipation of further irrigation development, a few farmers in each district, chosen from among those who already receive off-season water, should be assisted to become pilot farmers. (See fourth measure under "Knowledge" heading.)

Public works. Old local roads should be repaired and new local roads built to link up with roads constructed under the irrigation development program. This would provide employment and help marketing in the longer run.[2]

ECONOMIC

Price incentives. One of the most effective measures would be to increase the domestic price of rice to the world level. The farmers' price would thus be raised from the present level of $40 to about $74 per ton of paddy. This would make profitable the use of moderate amounts of fertilizer, as the following calculations show:

Cost per acre of 200 lbs. of fertilizer @ .04 per lb.	$ 8.00
Value of 500-lb. yield increase @ domestic price	$10.00
Value of 500-lb. yield increase @ world price	$18.50

Thus the farmer's net return per acre would increase fivefold from $2 to $10.50. Given the risk involved, the first figure provides no incentive to use fertilizer; the second does. The application of pesticides would also become more attractive, and farmers would be more inclined to invest in irrigation pumps and the leveling of land.

The question of maintaining or dropping the export tax is a complex one. If the Thai government feels it has to keep the tax, an alternative would be to grant a subsidy of about 50 per cent on the price of fertilizer. In the preceding example this subsidy would result in a farm income gain of $2.30 for each $1.00 spent on fertilizers, and the cost to the government would amount to $20 for each ton of increase in paddy production. Nearly all the increase would go to exports on which the government would receive the tax revenue of $34 per ton of paddy.

[2] The use of public works programs to reduce rural unemployment is discussed in Chapter 4.

Supply of inputs. The domestic price of fertilizer is unduly high in Thailand – nearly twice the world price – because the transport and distribution system is deficient. The system should be studied with a view to its improvement.

Marketing. A similar study of rice milling operations should be made with a view to improving the efficiency of the marketing system and the quality of milling.

Credit. The comparative efficiency of various alternative farm credit agencies – production credit associations (cooperatives), state-aided local private banks, and farmers' clubs – should be evaluated. In anticipation of future needs, supervised credit experiments should be organized in cooperation with each type of lending agency.

ORGANIZATIONAL

1. Planning should begin for the establishment of rural development boards and related institutions in accordance with the proposals under "Organizational" in the section on longer-term measures.

2. The number and the functions of farmers' clubs should be expanded, and a few pilot farmers' associations should be organized. Each association would serve a number of farmers' clubs, channel credit and farm supplies through them, and eventually undertake marketing.

3. A cadastral survey and a survey of landownership should be undertaken to expose such problems as imperfect titles and fragmentation.

KNOWLEDGE

Applied research. A general regional research center should be established to study all aspects of the cultivation of rice and other rotation crops relevant to Thailand – soil fertility management, engineering, farm management, marketing, and possibly livestock production.

Local units. Farm research units should be created in the districts. These units would be directly associated with the regional research center, and each would be operated by a farmer.

Extension officers. Recruiting and training of the substantial number of additional officers needed for an expanded extension program should be begun.

Training. One or more district centers should be established for the training of extension officers, farmers' club and association leaders, and for the training of key farmers selected by local clubs as pilot farmers.

General education. Plans should be made to expand general adult education and to improve the use of mass media for rural education.

PSYCHOCULTURAL

A series of studies should be launched with the following objectives:

1. To determine optimal approaches and points of attack (or nonintervention) for the program.

2. To help identify potential rapid innovators (both individuals and groups) who can be effective in the diffusion process.

3. To identify and enlist local leadership, both formal and informal, and local institutions in support of the program.

4. To identify local "felt needs" as well as externally perceived needs.

5. To identify existing channels of communication and if necessary suggest new ones.

6. To provide continuing evaluation and feedback on program's successes and failures.

LONGER-TERM MEASURES

Planning for the longer term should anticipate an enormous increase in the supply of dry-season irrigation water and better water control in the rainy season through irrigation, flood control, and drainage. Efficient use of this added resource will require large increases in all physical inputs. In the following list of measures to achieve this balanced increase in inputs, it is assumed that the short-run measures will be continued and that the results of studies undertaken in the earlier phases will be translated into action programs.

PHYSICAL

Fertilizer. The use of fertilizer should be increased to about 80–100 pounds of plant nutrients per acre on suitable soils. Use of mixed higher-analysis fertilizers, which can greatly reduce costs, should be stimulated.

Seed. Research on new varieties of rice and other crops will have to be accelerated. New varieties should be able to stand high-analysis fertilizer and should have early maturation and other characteristics required for multiple-cropping.

Multicropping. Multiple-cropping of rice and new crops should be extended on the basis of economic and agronomic feasibility. Green manuring should be introduced wherever feasible.

Mechanization. Increased farm output will require a re-examination of the role of mechanization. It may be advisable to introduce mechanical power and equipment for pumping, for deep plowing, for turning green manures, for shelling, threshing, and drying, and for transportation. The specific processes to be mechanized and the equipment to be used will have to be determined on the basis of engineering-economic studies.

ECONOMIC

1. A consistent policy including a lower rice export tax and/or higher minimum price guarantees should be evolved. Then the fertilizer subsidy can be reduced, and perhaps a charge for irrigation water can be levied. If not, the fertilizer subsidy and the free water policy must be continued, and perhaps new subsidies will have to be added. It will always be necessary to minimize the cost of fertilizer distribution.

2. With the expansion of new crops, some of which will have only national or regional markets, action will be necessary to limit price instability of a few selected crops.

3. A market information program should be inaugurated.

ORGANIZATIONAL

Long-run proposal. The main long-run organizational proposal is a coordinated approach to rural development in the Central Plain. The land under the existing and planned irrigation projects will comprise all or parts of fourteen provinces. An effective and greatly expanded system of farm services will be urgently needed to help farmers capitalize on this opportunity for an intensive irrigated agriculture.

Farmers' organizations are needed to help farmers plan their operations and make known to the Irrigation Department their water demand schedules. More outlook and marketing services will be required; so will extension advice on production practices and farm

management. As economic development proceeds, demands for improved health and social services will grow.

The reorganization and coordination of the agencies involved in rural development might follow these guidelines:

a. Establish a strong permanent national body to plan, direct, help finance, and coordinate the regional program for irrigated agriculture. This body might be specific for this purpose, or it might cover rural development throughout Thailand. Its leadership should be outside any existing ministry. Each affected ministry should have membership on the new board, which would be responsible for seeing to it that the actions called for by the plan are taken by the agencies at the right time. The central board would provide supplementary funds for the various agencies to perform the special jobs called for by the program. Great emphasis should be placed on interministerial coordination at the provincial and district levels.

b. Provide a credit system to finance new inputs in accordance with approved farm plans. If a central agricultural credit agency is not established, the board should provide funds to local credit agencies such as farmers' associations and local cooperatives.

c. Provide for the identification of local farm leaders, preferably by their fellow farmers, and for their training in the responsibilities of group action and leadership in educational programs relating to improved production practices.

d. Encourage farmers to form associations or clubs (perhaps building on the present farmers' clubs) in which they can work together to plan water deliveries and crop rotations and act jointly in the procurement of farm supplies and credit and in marketing; provide for the federation of those clubs on a scale adequate to permit high-quality management for farm supply, credit, and marketing services.

Land tenure. Action should be stepped up to clarify titles, and provisions made to exchange land as needed for irrigation works.

Local government. Self-government should be strengthened by giving local bodies greater responsibility for the administration of local affairs. The farmers' associations and clubs should be encouraged to press local government to build and maintain public works.

CHAPTER TEN

The Rain-Forest Tropics

The Region and Its Problems

The region consists, for the most part, of a belt around the world some five degrees north and south of the equator interrupted in places by higher elevations or by the effects of those elevations on the movement of the tropical air masses. It includes much of Indonesia and Malaysia and the delta of the Ganges in Asia, a strip across most of Africa including the basin of the Congo, the Amazon basin and the western lowlands of Ecuador and Colombia in South America.

The climate of the region is characterized by year-round high temperatures, generally high humidity, and high rainfall that tends to be distributed throughout the year. Most of the soils are latosols – very old, highly leached, low pH. and low organic matter types. Few available plant nutrients are held in the soil. Nutrients must be captured by growing plants as they become available and held in the biological cycle; otherwise they are rapidly lost by leaching. Interspersed with these latosols are smaller areas of younger alluvial and hydromorphic soils.

Agriculturally the region may be subdivided into four major types:

Wet rice culture. This part of the rain-forest tropics is discussed in Chapter 9.

Tree crop agriculture, where primary emphasis is placed on tree cash crops (rubber, cacao, oil palms, coconut, bananas) with food crops produced for subsistence. Such areas are densely populated, have well-defined farm units and well-developed local social and other institutions. They are prevalent in much of Sumatra, Java, Malaya, and parts of East and West Africa.

Traditional agriculture based on the "slash-and-burn" or land-rotation method. It is dependent largely on subsistence crops. Only a fraction of the total area is cultivated at any one time. Soil productivity declines very rapidly under cultivation, and years of "bush fallow" are required to restore productivity. In general such areas

are sparsely settled. Enterprises that can be identified as farm business units, as the term is commonly used, generally do not exist. People are usually organized in extended family and tribal systems.

Vast areas of unsettled jungles that contain nomadic isolates. Such areas are found in the Amazon basin and in parts of Africa. Even in the regions of settled tree crop and traditional agriculture there are substantial areas of unsettled land.

THE PRIMARY PROBLEM

The general goal in this region must be to develop systems of mixed crop-livestock farming suitable to soil and climatic conditions that will make it possible to expand food production in the settled areas of tree crop and traditional agriculture, provide profitable diversification in these areas, and provide in the presently unsettled areas a form of agriculture that is not critically dependent upon the tree cash crops.

Historically, agricultural progress in the rain-forest tropics has consisted largely of the introduction of tree cash crops. This has generally been successful because, first, the new tree crop agriculture closely approximated the original ecology of the region and therefore it was not particularly difficult to develop cultural and soil management practices conducive to high productivity and, second, the products of the tree crops were in demand on the world market.

These settled areas that depend on tree crops are facing difficulties that underline the need for change. First, rapid population growth is placing severe strain on domestic capacity to meet food requirements. Food imports in some nations have soared, reducing the foreign exchange available for modernizing agriculture as well as for industrialization. Second, export dependence on one or two tree crops has made these countries highly vulnerable to international demand and to market factors beyond their control. Falling prices, a general trend in recent years, have reduced government revenues. Third, several of the tree crops face an adverse or undecided future due to new synthetics or competing natural substitutes from temperate zone agriculture. The gradual erosion of the market for tree crop exports and the threat of synthetics lend special urgency to the goal of diversification. Most of the future growth in output should be in food crops. Nevertheless exports from tree crops can be a major source of foreign exchange for many years, provided the efficiency of production can be increased. Technology can be improved and

production costs lowered in the existing tree crop complex; measures to stabilize the international markets in these commodities should also be taken.

For example, new, higher yielding varieties exist that can lower production costs. Important as such efforts are, however, they should not deflect attention from the long-term goal of diversification.

Population pressures are also beginning to be felt in the areas where traditional slash-and-burn agriculture predominates. With presently known methods the growing food needs of the rural population tend to be met by shortening the "bush fallow" part of the cycle – replanting the land before its fertility has been fully restored. Yields per acre of cultivated land are declining in some places. Although food deficiency is not as acute in Africa, for example, as in India, serious problems of malnutrition, particularly protein deficiency, already exist. Growing population and declining yields due to overcropping can rapidly bring these areas to desperate straits. But superimposing tree crops on traditional agriculture, the only proven procedure in the tropical rain forest, will only lead these areas into the troubles now faced by the tree crop regions. The tree crops will not provide for their increasing food needs.

Development of unsettled areas is an immediate necessity in some countries, such as Malaysia, to relieve the population pressures in the tree crop zones and to provide food for the growing urban population. In the vast reaches of the Amazon basin of Brazil, on the other hand, settlement from the Andes is mainly limited to the fringes of the rain forest. However, the demands of the growing world population will in less than a generation make it imperative to develop some of these zones for food production.

The great need in the rain-forest tropics, then, is for diversified agriculture based on appropriate mixes of tree, food, fiber, fodder, and soil-improvement crops, and associated livestock enterprises. Such systems of mixed crops plus livestock are needed in all three zones of the region: to diversify in the settled tree crop areas, to modernize and increase production in the traditional "slash-and-burn" areas, and to provide a stable productive agriculture in the new settlement areas.

THE KNOWLEDGE GAP

When we seek policies to meet this need, however, we find that many required factors are poorly developed or lacking. Some are immediate blocks; others are potential bottlenecks that can be ex-

pected to become important as soon as the immediate impediments are removed or reduced. Three factors of special relevance in the rain-forest region – extension, roads, tenure – are discussed later in this chapter. But the foremost limiting factor is the knowledge gap.

The major immediate requirement is research on the biological-physical and socioeconomic factors prerequisite to developing new systems of mixed cropping plus livestock. In the case of tree crop agriculture, improved varieties of rubber, cacao, and other crops and accompanying cultural practices are available. Fertilizer needs and responses are well enough known to justify fertilizer use. Many of the major insect and disease pests have been identified, and control measures developed.

In contrast very little is known about the annual food and fiber crops beyond the accumulated wisdom of the traditional cultivators. No one has yet found a method of growing such crops successfully over a period of years except in the traditional bush-fallow manner. No one knows how to handle the latosols under culture of annual crops without disastrous losses in productivity and irreparable damage to soil structure. There are few improved varieties for these soils. Disease and insects are prevalent, but little is known about their control. Power sources other than human are essentially unused. Productive livestock as an adjunct to a mixed cropping system is almost nonexistent, and its effective use will require much more knowledge than is now available about management practices, adapted breeds, nutrition with local feeds, and disease and parasite control.

Knowledge is equally lacking on the economic farm management aspects of a viable mixed cropping-livestock agriculture. Little is known about the economics of specific practices. As the proposed farm enterprise is developed from the standpoint of its biological and physical feasibility, its economic feasibility and social acceptability must be tested, both alone and in combination with other enterprises.

No one yet knows the size of an economic farm unit. Information is vitally needed on two questions: What should be the pattern of farm organization? Given the desirable pattern, how can it be developed out of what now exists? The socially acceptable units of operation for a diversified agriculture may conflict with the agroeconomically determined optimal form. Special care should be taken to allow for the continued evolution of farm patterns. It must not be assumed that a single revolutionary change will serve for all time.

An important question is whether diversification should be regional or within the individual farm. No clear answer can be given at this time, but several factors may be important in the final decision, including:

1. Single-enterprise farms resulting from regional diversification may require less managerial skill and may have economy-of-scale advantages over multiple-enterprise diversified farms.
2. Conversely, multiple-enterprise farms may be less affected by the market fluctuations of single commodities.
3. Inadequate roads and infrastructure may make regional self-sufficiency a short-run necessity and microdiversification a temporary but important stage toward eventual specialization.
4. Soil and microclimatic considerations may favor regional diversification with food crops grown on the appropriate soils and tree crops relegated to soils unsuited for food crops.
5. Conversely, it may prove impossible to develop soil-crop management techniques for sustained food-crop production except in rotation with tree crops, thus making microdiversification mandatory.

Faced with the existing vast deficiencies in knowledge, we find that only relatively minor improvements in food production can be made with what is now known. Under these circumstances, the single most important requirement at this time is a greatly expanded and improved research program.

This is not to deny the importance of pursuing short-term objectives – better storage facilities, for example – that can increase the food supply. It is simply that such factors can have only limited impact until the farmer can diversify his tree crop enterprise, increase the productivity of his food crops, and develop a related and integrated livestock enterprise. Once the requisites of production technology exist, immediate steps will be required to provide the other necessary factors. Research to determine the optimum time sequence of these steps would be valuable.

The Research and Training Program

In the rain-forest tropics, research must begin at the most basic level. While scientific principles are generally transferable from one part of the world to another, specific technologies must be adapted to the ecological, economic, and social context in which they are to be used. The degree of transferability, and hence the place along the continuum from basic to adaptive research at

which research in a given area must commence, is determined by the magnitude of the differences between that area and another in which knowledge and technology are far advanced. In this respect the problems of the tropical rain-forest area are quite different and for their solution require more basic research than the problems of most other underdeveloped areas. Less of the knowledge and fewer of the technologies from developed areas can be transferred profitably to the rain-forest tropics. For example, soil management practices adapted to the temperate zones are actually harmful in the tropical rain-forest.

The integration of research and training at all levels is particularly pertinent in the rain-forest area. There is of course the usual symbiotic effect: The research man is a better researcher if he has the disciplinary benefits of teaching; the teacher is a better teacher if he has the intellectual stimulus and the practical realities provided by research. In-service training at all levels in the research program will provide effective training for future research and extension workers and technicians. But in most countries in the wet tropics another factor is even more important: The supply of well-trained, competent agricultural scientists and teachers is pitifully small. If the best of them are sealed off in separate research institutes – an all too common practice – they become academic eunuchs.

In most countries of the wet tropics the existing agricultural research has developed mainly along commodity or problem lines. The central thrust of research has generally been directed by government rather than universities. In fact, in many of these countries, colleges of agriculture with research potential are recent developments, and research programs at the universities are uncoordinated with those of other universities or government. Aside from shortages of facilities, funds, and research personnel, this lack of communication, coordination, and mutual planning among existing institutions causes a waste of resources.

The size and complexity of the nation's research-education institutions should be determined by, first, the complexity of agricultural problems and the nation's ecological diversity and, second, by the potential ability of the country to staff and finance those institutions. Although external financial resources are usually available, the size of the research-educational complex should not exceed what the country itself can reasonably expect to finance sometime in the near future – say, ten to twenty years. Thus institutional goals range all the way from countries in which two or more central locations are

indicated (for example, in each of several states in Brazil), with the related network of regional stations and local fields, to only local field trials in some nations.

Many countries will not be able to support a central location of the depth and complexity required to solve the basic problems of agricultural diversification in the rain-forest tropics, and some countries will not be able to support even regional stations. Yet regional stations must be fed with basic knowledge, concepts, and materials from central locations, and local field trials must be fed with further refinements and adaptations from the regional stations. International cooperation can help these smaller nations and can strengthen the total research effort in the rain-forest tropics. One possibility is a completely international institution like the Inter-American Institute of Agricultural Science (IIAS) of the Organization of American States, or an institution in one country may undertake to serve its neighbors, or a number of countries may agree to a joint plan of research and to the pooling of research results. A model of this kind of international cooperation is the FAO grain improvement program in the Near East. Since the research needs of the region are extremely broad, overriding priority obviously must be given to organizing a research system capable of conducting basic research in the physical and social sciences and in the interactions among them. This is a long-run effort. In the meantime, however, some short-term research can provide quick benefits.

Collecting unpublished and scattered material is one such possibility. Although little published or organized information is available on the problems of annual crop and livestock production in the rain-forest tropics, many ideas have been tested and useful observations made, often by the research and agricultural officers of the colonial services. Unfortunately, much of the information was stored in inaccessible places, left unpublished, or taken home by departing colonial officers. The assembling and synthesis of this unpublished and often fragmentary information would be useful in providing the basis for immediate action programs and guidance for expanded research efforts.

A survey of land settlement schemes would also be useful. Settlement is now going forward in most countries in the region, usually without benefit of systematic analysis of the most efficient methods of land clearing, land preparation, and settlement based on experiences in other countries having similar climatic conditions and forest cover. An evaluation of the procedures and their results of land set-

tlement schemes that have been carried out in the past or are currently in progress would provide valuable information.

AGRICULTURAL EXTENSION

Change in agricultural practices requires informed decision-making in the adoption of new technology, in farm organization and operation, and in adjusting to changes in the economic and physical environment. This is equally true of nonfarm agricultural businesses providing inputs and markets to the primary producers. Since the changes needed in the rainy tropics are so far-reaching, the efficiency of agricultural extension is a correspondingly important factor. Today extension services are typically understaffed and often ineffectual.

An educational service intended to help raise the performance of the farm sector must serve two functions. First, it improves the ability of the decision-making unit of the farm and business accurately to recognize problems, seek information relevant to the solution of such problems, analyze alternative courses of action, decide, and act. Second, it provides the decision makers with a continuing and reliable source of technical, economic, and institutional information at low real cost.

Several kinds of administrative structures can perform such an educational function. The particular structure that will be most effective in a given situation will depend on the nature of that agricultural sector and its ancillary institutions. However, any successful agricultural educational service must have, regardless of its administrative organization, certain fundamental characteristics.

The criteria for government services described in Chapter 6 are valid for the rainy tropics. But the job in this region is particularly difficult. More than elsewhere, the extension service will be dealing with revolutionary changes in farm technology, and indeed in the farmers' way of life, rather than with refinements in an existing pattern. Since research will be only in its beginning stages, more than the usual emphasis on experimentation will be necessary: major mistakes will inevitably be made, policy will have to be constantly revised. Feedback is essential, and so the extension service must be tied particularly closely to the research institutions. Since extension services will be undermanned for years to come, and since their recommendations will be subject to more than the usual quota of error, it is especially important that they be designed to improve

the farm community's decision-making ability – rather than to impose fully designed patterns on the farmer. Ideally, the farmer would become a partner in the research process.

ROADS

The tropical rain-forest region contains the world's largest undeveloped land area. Developing settled agriculture in regions such as the Amazon basin or Borneo will require considerable public investment in roads and agricultural infrastructure.

Although there are a number of unresolved empirical issues about the role of agricultural infrastructure, it is generally agreed that some level of infrastructure is an absolute precondition to the development of a settled agriculture with surplus production that can be siphoned off to urban areas. Of all the forms of such infrastructure, roads are probably the most important, both in already settled areas and for the opening of new areas.

The general contribution of roads is easy to see. Roads open up wider markets to the producer and increase the efficiency of price communication and product distribution. They reduce losses in the transport of perishable farm products by shortening delivery time and by lessening damage in shipment. They make it possible to provide urban-produced inputs such as chemical fertilizers, machinery, equipment, and fuel at lower cost to the farmer.

Despite a general and intuitive knowledge of the importance of roads, several issues and questions of strategy are as yet unresolved. Very few empirical studies have been made to measure the economic role and value of rural roads. What criteria should be used to determine when a road should be built and where it should be located? Information is needed about the proper timing and sequence of road construction. For example, should main roads be built prior to the existence of settled agriculture or before an agricultural surplus emerges, as a stimulus to development – or should the construction of roads follow agricultural development of the region and the consequent pressures for improved transport systems? When and where should access and feeder roads be built?

Further, very little information is available on the rates of return for capital investments in road construction. Such estimates have an obvious use in the allocation of governmental expenditures among various other public works such as irrigation and drainage schemes, storage and warehouse facilities, and electricity and power installations.

TENURE

Africa below the Sahara is a special case in land tenure. The discussion of tenure in Chapter 7 was based on Asian and Latin American conditions and focused mainly on the relationship between tenant and landlord. In sub-Saharan Africa, landlordism and, in fact, individual ownership of land as it is understood elsewhere are virtually nonexistent. Africa's tenure problems are completely different.

The basic point about much of West and Central Africa is that form rather than "reform" is at the core of land tenure problems. (The discussion here is based on southern Nigeria, but this land tenure pattern is common in the African rain-forest region). Viable farm units must be pieced together out of vast areas occupied by tree crops, mixed food crops, land in bush fallow, and land that apparently is relatively empty. The difficulty is suggested by the seemingly disorderly layout of tree crops and cultivated patches of food crops; by the practice of shifting cultivation; and by the fact that every foot of land in southern Nigeria is owned in some sense whether or not it is used for agriculture. It is becoming clear that the traditional tenure system hinders any rapid increase in productivity. It also fails to provide sufficient legal protection for farmers now that land is getting scarce as population grows and agriculture becomes more commercial.

Tenure of land in southern Nigeria centers on the extended family, including chiefs' families, within the social context of a larger community (usually a village or a small group of villages) that in effect holds loose trust rights. The chief, representing the community, holds loose trust rights to farmland surrounding the village, and the historic allocation of land for use has been to families. Use rights in land are allocated by heads of extended families to nuclear families. These rights are inheritable. As sons grow up and marry, the family head provides them with land for cultivation from family holdings. However, the extended family never becomes completely independent of the larger community, nor is there clear independence of younger generations within families. Up to the present at least, southern Nigeria has no landlords and consequently no tenants on farms. Rural land is seldom bought and sold outright, for land is conceived to belong ultimately to the community, not any member of it.

These land rights in southern Nigeria are customary rather than sanctioned by the new Western-based legal codes. In the normal course of agricultural development such customary rights tend to

crystalize into property rights. Southern Nigeria is now approaching this critical point, and much of the success of general agricultural development may depend on how the transition in tenure is guided.

The basic dilemma is that the existing system tends toward group security and survival at the expense of economic progress. For example, while land is inheritable, making for family security, the ownership rights that attach to a person within the family are seldom strong enough to leave him entirely free to dispose of his holding by lease contract or outright sale. He may within limits exercise the right to pledge his allotted land or abandon it, but the family holds the right of redemption and reversionary rights. This discourages one who acquires land by loan-pledge from making improvements. The burdens that customary tenure places on transfers and alienation of land outside the family make it extremely difficult to gain economies of scale, while family farms are becoming smaller through population growth.

Tradition also holds that anyone who plants a crop is permitted to harvest it. When this principle is extended to tree crops, the person who is allowed to plant cacao or palm trees may claim a virtually permanent right to harvest. This means that a stranger to the village would hardly be permitted to plant trees on land where he is a temporary occupant.

These principles of inheritance within the family, restraints against the alienation of land outside the family, and restrictions on permanent plantings by strangers on family lands were all well chosen to preserve family cohesion and survival. Doubtless they would continue to serve this purpose and maintain a reasonable balance among the families in the village if the community were static.

In Nigerian villages a higher order of prestige and influence and corresponding access to additional land were always available to chiefs. This caused no difficulty so long as land was plentiful. But in recent years the increase in Nigeria's population (up to 1,000 people per square mile in some rural areas), the growing commercialization of agriculture and the growth of cities have all combined to make land scarcer and consequently more valuable. The basic contradiction between tenure designed for group survival and economic growth is increasingly exposed. The old devices of tenure are precommercial; their design never anticipated the consequences of an exchange economy. And since many tenure practices have no clear-cut sanction in law, peasants are left unprotected against the pressure of new commercial forces.

Excess village lands, for example, were traditionally held in trust

for use in case of need. In their role as trustees of this village reserve land some chiefs appear to be sealing it off as their own property, thus circumscribing the right of others to occupy it on the basis of need. (In the past, when the economy was one of subsistence and land was plentiful, a chief would have had nothing to gain by doing this.) Thus a few individuals with above-average knowledge and resources are finding ways to evade customary tenure and are accumulating land in their own behalf. This conversion of customary rights into negotiable property rights, if allowed to continue unrestricted, could produce a few large landholders in place of many small ones. Africa would have an explosive situation similar to that in Asia and Latin America.

The transition to a viable form of tenure must be made while there is still time. Devising a form of tenure that will stimulate the use of new inputs, protect the small holder, and evolve out of the present order, without too much conflict, will of course be far from easy. Among the creative tasks of research would be the discovery of legal forms within which the combination of tree crops and mixed farming, now without design, could be transformed into a pattern of viable farm units. In most of sub-Saharan Africa it would be a mistake to push other research and development of institutions very far without attention to the fundamental question of land tenure. What has happened in Asia and Latin America provides no guidelines for Africa.

CHAPTER ELEVEN

Monsoon Regions and the Subtropics

The Region and Its Problems

The monsoon and subtropical region includes most of the Indo-Gangetic plain, the northeastern part of Thailand, much of the Philippines, belts across Africa north and south of the rainy tropical belt, the Near and Middle East, northeast Brazil, and other smaller regions. (Those areas where rainfall is sufficiently high that wet rice cultivation is the dominant form of agriculture are dealt with in Chapter 9.)

This is a region of long growing seasons; temperatures in most of it are never so low that crops cannot be grown throughout the year. But almost nowhere is the rainfall sufficiently high or well distributed through the year to take full advantage of these favorable temperatures and abundant sunlight without irrigation during at least part of the year.

Wherever rainfall is sufficient for at least one crop a year and the soils and topography are suitable, most of the land is already under cultivation. Grain crops other than rice predominate: maize, sorghum, millet, wheat, barley; peanuts, cotton, and sugar cane are common, as are grain and forage legumes. Population is usually dense and the level of technology low. Development here must be evolutionary, starting with the present pattern of cultivation and the already established population.

Elsewhere in the region there are substantial areas, mostly arid to semiarid, with soils and topography amenable to cultivation under irrigation. Here the capital costs of establishing productive agriculture are high, but there is far greater opportunity to choose the type of farming and the type of economic, social, and administrative climate within which it can operate.

In these two sets of circumstances – high population and already settled agriculture on the one hand, and the possibility of a wholly new pattern of development projects in low-population regions on the other – different sets of first-priority problems emerge. In the first the predominant problems center around the task of reorienting

social and administrative patterns to conduct effectively the variety of developmental activities that are essential to the evolution of presently existing agriculture. In the second a precondition to being able to begin is a very substantial amount of agronomic, economic, and cultural research.

HIGH-POPULATION REGIONS ALREADY UNDER CULTIVATION

The farms are already there, and they are small. The farmers are already there, and they are members of established cultures with their own distinctive values, customs, and forms of organization. The better farmers are already making the best use they can of existing resources, techniques, and knowledge. Only a very limited (though not to be ignored) increase in production might be brought about by raising the performance of the less able farm operators closer to that of the best. For the most part, agricultural development in these areas must depend on the availability of new physical inputs, new knowledge and skills in husbandry and management, new attitudes with respect to the nature of farming, new interconnections between farming and the rest of the economy, and adequate incentives to farm operators to adopt new inputs and practices.

For some of the measures bearing on agriculture the nation must be treated as a unit, and uniform policies or national programs must be established. Research and manufacture of inputs are examples. For development not to be inhibited by imposing national patterns that do not meet the specific needs of different ecological regions within the country, certain activities should be designed specifically for each of the major regions. Even within ecological regions in each country there are substantial differences that call for varying patterns of public programs if maximum rates of agricultural development are to be achieved.

The principles governing national policies and organization were discussed in Chapter 6. Here the focus is on these questions: What are the activities for which particular attention must be paid to "locality-units" of public services to agriculture? What should be the size and operating characteristics of these "locality-units"?

By "locality-units" we mean the unit of each activity closest to farm operators and village communities. These are the cutting edge of any program of agricultural development. Only through effective locality-units can any regional or national program succeed. The

operating unit in agriculture is the farm. Increases in production come about only as each of many farm operators makes decisions to change his farming practices. In part the farm operators may be encouraged to do this by the general economic climate and the policies of the national government, but the necessary instruments must be readily available to them where they live and work if they are to take advantage of this general climate and actually increase their production.

SOME FUNCTIONS OF LOCALITY-UNITS

Six functions need to be performed by these locality-units:

1. Providing farm operators ready access to new purchasable inputs.
2. Providing ready access to markets for increasing amounts of farm produce.
3. Stimulating farmers to adopt more productive inputs and practices, training them in the new skills involved (the function commonly called "extension education") and organizing their cooperation for such enterprises as water management and pest control.
4. Local verification trials of proposed new practices.
5. Access to adequate supplies of production credit.
6. Access to new power sources.

In addition to these functions, but not unique to any one of them, is the need to develop stronger incentives for farm operators to adopt more productive methods and incentives for members of the staffs of the locality-units to perform their duties with increasing vigor and competence. Most essential at the locality-unit level are readily available new inputs and accessible markets for the increasing farm produce that the new inputs make possible. Most farm operators in the region already sell some products and buy some consumer goods, but only the more progressive farmers in the more progressive areas now buy production inputs. For all farmers agricultural development will require more buying of production supplies and equipment and more selling of farm produce.

In the case of production inputs a special problem at the begining, when a new input is recommended, is the lack of an established demand sufficient to attract private merchants. Moreover, if a merchant has previously handled only consumption items, he has had no experience with the building up of inventory to meet highly seasonal demands, in many cases for items that, if not available at a precise time, will remain unsold for a long subsequent period.

Under these circumstances widespread experience indicates that, even if the handling of production inputs by private merchants is

preferable in the long run, these inputs must be made available through a governmental program when their purchase is first becoming established. In parts of Latin America extension offices stock farm supplies for sale to farmers at a price slightly above what a private merchant would have to charge to make a reasonable profit. As demand increases, private merchants begin to stock the supplies, charging slightly lower prices. From that point on, the small stocks, if any, still kept by extension offices serve only as a standby reserve, a source if the private merchants run out of supplies.

Two distinctive features of the region are that the small size of the individual farms means that purchasable inputs must be available in small amounts for individual sales, and that the general lack among farmers of any transport vehicle faster than a bullock cart means that the locality-units for the sale of inputs are useful only within the radius of easy walking distance. In the case of access to outside markets, again options are available: private merchants, governmental programs, and farmers' cooperatives. Low initial demand generally is not a problem because in most parts of the region a network of private merchants already exists for farm produce. Instead the predominant problems are:

1. A lack of feeder roads to reduce the costs of haulage and therefore to increase the at-the-farm price of farm products and to widen the area within which perishables can profitably be grown.
2. A lack of competition between primary buyers, and a lack of central market information to ensure a "fair price" being paid to the farmer.
3. A large number of intermediaries in the marketing chain.
4. A lack of good farm or village storage facilities to allow farmers to hold nonperishable products after harvest until an advantageous time to sell.

Whereas access to inputs and markets is essential to expanding production, extension education is an important accelerator of the process. Innovations, even if they are effective and profitable, spread slowly under almost any circumstances; extension education accelerates their diffusion.

No one form of locality-unit for extension education is preferable under all circumstances, nor is there any ideal amount of agricultural land that it should try to "cover." Both the form and the area served by such a unit should be adjusted in accordance with two controlling factors. One is the size and degree of previous commercialization of individual farms, two features of farms that are closely associated throughout most of this region. The other is the laws of learning as established by long experience in many countries both in extension

education and in schools. These laws apply at two points in the extension education process: in contacts between extension teachers and farm operators and in the training of extension teachers.

These considerations point to two alternative forms of locality-units for extension education in the high-population small-farm areas: the central training unit, and a staff of extension agents who go to farm operators on their farms and in their villages.

The central training unit has substantial advantages in localities made up almost exclusively of quite small farms. In such a locality there are so many farmers per square mile that taking extension to all of them becomes prohibitively expensive. Moreover, where farms are too small to have their own work animals, cooperative effort by small groups of farmers seems essential if the rate of development is to be accelerated. Under these circumstances extension education can be conducted through these same forms of cooperative organization, as in the Comilla project.

The Comilla method is to have each cooperative union select one "model farmer" to attend weekly training sessions at the federation (thana) headquarters, then for him to pass on to other farmers of his union the knowledge and skills he has acquired. In this type of locality-unit the crucial size factor is the number of model farmers per class. In Comilla this number may approach 50, but educational experience elsewhere indicates that classes of 30 to 35 are preferable.

In localities where the farms vary more in size, with an appreciable number as large as 10 to 20 acres, a staff of extension agents is the alternative to a training center, but should not necessarily replace it. On farms of this size, already somewhat more commercial, the individual farmer can try out new methods without so much joint agreement by his neighbors. This possibility is even greater where farm operators live in dispersed farmsteads, each on his own holding. Since each farmer has more land, learning by one farm operator can have a larger productive effect, and therefore the visits of extension teachers to individual farmers become less costly in terms of potential increases in production.

Two criteria determine the optimum size for locality-units of extension education operating primarily through a staff of extension teachers. The first is that there should be one member of the extension staff for about 300 farm operators. This is an approximate figure based on experience; it takes into account the fact that for teaching to be effective, for learning to occur, there must be frequent contacts between each farm operator and any one new idea. While these contacts need not all be individual visits (some may be meetings) and

need not all be personal (some may be by radio, printed matter, or pictures), frequent contact between potential innovators and the extension teacher is essential. No extension teacher can normally have effective teaching contacts with more than perhaps 100 farmers per week, even using several group meetings, and effective influence at early stages of agricultural development probably requires at least one personal contact every second week. This would indicate 200 instead of 300 farm families per extension teacher, but many farm operators will not respond.

The other factor in the optimum size of the locality-unit for extension education is the number of extension teachers working together in each unit. This optimum number is likely to be 30 to 45. With more than 45, the "staff conference" form of combined in-service training and administrative device becomes unwieldy, and there cannot be enough learning by each member of the staff to be effective. With fewer than 30, training by administrators can be more intensive, but the extension workers themselves are less likely to learn from each other; the latter point is at least as important as the former.

Thus one locality-unit for extension education, using a paid staff of extension teachers going to farmers, would ideally cover an area farmed by 9,000 to 13,500 farm operators. Where such a unit must cover a wider area, greater use must be made of radio and other mass media to try to compensate for too-light coverage.

Where extension education depends entirely on training model farmers at a training center, the size of the area will depend on how much is covered by the farms of members of each union and on how many classes of 30 to 35 model farmers each can be accommodated weekly by the center. Wherever extension education exists, another locality-unit should be devoted to conducting verification trials, under conditions faced by local farm operators, of the changed practices being recommended to farm operators by extension teachers. These trials include comparative yield tests of varieties of crops already being grown in the locality and tests of allegedly "improved" varieties being recommended by experiment stations. They should also include fertilizer and water application recommendations.

The purpose of such verification trials is threefold:

First, to find out whether the recommended practices are really valid under the conditions of that locality.

Second, to provide a constant reminder to extension teachers of the nature of experimental science, and a caution as to the necessity of being absolutely sure about what is being recommended.

Third, to have available in the locality technicians who know how to lay out plots, how to apply new inputs with precision, and how to measure results in order to assist extension teachers in setting up valid and effective demonstrations on the fields of farm operators.

Credit is obviously an imperative in any program to convince farmers to buy new inputs. The standard instrument for credit, the farmer cooperative, has been tried in many parts of the world, with results ranging from success to disaster. The Comilla pattern of cooperative organization, described in Chapter 8, has proved successful in the area (dense population and small farms) that we are discussing here. Once again, however, we do not believe that Comilla should be blindly copied, nor that other forms of providing credit should be discounted.

Mechanization may be necessary, to some degree in some places, to break existing bottlenecks. The condition for mechanization that we proposed in Chapter 3 – that it must be labor-complementary, not labor-saving – obtains in parts of this region. In planning the size of a locality-unit for mechanization, the key factor is the need for service and repair facilities. In the case of tractors, a pool of 12–15 machines is probably a minimum number.

COORDINATION OF LOCALITY-UNITS AND GOVERNMENT

Each of the six functions we have described should be organized in locality-units appropriate to its needs, not forced into the straitjacket of a "block" of predetermined size. In some cases, having each locality-unit of a size optimum for its own function may mean that several locality-units of one activity may operate over the same geographic area as a single locality-unit of another activity. For example, the area covered by one credit unit might be the same as that for two to four extension units, one or two verification-trial units, or one for mechanization.

However, these specific optima may have to be adjusted so all activities can be coordinated by a single minor administrative unit of the government, whether pre-existing or newly created. It cannot be stressed too strongly that an effective local "cutting edge" is unlikely if each of the six activities is administratively related to only a more central unit of that same activity. The complementarity and interdependence among these activities is so strong that all of them must be administratively integrated in a minor unit of government if any one activity is to be even reasonably effective.

PROGRESSIVE INITIATION OF PROGRAM IN DIFFERENT LOCALITIES

As noted earlier, the localities within any one country in the region vary markedly in agricultural potential, size of farms, present degree of commercialization of agriculture, and other characteristics. Well-articulated locality-units of optimum size and intensity cannot be initiated everywhere simultaneously. The priorities in initiating programs might be as follows:

1. Start with integrated sets of locality-units of optimum size in one or a few contiguous localities in a region of high agricultural potential and with a reasonable proportion of larger, more commercial farms (whatever the range in farm sizes may be).
2. Next, multiply the program in localities of the same type and add a few integrated programs in other localities where somewhat smaller farms predominate.
3. Move next, while multiplying integrated programs in the above areas, into a few localities where only farms of the smallest size exist.
4. Having established the full range of locality units of all six activities in a few localities having only small farms, extend the services to localities with larger farms.

The reasons for this sequence are two. First, the potential for early increases in both total and marketed production is greatest in localities having the larger farms. Second, a smaller, simpler combination of activities may be reasonably effective there. For example, while purchasable inputs and market access are always necessary, these may be easier to provide for farms that are already partially commercial; credit may not have to be provided through special new agencies in the beginning; and operators of larger farms are likely to be more responsive to extension education. On the other hand, in localities made up wholly of small farms it may be nearly useless to offer any service until all can be provided.

This progression in initiating programs in different types of localities is depicted in Chart 3.

LOW-POPULATION CULTIVABLE REGIONS

Just as it must be taken as given that the density of the population at present dependent on agriculture for a livelihood cannot be reduced in the next twenty years in the high-population areas of the monsoon and subtropical region, so it must be recognized that large-scale development schemes in areas of low population cannot be relied on to decrease the density of the agricultural population in the heavily-settled areas. Emigration is seldom suffi-

CHART 3. INITIAL ACTIVITIES OF PUBLIC SERVICES AS INFLUENCED BY SIZE OF FARMS

ACTIVITY	FARM SIZE		
	All under 3 acres	Up to 8 acres; 40% over 3 acres	Up to 25 acres; *60% over 3 acres
TRAINING	Training center only	Center or extension agents	Extension agents plus some training at center
VERIFICATION TRIALS (RESEARCH)	Yes	Yes	Yes
CREDIT	Yes	?	Useful, but not of highest priority in the beginning
PROVISION OF NEW INPUTS	Yes	Yes	Yes
MARKETING OF PRODUCE	Yes	Training for marketers	Training for marketers
POWER CULTIVATION	Most useful	Useful	? in beginning stages
VILLAGE WELFARE ACTIVITIES	Start here ---→	---→ Move into these ---→	Then move into these

If a wider region contains some localities of each of the above three types, then:

		1. Start the first units here
	2. Then start some units here, perhaps adding power cultivation	
3. Start units here after others are going well		
	4. Extend credit and marketing to these	
		5. Extend credit, marketing, and power cultivation to these

*Although they would be useful, credit, marketing activities, and power cultivation are omitted here because they may not be absolutely essential to get development started.

cient to have this result, particularly where farm units in the new scheme are larger, as they must usually be if efficient production is to be achieved.

The case for development schemes in low-population cultivable areas is not based on emigration. Rather it is based on the fact that there are places in which modern technology, frequently including irrigation, can add substantially to the present land resources of a country, thereby allowing for the extension of agriculture. The development of new lands, particularly in association with irrigation, is going on in many countries of this region – in India, Pakistan, Iran, Iraq, Syria, Egypt, Sudan, Mexico, and elsewhere. It is also go-

ing on without irrigation in Malaysia, Indonesia, and Assam; in many parts of East and West Africa; and in Brazil and other countries in Latin America.

Circumstances in many places in the monsoon and subtropical region probably warrant major schemes to bring new lands into cultivation. But any such scheme is a costly, risky, and complex undertaking to be decided upon only after all of the facts are in.[1]

Two considerations make it important that extensive and intensive feasibility studies precede any such program. One is that the same level of investment would often yield greater returns if applied to regions already under cultivation. The other is that a wide variety of factors affects the actual productivity to be anticipated from the settlement of new lands. A discussion of the major types of feasibility studies and the major questions to be answered follows.

AGRONOMIC POTENTIAL

The first step is to estimate the agronomic potential of the area being considered for development. This is influenced, first, by factors of the physical environment: climate, topography, soils, water supply (both surface and underground supplies and river waters potentially available for irrigation), sources of power, and the accessibility of the region.

Taking these factors into account the next step is to consider what crops might be grown in the region, what yields might be anticipated, what pests and diseases would have to be controlled, and what market is available or might be developed to absorb the new production.

In making these estimates a number of model farms must always be set up at points representative of different sets of soil and climatic microconditions within the region to test whether the proposed crops can in fact be grown successfully and in what crop combinations. Research takes time, while time itself often seems a pressing consideration.

It is not easy to choose between waiting for research and getting something going in the present known circumstances. It may be wise in one case to start by recommending both the seeds and the practices of better farmers already in the area without waiting for the improved varieties that research may later bring. In another case it may be fatal not to know the hydrology of a river, or the readiness of people to move into a new area, or the system of farming on a

[1] One such scheme, Gezira in the Sudan, is described in Chapter 8.

consolidated unit that will really bring higher income, or the degree of extra effort that people will tolerate.

For these reasons a pilot farm is a useful device to test intelligent guesses and to condition both organizers and people to change. Moreover, the function of a pilot farm need not be limited to the start. It can be a site for continuous testing. Although its first task is to gauge initial difficulties and possibilities, it can serve after the project is fully in operation as a site for training institutions as well as for further modifications in both administrative and production methods.

CULTURAL FEASIBILITY

Before proceeding to determine what types and sizes of farms should be established within the area, whatever cultural restraints may be present must be discovered. One set of restraints has to do with current political, social, and ideological pressures. Another involves the genuineness of the government's desire for planned development and its readiness to accept the patterns of management essential to the scheme's success. A third has to do with the degree of willingness of farm operators to exert extra or different effort and to accept the technological and the managerial routines that the scheme will require.

TYPES OF FARMING

The cropping patterns, rotations of crops, and feasible degrees of diversification that can be projected are functions of the foregoing considerations. Emphasis on one or two cash crops is imperative if modern technology, including purchasable inputs, is to be introduced. A development scheme that simply reproduces the low-technology agriculture of already settled areas is seldom justified. It would only expand the area of existing problems, and such patterns, once established, are hard to change.

While diversification has advantages in some places, it multiplies the problems of providing purchasable inputs and new technology. The simpler the pattern of cropping that can be kept in the beginning, the easier for the project to succeed. The initial cropping pattern should therefore be based only partially on considerations of maximum production; the current level of skills of farm operators in husbandry and management should also be taken into account.

SIZE AND ORGANIZATION OF INDIVIDUAL FARM UNITS

Generally the sizes and types of farm units to be considered are large-scale private enterprise units, large-scale state or collective

units, and smaller-scale family farms supported by common public services. Protagonists of large-scale private enterprise units may claim that their contribution to national production and to taxation will be greater than that of any other system and that, because they find their own capital, national resources can be devoted to such other purposes as infrastructure. Opponents may point to many private estates that have been anything but productive and may deprecate the extreme inequality in income between the large estate owner as compared to the workers on it and the rest of the rural population.

A desire for social equality leads many who believe that a large unit is the best base for modern production to favor state or collective management. The efficiency or inefficiency of this solution, and indeed the claim that large estates are best, might well be a subject for research if it could be divorced from ideology. A negative answer in the Soviet Union may be due to transitory factors like poor management and unattractive price differentials between town and country products. A positive answer in Yugoslavia may be connected with decentralization and independent contracts between farm and factory. Israeli experience, on the other hand, where freedom of choice exists and where the purely collective kibbutz is being superseded by the relatively individual-oriented moshav, may suggest that individual incentive is a vital ingredient and that, when combined with supporting services, it can include both efficiency and a reasonable distribution of benefits.

Although all three methods may well continue in many countries, the huge numbers of the rural population, the constant increase in these numbers, and the fact that they are mainly small subsistence farmers make the selection of a family farm unit attractive, if the supporting services and farm layout can provide for efficient production and satisfactory income. In choosing the size of the family unit, however, a dilemma sometimes arises, as occurred in Kenya, between satisfying more people in smaller units, a solution that may lead only to equality in poverty, and planning units that can produce higher incomes, savings, and taxes — but not enough units for all. Where land is plentiful a ladder of farms of varying size can provide farmers with a progressive opportunity to move up as they emerge from subsistence techniques into increasing competence.

PROVISION FOR SUPPORTING SERVICES

Particularly if the decision is to establish family-sized farms of reasonable acreage, an integral part of the scheme must be the pro-

vision of adequate supporting services. Even in the Punjab, in one of the biggest settlement movements in history, where irrigation enabled great improvement at first, the absence of supporting services was one of the factors responsible for the largest irrigated region in the world now giving one of the lowest returns from auxiliary water. To permit farmers to settle new land, or old estates without an organization plan and without supporting services may lead to disaster.

Many irrigation projects have included only the major canals, leaving farmers to make their own field distributaries and do their own land leveling. Often this is ineffectively carried out, and an expensive national investment in dam and canalization ends in high water loss and low crop yields.

An example outside irrigation is that of the Malayan settlements where no provision was made at first for schools, and the farmer was expected to clear the jungle himself. He had to send his children to school elsewhere and so he was frequently absent visiting his family; nor were his children available to help him. Reliance on the farmer to do the clearing resulted in delay and costly irregularity in what should have been a uniform planting pattern for rubber production. Only when clearing, planting, and schools were included in the combination did the settlement begin to be a success.

One of the lessons from crowded areas has been the sometimes baneful influence of the large landowner-moneylender-trader. Credit should be closely allied with other inputs, but this requires trustworthy supervision and accountants. The owner of the store or processing factory, or means of transport to market, or pump, or machinery for the preparation of land often has a stranglehold over the farmer. Should the organization for the scheme be such that these key entrepreneurial points are operated at cost for farmers (as in the Gezira scheme) pending transfer to their ownership? If this is the choice, is the capital available to create these assets and are qualified personnel available to manage them and to handle the marketing beyond them? If not, additional capital and training has to be provided. Lack of foresight in these areas and a tendency to assume that private enterprise is in all circumstances competitively beneficial may wreck the whole investment in the other services, because if the farmer does not receive a substantially higher income his interest will evaporate. But this also may happen if the management of these operations provided in the scheme is inefficient and uneconomical.

The design of a development scheme therefore involves not only

the provision of a few major capital investments such as irrigation, land clearing, and drainage to make a region physically cultivable; it also involves designing a total pattern of cultivation, the creation of a wholly new network of supporting services, and provision, direct or indirect, for a wide range of facilities and arrangements for settled human habitation.

Not every settlement scheme need include governmental provision for all of these. However, the feasibility studies must determine whether each factor is available, from whatever source. Moreover, the cost of all the supplementary elements that must be financed by the government needs to be taken into account in estimating the capital needs for the project.

HOW MUCH "PATERNALISM"?

Two issues discussed in Chapter 6 are especially important in designing settlement schemes. One is the degree of paternalism. To what extent should the scheme rely on providing opportunities for higher productivity to farm operators, leaving the decision whether to seize these opportunities largely to them, as opposed to having the new agriculture managed by officials of the scheme itself? The first course is likely to result in lower productivity in the early years, while the second defeats itself in the end because farm operators lose all initiative and wait for the government to do everything. At the same time, the weakest link in the development chain is actual implementation, and farm operators may willingly accept a considerable amount of regulation provided that it actually results in steadily rising net incomes.

When designing a program for settled areas, for farmers who will remain on the land they now occupy, planners may be narrowly limited in their choices by existing cultural patterns. In a new settlement, the range of choice is wider (though not unlimited, for the settlers will bring their culture with them). In either case, the degree of paternalism that will produce the best results is difficult to determine. Surely some participation by farm operators needs to be fostered from the beginning. Where people are highly educated and experienced they can freely participate without loss in efficiency, although even in the land reforms in Japan and Taiwan, no less than in Southern Italy, strong inducements, like monopoly purchase of the main crops or monopoly access to credit, were necessary to fortify the loyalty of farm operators to the cooperatives set up by the government. Where resources in competent manpower are scarce, the competent organization of at least supply, processing, and mar-

keting by some external agency may be the first priority, leaving the grafting in of full participation by the people themselves to some later time when successful routines have been established.

IMPLEMENTATION OF THE PLAN AS A WHOLE

Choice of bureaucratic structure — new as opposed to existing services — is the second issue. Very often, and particularly in ex-colonial countries, the instrument at hand is the existing government services. These services were seldom designed for implementing development, a comparatively new field for government action (in contrast to mere advice) which before World War II was left largely to private enterprise. The regulations and attitudes prevalent in regular government services, and the type of man they recruited, are thus not automatically those that might be chosen to implement development schemes by a business institution. The question is whether to try to adapt the government services to development purposes or to set up some alternative instrument such as an autonomous corporation that can establish a routine and a cadre specifically suited to the job. Since each procedure has advantages and disadvantages, the choice is one to be made with extreme care.

ECONOMIC FEASIBILITY

Only after all the foregoing considerations have been fully explored has the time come to make a study of the economic feasibility of the scheme. How much will it cost? The cost is not for capital investments alone, but for all the supporting services that must be provided under the particular local circumstances. Is this amount of capital available or can it be secured? Could it be invested to increase productivity on lands already under cultivation? In which case would the national gain be the greater? Or can both be done?

ADMINISTRATIVE FEASIBILITY

Assuming that the economic costs and returns suggest going ahead with the scheme, are adequate administrative resources of trained personnel available to operate it? Here the problem is not so much one of supervising the construction of dams, canals, drainage structures, and so forth; that kind of managerial talent can be hired from abroad if necessary. More important is the administrative talent required for the continuing operation of the scheme after it has been launched.

CHAPTER TWELVE

The High-Altitude Region

The Region and Its Problems

High-altitude valley and plateau areas in the tropics are found in South America, East Africa, and parts of Asia. Here we shall discuss only the Andean regions of South America.

The three countries in which most of the Andean region lies — Ecuador, Peru, and Bolivia — include, in addition to the Andean highlands, the lowland areas of the Pacific Coast (except Bolivia) and the largely unsettled lands to the east of the mountains.

AGRICULTURE AND ECONOMIC DEVELOPMENT

The proportion of the population of the Andean countries that is made up of farm families ranges from 53 per cent in Ecuador to 72 per cent in Bolivia. More farmers live in the mountain areas than in the lowlands. In Peru the population ratio of the highlands to the lowlands is over 2:1, and in Bolivia it is even wider. The per capita income of the highland people is much lower than that of the lowland people. Peru, for example, with an average per capita annual income of $179, has a coastal lowland/highland per capita income ratio of 3:1.

In Peru especially, agriculture on the Pacific Coast is highly productive and responsive to economic stimulus, while the Andean highlands, with 60 per cent of the population, are characterized by a traditional agriculture, less favorable ecological conditions, and much less responsiveness to market demand. In this kind of an economy the possibilities of developing highland agriculture are conditioned by two factors: development of the national economy can proceed without the participation of traditional agriculture, and development in highland agriculture needs to be tailored to emphasize products in which the Andean region can compete with the more developed coastal area.

Economic development in Peru has not been held back by lagging highland agricultural production. Coastal agriculture has provided the agricultural production for both increased domestic de-

mand and increased exports of sugar and cotton. Incomes of those who remained in traditional agriculture probably have not changed, for there has been no increase in yields and thus no increase in production and income per worker.

Since the three countries are similar ecologically and face similar social problems, opportunities exist for applying research results and administrative techniques to the whole region. Lessons learned in settling the eastern lowlands in one country are likely to be relevant to settlement in other countries. Ecuador and Peru face similar problems in reorganizing highland haciendas under land reform programs. Intensive approaches to local development, like the one in Vicos, provide lessons generally applicable in aiding highland Indians in all three countries.

The Andean countries each contain three major ecological zones; and the high ranges of the mountains also divide each country into many smaller zones. It is a costly task to develop transportation that would better integrate small producing areas with cities and link up larger regions with the major city markets; at best transport costs are likely to remain greater here than in regions with less difficult terrain.

In such circumstances it might be worthwhile to direct some research to the opportunities of stimulating nonagricultural investment in the highlands and in areas of settlement to the east of the Andes. The goal would be to build stable regional economies with regional agricultural and nonagricultural sectors providing markets for each other and with a proper mix of products, both agricultural and nonagricultural, exported out of the region to pay for necessary imports. The point is that with a difficult terrain the optimum proportion of interregional trade to total production of the region might economically be smaller than with the same resources and more level topography. Local demand for agricultural products is more important as a stimulus to local production where the terrain is difficult than in places where transportation costs are lower.

THE REGION'S PROBLEMS IN AGRICULTURE

Mountain agriculture varies greatly in types of crops and their yield potential as one proceeds upward from the lowest altitudes to the highest.

This rugged Andean terrain is characterized by considerable fragmentation of agricultural zones and a continuum of finely graded differences in ecologies over short distances. Farms located less than

300 meters apart on a slope may require different varieties and cultural practices for efficient crop production.

At lower altitudes, mean temperatures are higher, frost is absent or very unlikely, soils are deep, flat, and productive in valley bottoms, and irrigation exists or is possible. At higher elevations average temperatures are lower, frost danger and the likelihood of hail damage increase; the growing season is shorter. Usually the soils are less productive if they are on slopes; if flat they suffer from conditions also associated with low productivity. At very high altitudes in the *punas* or *jaleas* (regions above 3,500 meters in Peru and Bolivia and above 3,000 meters in Colombia) and in the altiplano (above 3,800 meters in Peru and Bolivia) there are extensive areas where only very hardy range grasses and creeping vegetation prevail. Due to the low quality and productivity of the range grasses, millions of hectares of range land are adaptable only to sheep and auchenid (for example, llama and alpaca) raising with very extensive grazing areas.

Throughout the Andean highlands of Chile, Argentina, Bolivia, and Peru the rainfall, in addition to being low, with local rates ranging from 497 mm (Jauja, Peru) to 1,144 mm (Cajamarca, Peru), is highly variable (up to 25 per cent around mean values from year to year), with irregularities at the planting periods that cause delays in planting and increased likelihood of harvest losses due to frost.

The short growing season, low average temperatures and short photoperiod require crops with short vegetative seasons. Since these crops are more vulnerable to environmental hazards and require more labor, they bring forth a lower output/labor-input ratio than crops in lowland tropics or temperate zones.

The great majority of farm units in the Andean highlands are small and located on the less productive lands. Small farmers living at the subsistence level cannot make any savings. Having in most cases no title to the land, they are not eligible for credit, and, even if they were eligible, they either are too far from a government lending office or they do not know how to proceed to request a loan. Often they would not know how to use it. The risks and uncertainties involved in growing crops in the highlands and the requirement of land mortgages as collateral discourage even knowledgeable farmers from seeking loans. They operate either without additional purchased inputs or with money lenders' credit at high rates of interest. Furthermore such purchasable inputs as fertilizers, seeds of improved varieties, and pesticides are available only in large towns.

The highland farmers on most small farms use their own power or oxen on the less steep slopes or level land. According to the 1961 census in Peru, in three typical highland departments (Cuzco, Cajamarca, and Ayacucho) only 0.7 per cent of farm units were tractor operated, and 36 per cent used human power alone. Data from the Economic Commission for Latin America indicate that in the early 1960's upland farmers in Ecuador produced 1.2 kilos of maize per man-hour, while a farmer in Argentina produced 21 times as much.

The mountains are formidable barriers to commercial traffic of the magnitude required for the establishment of modern integrated markets. The highway systems in the mountains of Bolivia, Peru, Ecuador, and Colombia are inefficient, of limited mileage, poorly maintained, and leave most of the area without intraregional road communications other than pack trails. Many highland agricultural areas are isolated from potential markets for lack of feeder roads transitable by trucks. Even some of the best roads leading to large towns are blocked during extended periods of the rainy season by landslides and other mishaps. Perishable produce may often be lost when the nonrefrigerated trucks on which it is carried are detained by roadblocks. Very high freight rates are the result of slow traffic, rapid deterioration of vehicles, and high maintenance and replacement costs.

Marketing is therefore a major stumbling block to increasing the productivity of highland Andean farmers. With many varieties of potatoes, corn, wheat, and other commodities, each locally preferred, with small quantities of produce being marketed by the majority of small farmers who are usually uninformed about price fluctuations, the receipts of small farmers are much lower than they would be under other market conditions.

Large haciendas exist where land is greatly underused, while nearby there may be extreme concentration of population and fragmentation of land property. In ten highland departments of Peru the 1961 census figures list over 300,000 hectares of land in fallow and 800,000 hectares of cultivable land currently not being farmed. With redistribution of population, change in tenancy status, and the addition of physical inputs such as fertilizers on fallow lands, much of this acreage could be made agriculturally productive.

Resource Surveys and Research

Lack of knowledge about the physical environment and the biological types that are best adapted to it is a factor limiting

agricultural advance in most of this region. The Andean highlands have not been properly surveyed in regard to soils and hydrological and natural vegetation resources.

Agricultural programs in the rough mountainous terrain of the Andes are risky at best, but they can be made more successful by assigning the land to its most appropriate use. Natural resources surveys lead to conclusions regarding land capability. The farmer and his advisers will perform their tasks of production more efficiently when the farm plan includes a land capability map backed up by full information on its endowment in natural resources.

Surveys are generally carried out by plotting field data on aerial photographs. Some of the factors mapped in agricultural resources surveys are soil types, geologic formations, surface waters, groundwater, climate, vegetation, human resources, infrastructure, existing land use and tenure, and finally land capability. For specialized agricultural surveys it is necessary to gather additional kinds of data.

The resources survey of a region is usually general, leading to more detailed investigations later. For example, discovery of good soils, adequate stream flow, and suitable sites for diversion dams may lead to the close examination of an area for irrigation. Another area may combine forest resources and a railroad, which might suggest detailed forest inventories leading to the development of sawmilling. Surveys of several kinds of resources simultaneously tend also to reveal hidden relations between one resource and others. Some basic technological knowledge of fertilizers, cultural practices, and varieties has been obtained at agricultural experiment stations in the Andean area, but much more is needed for countrywide action on package programs in specific fields, such as range management, improved corn varieties, frost-resistant and drought-resistant crops, management of irrigation water, residual effects of fertilizers, and animal husbandry.

Agricultural experiment stations with a supporting network of substations for verification testing should be created in each major ecological region of agricultural importance. The best Andean research program has been established in Colombia with outside advice and assistance from the Rockefeller Foundation. It has produced valuable improvements in technology in the areas of grains, potatoes, vegetables, and pastures. Many of the improved varieties from this center are suited to the Andean highlands of the neighboring countries of Ecuador and Peru. These successful crop adaptations suggest that a single central research institution for the An-

dean highlands, provided with satellite substations representing the major ecological subregions, could achieve plant breeding goals for the entire tropical highland region of Latin America and perhaps for other continents as well.

Existing knowledge is poorly diffused as well as insufficient. Written reports on research results from existing experiment stations do not circulate widely. Extension specialists are scarce; extension agents are few and concentrated in or near the larger towns. Mass-media devices for extension are not sufficiently used, not enough farmer demonstration plots exist, and the organization of package demonstrations is deficient. Intensive training courses for farm leaders are too few. Educational resources are diluted in extension and in universities by unnecessary duplication of systems or institutions.

Development Projects in Andean Agriculture

There are many types of farming in the Andean highlands. They can be grouped according to the major crops and types of livestock. Or land use may be classified according to systems of land tenure. A third way of looking at agriculture is by the markets or consumers for which the production is intended. Here we have divided our proposed programs into five compartments:

Land tenure: migration and reform
Irrigation improvement
Grazing improvement
Forestry development
Market-oriented production

These compartments must be considered as closely related development projects that should proceed concurrently in each of the Andean countries if possible.

LAND TENURE: MIGRATION AND REFORM

Every Andean country has two places where Indian farmers, now living on minifundia (farms that are too small), could find land for a new start. These are: resettlement on public lands in the lowlands, and resettlement on institutional or government-held haciendas in the Andean highlands. Small farms could also be reorganized. Giving these opportunities to the land-hungry Andean people requires only limited amounts of technical assistance and credit. Vacant land in the lowland regions is available for resettlement of sur-

plus farm families from the Sierra.[1] Bolivia, Peru, Ecuador, Colombia, and Venezuela are blessed with extensive reserves of public lands, especially on the eastern slopes and lowlands. Some vacant forest and savannah regions are already being used for resettlement from the highlands. Roads have reached the llanos of Colombia and Venezuela, where farming and ranching have expanded and created settlement nuclei.

Ecuador has one road into the Oriente from Ambato in the central highlands, reaching Puyo in the eastern foothills, and settlement is spreading to many other Oriente communities that still lack motor roads. The Ecuadorian Institute of Colonization gets more and more requests from settlers to send surveying teams into this region to adjudicate farm boundary disputes and to arrange for granting of titles.

Peru has located 50,000 people along the Central Highway to the eastern Selva. Other penetrations by roads into the Selva have been made in the Marañon valley, San Martín province, San Ramón, Perené, Satipo, Quincemil, and Tambopata. These roads are effectively promoting the marketing of both agricultural products and timber.

Bolivia has the most ambitious program of spontaneous land settlement in the eastern lowlands. This settlement has come about during the last few years as a consequence of the construction of new highways from La Paz and from Cochabamba. Agricultural markets for the products of new farmers already exist in eastern Bolivia; sugar cane, rice, coffee, cacao, cotton, and corn are beginning to move on the roads. Markets and land are a magnet that attracts highland farmers who are landless or who have undersized plots. The government is assisting with limited extension activities in the newly settled areas. Migration to lowlands has been going on for some time, but the rate might be speeded. Technical and social science research on the problems of settlement may prove important in promoting migration. Research on size of farm, tenure institutions, and the organization of service agencies to aid settlers may lead to more equal sharing in the opportunities in settlement areas.

However, migration is unlikely by itself to enable the people who remain in the highlands to participate in the benefits of economic development for some time to come. The Andean highlands them-

[1] Developing a stable agriculture in the lowland rain forests presents major problems, described in Chapter 10.

selves can be made more productive with the help of land redistribution and reorganization. Already the governments of the Andean countries own large areas that are available for agriculture, grazing, or forestry once their capability is known. Some are from the residual public domain and others have been expropriated. These lands are ready for assignment to private homesteaders or communities, or to be held and managed by the government, as in the case of national forests.

Such semiprivate institutions as the Social Security Agency, universities, and the Church are holders of extensive highland areas, usually in the form of old haciendas, which they are often willing to sell.

The highlands also include barren stretches of grasslands and moorlands for which a truly productive agricultural use has never been found. Similarly, on Andean slopes there are forested areas that contribute little economic benefit to their owners. These private lands can be inventoried by resources surveys and adapted for development at low cost. For example, a watershed covered by heavy vegetation can be extremely valuable as a regulator of stream flow, though its forest products may remain inaccessible for lack of roads.

The more intensively cultivated lands are divided between private and communal holdings. The large private haciendas have historically secured labor by binding agreements with their peons, who farm an acre or two of land and in exchange work a few days each week on the hacienda. Small private holdings prevail in some areas, as among the coffee growers of Puno province and the small potato farmers of the altiplano. Communal lands are the joint property of Indians in the ancient villages of the highlands. Such community-owned land is parceled out for cultivation or may be used for grazing by the animals of the whole village.

Land reform is at different stages in the Andean nations. The Bolivian revolution in 1952 transformed land tenure and the social structure. Peru, which passed a land reform act in 1964, and Ecuador have not gone through a social upheaval like that in Bolivia. They have a chance to accomplish a more peaceful and better planned change, in which wider distribution of landownership would be accompanied by the necessary new government service agencies to the highland farmers.

In planning development projects on large haciendas that might be acquired by the government for redistribution to small farmers,

the experience of the Cornell project at Vicos suggests two major organizational principles:[2]

Management and advisory leadership supplied from outside the local community. (This leadership might have to be shared by several haciendas.)

Retention of a substantial block of productive hacienda land that can be worked by the community under the direction of this outside leadership. This was the source of community income at Vicos.

Reorganization of undersized farms is much more difficult and less promising than the redistribution of hacienda lands. There is a good reason for carrying the two out simultaneously, however. There will never be a better time to entice a poor man off his inadequate plot of one hectare than when other lands are available for his use. Ideally farmers should be selected for such thinning out operations by ability, family need and industry, but not by their financial means.

The undersized farms might be acquired by the government or sold to adjoining holders of undersized plots. Any procedure that eliminates bureaucratic delays is preferable. The experience in Japan (described in Chapter 7), where the local villagers conducted their own land reform, suggests a considerable degree of local participation with governmental action being primarily a ratification. In Japan the local boards essentially were able to award land to tenants. In the Andes their role would be to help in choosing able and industrious but underprivileged people in their community to be given an opportunity to transfer to a better land tenure status.

IRRIGATION IMPROVEMENT

Irrigation more than any other single factor sets the stage for use of all other new inputs. The Andean highlands are well endowed with permanent streams and a scattering of snowy peaks and glaciers. Water resources are highly valued, and irrigation is an ancient art. Development of additional irrigated land consists in overcoming the obstacles that have been limiting in the past. Schemes that may now be feasible include four major types:

Diversion canals. In many stream valleys the opening of diversion ditches has been blocked by hard-rock sections whose removal is beyond the capabilities of either hacienda or village. With govern-

[2] The Vicos Project is described in Chapter 8.

ment help, the use of dynamite, air hammers, and heavy machinery may be feasible.

Diversion tunnels. The distribution of river water and rainfall in different basins of the Andes occasionally permits the use of tunnels from a humid hydrographic basin to another where water is lacking. Such tunnels have become more feasible in recent years because of improvements in rock-breaking tools and tunnel technology. Many sites are known, and action may wait only upon the availability of capital.

Storage dams. When a market can be found for hydroelectric power, multipurpose dams to store water during periods of high stream flow become attractive. Where natural lakes are drained by small rivers, building relatively small structures at the outlets will provide storage. Full exploitation of this potential awaits thorough aerial surveys of dam sites and irrigable areas and hydrographic and meteorological measurements in the watersheds.

Groundwater resources. The presence of enclosed physiographic basins and lakes in the Andean highlands makes possible the storage of water underground as well as on the surface. Around the Titicaca and Junin basins tube wells for irrigation may be feasible. These areas, deficient in rainfall, would benefit in potatoes, wheat, and intensive pasture if water could be pumped from the underground reserves. Undeveloped hydroelectric resources in the same regions could supply the needed power for pumping. Windmills are another possible way of pumping.

Where frosts are causing severe losses of potatoes, as at Puno, the crop can be protected by night-time sprinkling of the vines. This new technique is widely used for springtime frost protection in the United States and West Germany, where it is applied to berries, apple blossoms, early peppers, and tomatoes. The standard equipment for sprinkler irrigation includes a portable centrifugal pump and distribution lines of aluminum pipe fitted with rotary-nozzle sprinkler heads.

In each region offering a supply of water for irrigation, surveys are needed to determine the potential of the land for agriculture. The intensive production possible under irrigation also requires careful consideration of market potential. Potato production for example, could easily reach a level exceeding the urban market capacity. Alternate crops may be necessary. Rotation of crops may serve to discourage soil diseases and insects. Food processing and

storage may enable the farmer to deliver produce to his urban customers all year, thus widening his market.

GRAZING IMPROVEMENT

The cold regions (*tierra fria*) of the Andes, located above 10,000 feet, include the drier altiplanos and the humid páramos. In both the prevailing vegetation is grass, and grazing by sheep is the major land use.

Because of the size of this cold region, concentrated efforts should be made where the visible achievements of demonstration projects could exert an influence on the surrounding people and farms. Two points should be made about the supply of animal food:

First, inventories of the native and introduced forage crops of greatest value for specific areas are needed. The inventory must include legumes, crucially important for livestock feed because their protein content is higher than that of the grasses. Northern Peru, Ecuador, Colombia, and Venezuela have a high proportion of moist páramo highlands on which legume production may be possible even without supplemental irrigation. Meat, milk, and wool production is essentially a process of converting protein, which in the Andes involves the long slow accumulation of protein by the animal from the grass upon which it fed. Animals supplied with liberal amounts of legume protein may mature twice as rapidly as their grass-fed counterparts.

Second, a novel and economical way now exists to supply extra protein and supplement the carbonaceous grassy intake from present Andean pasture lands. This is the free-choice feeding of a cheap mixture of molasses and urea. Developed in the United States, it has permitted cattle feeders to fatten steers to full maturity without using expensive grain or protein supplements. This direct feeding of a cheap nitrogen fertilizer material, urea, is a technological breakthrough of some potential importance for the high Andean grassland areas.

FORESTRY DEVELOPMENT

Rough lands and stony soils, plentiful in the Andes, are usually more suited to forestry than to other uses, though the years it takes to grow a marketable tree makes forestry an unpromising endeavor for poor subsistence farmers working as individuals. Recent experience in the Andean countries has indicated, however, that tree plantations can be established that benefit the economy and the commu-

nities collectively. A forest in the neighborhood benefits all the people by providing cheap wood, contributing beauty, stabilizing erosive soil, providing employment, and attracting industries. The barrenness of the Andean highlands is not a necessary condition.

The aerial survey to pinpoint areas suitable for aforestation is one of the cheapest and most promising long-range means toward improved productivity in the Andes. These surveys may take place in conjunction with other studies of land for agriculture, grazing, or irrigation. Usually the land least favorable for farming is reserved for forestry if it has proper soil and moisture and if an adapted kind of tree can be obtained.

Forestry projects require local and urban markets for wood. Local demand for firewood, poles, and timber may be satisfied by a few hundred acres of plantations per village. Urban centers, railroads, mines, seaports, and construction projects are much greater potential outlets for well-chosen sites. One thousand acres of a single species of timber planted alongside a railway line is worth twenty times a similar forest 500 miles away by road. Other advantages of plantations over natural forest are uniformity of product, uniform age, and accessibility to the laborers who will cut and deliver the timber.

MARKET-ORIENTED PRODUCTION

The five northern Andean countries have at least 34 important urban centers in the highlands around which agricultural projects could be organized. Planning should take full advantage of such major congregations of people and purchasing power.

The produce that could be grown for these markets would require the efforts of millions of farmers. The evidence shows that the food demand of the urban populations is highly elastic. Thus a new class of modern efficient producers of such products as fruit, grain, potatoes, milk, meat, cheese, eggs, chickens, vegetables, and habas beans could expect to build their sales without difficulty. The modern world of communications and rising expectations has set the stage for a new kind of selling in these high-cost markets. Packaging, grading, refrigeration for perishables, and other advances in food preservation and processing are within the reach of these fast-growing communities.

Market development begins with the basic resources survey of accessible markets and agricultural potential. Then detailed studies must be made of available land areas, public or private, that lend themselves to the production of good salable foods. Soils, irrigation layouts, farming patterns, the present marketing setup, and com-

munity services must be examined, and, as always, plans must be made for supplying farmers with technical advice, planting stocks and other new inputs, and credit. Urban markets must be integrated with the new farm enterprises to reduce intermediate costs and to assure fast delivery of attractively packaged goods to the market shelf. Alert urban businessmen should be encouraged from the outset to set up supermarkets. The farmers must organize to standardize a high level of quality; they must therefore be shown the advantage of uniform high-yield, high-quality produce, for marketing is the crucial element in this kind of food production enterprise.

The agency conducting the surveys must choose for investment those places that offer the greatest opportunity to assist small farmers while satisfying strict criteria of economic returns on scarce investment capital. Some clear opportunities for modernizing market production are likely to be found in the vicinity of every one of the 34 highland cities.

Improved marketing will help diversify the economies of the Andean countries. More urban diversity in the highlands will attract rural populations as an alternative to the present mass migrations to coastal cities. Growth of the highland economy will favor subsequent development of the eastern lowlands as rural hinterlands with abundant land and a complementary tropical agriculture for trade with the highlands.

The major cities in the lowlands of every country also offer specialized market opportunities to farmers in well-located parts of the Sierras. Farm production for these markets is already expanding. There are, however, unfilled needs and opportunities. The physical barrier of the Andes mountain wall and the unresponsiveness of Indian farmers to the incentive of the modern market are hindering both production and consumption of food.

Changes in government price and import policy would stimulate Andean production for urban lowland markets. For example, Peru might consider protection or support prices for wheat and malting barley, both of which are imported in large quantities though they are also produced domestically. A support price for beef would undoubtedly result in increased beef production in the highlands of Peru. As long as the policies of the governments are directed at placating political pressures in the cities — going to the extent of importing beef from other countries at "dumping" prices well below domestic prices — beef cattle feeder steers cannot be produced in the Andean highlands.

Export markets might also be expanded. Some Andean products are readily salable abroad if produced in quantity and quality, accumulated in exportable form, and standardized. The most obvious are wool (especially that of the auchenids), mutton, frozen trout, Peruvian flour corn, quinoa flakes, pyrethrum flowers, and lupin for tannin.

In each case the Andean region can capitalize upon its abundant labor force and its special climatic advantages. All these products require a cool mountain environment. The rare and valuable wool of native Andean animals (llama, alpaca, and vicuña) should be made into finished products for maximum return.

Integration of the production process with market needs and fashionable demand overseas is important in deriving full benefit from textiles if sold in finished form. The tourist industry, which can render many other benefits in the Andean highlands, will undoubtedly create an excellent market for native textile goods and handicrafts.

Social Strategies of Change

The will to develop undoubtedly exists in the government elites of the Andean countries, but the difficulties confronting the transfer of that will to a coordinated action program are great and complex. Their bureaucratic organizations suffer from many of the defects and handicaps described in Chapter 6. In addition to improving their own performance, the Andean bureaucracies will have to improve their strategies in dealing with their peasant populations. The target of the development effort is some 10 million peasant farmers living on the plains or the intermontane basins of the highlands of Ecuador, Peru, and Bolivia. About half are Indians who are monolingual in one of the dialects of Quechua or Aymara. The other half are Mestizos, who are for the most part bilingual, speaking Spanish and either Aymara or Quechua. The Mestizos predominate in the towns, and they occupy the best bottom lands in the intermontane basins. The Indians occupy the uplands and farm under harsher natural conditions.

However, their respective farming technologies differ little. If the Mestizo farmer is more productive than his Indian compatriot, this is largely because he occupies better land.

The barriers and differences between Mestizos and Indians, in part cultural and social (manners of speech and dress, for example), were established in colonial times and are likely to persist for many

years to come. One major difference is Indian serfdom. In Bolivia serfdom was abolished after the land reform, but it still persists, although illegal, in the highlands of Ecuador and Peru where over a third of the Indian population are living in peonage on large haciendas.

Sharp differences in fundamental values exist between the Indians and the Mestizos. The former generally hold hard work and frugality in high esteem, while the latter are much less prone to manual labor and prefer to live ostentatiously. Indians display great mistrust of the outside world; its encroachments in the past have largely involved exploitation in one form or another by Mestizos. The world view of both Indian and Mestizo farmers is fundamentally fatalistic and pessimistic. Levels of cooperation beyond the family or immediate kinship groups are rare, and until recently government concern for the fate of the peasant has been negligible.

Self-government in the village or community level is still undeveloped. The political authoritarianism of the landlords and the unilateral imposition of programs by the bureaucracy have barred the farmers from becoming efficient cooperating subjects in the development process. They have been treated as pawns on a checkerboard crisscrossed by pathways supposedly leading to progress but often blocked by interest groups.

In the few cases where liaison has been successfully established between government agencies and associations of small farmers the results justify the view that constant flow and feedback between governmental agencies and farmers are prerequisites to any successful program. This crucial issue of bridging the gap between the extension agent and the farmers is receiving attention, but experience is still lacking as to how this can best be done. Extension agents seem to spend considerable time glueing farmers together in what has the outward appearance of an organized association but in fact fails to provide the members of the young group with sufficiently strong material motives to make them become stable and self-supporting and eventually models for other farmer groups.

In addition to expanded technical and extension services, the peasant farmers could be reached in ways that are not now employed to any great extent. For example, not a single radio station in the Andean area beams regular agricultural programs to the people in their native languages, Quechua or Aymara. Given the fact that transistor radios are now found everywhere, it would seem feasible and cheap to beam agricultural information along with music and news to the Sierra villages. Research indicates that most people

who have access to a radio would gladly listen to a program oriented toward peasant life in the mountains.

A second mass approach that might have considerable effect is the publication of an indigenous periodical (in Spanish, since Quechua is not a written language) that could be mailed to the *personero* (legal representative) of every farming community. It could contain agricultural information, could help solve local problems or tell people where they could go to get the information they want.

The development programs themselves need a different focus. Most development programs initiated so far in the highlands have not had agricultural productivity as their central theme. Yet the people concerned are farmers whose greatest felt need is for more food. By dispersing their efforts in such areas as political organization, literacy, and general welfare, past programs have failed to capture the interest of the peasant who saw in them no direct benefit to himself. First of all, then, priority should be given to increased food production to establish both peasant motivation and an economic base for further development. This is where the least resistance to innovation is likely to be met. Moreover, most successful innovations have the advantage of producing results for the farmer – and thus further inducement to innovation – in the relatively short time of one growing season. Programs in other areas, such as literacy, do not often show such quick and tangible returns.

Development strategists must attempt to strengthen the community's ability to handle its problems. Research on peasant communities, both Indian and Mestizo, reveals an intense individualism and only a minimum (and often forced) degree of cooperation. On irrigation or the use of common pasture lands, cooperation does of course take place, because the very survival of the family depends upon it. If a common effort is not made to clean and repair the major irrigation canals, no individual farmer can receive his water; if he does not join with his fellow villagers to maintain the common pasture, he will have no place to graze his animals. But beyond such minimum cooperation there is little sense of community to which one can attach a program at the present time. Villagers are very suspicious of their own local authorities, who have so often bilked them in the past.

Decision-making bodies have to be developed in these communities, bodies whose members will identify themselves broadly with the welfare of the community as a whole, not with the special interests of a few. Much research is needed in this area. Little or nothing is known of the functional power groups at the local level.

Putting religious values to development use is a possibility that is not now exploited. All over the Andean area peasants are known as *muy fiestero* (very devoted to religious festivals). Mestizos and Indians alike spend much time, money, and effort celebrating feast days of patron saints who are believed to control the destiny of man. Much fiesta activity is related to the traditional yearly cycle of agriculture, the productivity of which depends on the proper celebration of the fiestas; when crops fail because of frost, hail, or drought, it is regarded as a castigation for sins committed in the community. This view generally receives reinforcement from priests, whose authority is highly respected in the community.

This deep commitment to religious values might be used to improve agriculture. Most communities have set aside certain lands or animals that belong to the saints. The product of the saints' lands is generally used for their annual fiestas; the priests usually work in close association with the traditional authorities to decide how this money is to be spent. If extension personnel were to work closely with parish priests who have access to the community, they might be able to convince the traditional authorities to try out new techniques on the saints' lands. The lands would thus serve as model plots for the many farmers who are obligated to work the lands for the saint. Demonstrations on such lands would have the advantage of introducing the new techniques through the channel of most prestige.

Would Andean farmers accept the program we have outlined? We believe the chances are good that peasant communities would respond favorably to the five major projects we have described:

Land reform. Perhaps the strongest single value of the Andean peasant is his great attachment to land. Members of the indigenous communities generally feel that they have lost their ancient property to outsiders through rapacious landlords taking advantage of special privileges accorded them by the political structure. Any reform designed to enlarge the peasant's share of the pie will be enthusiastically welcomed by him. The proposal to farm the lands expropriated from the haciendado through some cooperative or collective institution is not likely to meet resistance from local people. The resistance of the haciendado himself will of course slow the course of change.

Irrigation. The peasant farmer in the Andes seems to see water as his biggest problem, and it is precisely in this area that much

cooperation has occurred in peasant villages. Studies indicate that over 25 per cent of the free-holding peasant communities in the highlands have constructed irrigation canals in recent years through communal effort.

The cost of getting more water to large numbers of peasant communities is more than any government in the Andes can afford. It must continue largely to be a community effort. With some technical help it can be expected that cooperation in the form of communal labor for the expansion of irrigation systems would be forthcoming from most Andean communities.

Grazing and stock-raising. So important is the ownership of animals to most farmers in the Andes that innovations related to improvement of breed or pasture should be welcomed. A man is frequently assigned status in the community on the basis of how many animals he owns. Indigenous communities still contain rather large areas of communally owned pasture to which every member of the community has grazing rights. Given this type of organization, it should not be too difficult, with adequate technical help, to get the community to engage in stock and pasture improvement.

Forestry. Since wood for fuel and construction is in short supply in the highlands, resistance to forestation should not be high, particularly if food production is tackled first. The bottleneck in the past has been a lack of adequate stocks of seedlings and information about their planting and care. The peasant knows the value of tree crops, but he has been unable to take advantage of this resource.

Production oriented toward markets. Once the Andean peasant is able to grow enough food for his own family, he will be more responsive to economic incentives. That he already reacts to such incentives is shown by the local markets that are held weekly in highland towns and villages. And many communities have already constructed farm-to-market roads without help from central government.

The key to agricultural development in the Andes, as well as in the regions we have discussed in the previous chapters, lies less in any specific projects than it does in an approach that combines sound technology with imaginative social strategies. Such an approach requires a high degree of creativity and determination on the part of both agencies of change and the political leadership of the underdeveloped nations.

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