AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY
BATCH 42

1. SUBJECT CLASSIFICATION

A. PRIMARY: Food production and nutrition — AE30-0000-0000

B. SECONDARY: Development

2. TITLE AND SUBTITLE

Designing and managing basic agricultural programs

3. AUTHOR(S)

Kulp,E.M.

4. DOCUMENT DATE: 1977

5. NUMBER OF PAGES: 296p.

6. ARC NUMBER: ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS

MUCIA

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

9. ABSTRACT

A systematic and highly readable workbook of techniques for designing and managing basic agricultural programs. It is dedicated to the 700 members of the Izaula-Igogero Growers Cooperative Society, Busoga District, Uganda, who demonstrated vigorously how very rapidly a two-hectare farmer can acquire a taste for innovation and development. The book has four major parts: Fundamental Concepts (basic systems concepts, agricultural development systems dynamics, policy essentials); Farm-Level Analysis (the farm model, selection of innovations, programming technique); Project Formulation (project policy options, project pacing and outputs, project inputs, project financing); and Implementation Planning and Control (management of field agents, scheduling, the organizational dimension). The book is designed for practitioners and prospective practitioners--for agricultural planning specialists, project designers and managers, district and provincial agricultural officers, rural development officers, and students preparing for practical work in agricultural development. The book stresses techniques. A serious engagement with it will give the user considerable competence in certain concrete methods of analysis. But techniques have a way of capturing the game, of defining the situation, of diverting the mind from important matters the techniques themselves do not address. Therefore, they have to be applied carefully, with due regard for the way things work in a particular society and community. With careful application, the techniques can be used to design and implement practical arrangements for improving the conditions of peasant agriculture and its practitioners.

10. CONTROL NUMBER: PN-AAC-868

11. PRICE OF DOCUMENT:

12. DESCRIPTORS

Developing countries
Farm management
Methodology
Project planning
Research
Systems analysis
Technical assistance

13. PROJECT NUMBER:

14. CONTRACT NUMBER: CSD-2958 211(d)

15. TYPE OF DOCUMENT:

AID 590-1 (4-74)

PNAAL 868

Designing and Managing Basic Agricultural Programs

by Earl M. Kulp

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Bloomington, Indiana

Designing and Managing Basic Agricultural Programs

Earl M. Kulp

PASITAM PROGRAM OF ADVANCED STUDIES IN INSTITUTION BUILDING AND TECHNICAL ASSISTANCE METHODOLOGY

This publication was financed by a grant from MUCIA's Program of Advanced Studies in Institution Building and Technical Assistance Methodology, which is funded by a 211(d) grant from USAID. Contractors undertaking projects under government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official AID position or policy.

ISBN 0-89249-018-7
Printed in the United States of America
1977

Kulp, Earl M
Designing and managing basic agricultural programs.

Includes index.
1. Underdeveloped areas—Agriculture. I. Title.
HD1417.K85 658'.93'091724 76-55007 ISBN 0-89249-018-7

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Foreword

This is an uncommon book and a useful book. It is a product of talent and zeal, which is a powerful combination. It is based upon extensive field experience, certain techniques of planning and control, and strong opinions about what is and what isn't sound.

Earl Kulp has prepared a systematic *workbook*. It is unlike any other publication in this field. It is a coherent book of prescriptions and techniques. It *tells how* to do certain kinds of things. It explains *why* to do them and what to expect—within limits—from the doing.

It is a book for practitioners and prospective practitioners—for agricultural planning specialists, project designers and managers, district and provincial agricultural officers, rural development officers, and for students preparing for practical work in agricultural development.

This material must be used with wisdom and caution. Let me explain. The work stresses *techniques*. A serious engagement with the book will give the user considerable competence in certain concrete methods of analysis. We believe these techniques are useful or we wouldn't have published the volume. But techniques have a way of capturing the game, of defining the situation, of diverting the mind from important matters which the techniques themselves do not address.

Intrinsically sound techniques can be misleading in their effects. In this book, for example, excellent techniques are presented for analyzing the production characteristics of a prevalent peasant farming system and determining

prospective ways to modify that system. The arrangements and behaviors needed to implement the designed changes are duly noted and described. Manpower requirements, schedules and procedures are presented in an eminently sensible way. It does not follow that the recommended primary societies will invariably work, that the project-level officials will be properly motivated, that certain necessary events will truly happen. Why?

Basically because there are no universally reliable recipes for implementing solutions to large human problems.

As Kulp states in chapter 1, this book does not profess to cover everything. It presents the analytical and procedural basis for creating a new delivery system to improve a certain kind of agriculture. The focus of the text is upon that delivery system, and more narrowly upon certain crucial means of designing and installing it—upon determinate techniques of analysis and action. There is always a danger that those who adopt this focus will overlook some important properties of a particular socio-economic system of agriculture. The value of this work depends upon the validity of its underlying assumptions, in specific situations.

There are two of these basic assumptions. One is that these are appropriate methods for simplifying some of the "buzzin', bloomin' confusion" of the world, for reducing it to a manageable scope, making it understandable, and providing a basis for action. My colleagues who have reviewed this work in manuscript and I are convinced that what is offered here as a means of ordering certain slices of the world is of genuine practical value.

The other basic assumption concerns "the way things work" and the ways in which they can be made to work. For example, chapter 12 presents certain interesting and potentially useful control techniques. One of them is called "the critical path method" (CPM). The description of the method is both clear and careful. The author notes that the CPM approach to scheduling requires reliable stipulations of all the essential factors in a system of action, and of all the essential relationships among them. It requires, too, that we predict how long each important activity will probably take, and what causal linkages will occur.

In certain circumstances it is possible to meet these requirements of *determinacy* and *predictability* rather well, within the limits set by acts of God and caprice of nature. Yet most of the large-scale applications of PERT and CPM techniques in our own society have been stupid and perverse, because the action systems to which they have been applied are neither very determinate nor very predictable—in other words, because many things don't really work in the way the technique requires.

This does not mean that "chapter 12 is wrong." There are cases where it is quite right, and thus where it is useful to confront the fact of its inapplicability. Trying out the technique forces the user to face essential issues about how this

thing, this program or project, is supposed (or assumed) to work. If the project is sufficiently simple and determinate—and the whole emphasis in this book is upon simplification and standardization—then there can be practical applications of the technique. When this is not the case, knowledge of the technique can sharpen the thinking and behavior of managers and controllers who must in practice act more intuitively and pragmatically than a scheduling recipe will permit.

Chapter 12 can be dangerous. So can other of the techniques-plus-assumptions in this book. They can be dangerous because they are a kind of medicine, not be be taken without wise diagnosis and a careful reading of the label. In the world of development, people too often take the medicine without reading the label, particularly when the medicine is technology and technique.

Altogether, this volume is a network of painstakingly prepared techniques for designing and implementing rational strategies to improve productivity in peasant agriculture. Its bias is toward comprehensive, determinate, simplified planning and control. This bias is frequently and properly qualified throughout the text. Those who ignore these qualifications and the limitations of this system of analysis will do so at their own peril—but also at the greater peril of intended beneficiaries who will bear the costs of any error.

It is imperative that we build our ability to design and implement practical arrangements to improve the conditions of peasant agriculture and its practitioners. This volume stands as a consequential contribution to that end. Whatever risk it presents must be balanced by the intelligence and the wisdom of its users.

William J. Siffin
Director
International Development Institute
November 1976

Introduction

THE PROBLEM

For the past 20 years, economic development has been directed toward increasing overall GNP. It was believed that if a nation could achieve an adequate rate of increase in overall GNP it would "take-off" into self-sustained growth.[1]

By the end of the 1960s, many developing nations found that they had achieved respectable rates of overall economic growth. They also found, however, that unemployment and all its concomitant misery had increased over that period. The agriculture practiced by 90% of the rural population was stagnant; most of the population had been untouched by modernization.

Rural youths, despairing of finding a decent living on the land, were flooding into the ranks of the urban unemployed. Development had lost sight of the people. The 1960s witnessed the Green Revolution which averted, at least for some decades, the horrors of mass famine. But, as Robert S. McNamara, president of the World Bank Group, said:

> . . . increases in national income—as essential as they are—will not benefit the poor unless they reach the poor.

1. W.W. Rostow, *The Stages of Economic Growth* (Cambridge: Cambridge University Press, 1960).

> They have not reached the poor to any significant degree in most developing countries in the past, and this in spite of historically unprecedented average rates of growth throughout the sixties. Their nation may be developing, but their lives are not. The Miracle of the Green Revolution may have arrived, but not for the most part; the poor farmer has not been able to participate in it. He simply cannot afford to pay for the irrigation, the pesticide, the fertilizer. . . .[2]

Most African farmers and millions of Latin American peasants still do not use a plowshare. Most peasant farmers do not use a pruning hook or have their own vines, fig trees, or any other cash horticulture crop. Not only have most peasant farmers yet to benefit from 20th century technology and economics, but most have yet to reach the level of technology and economic diversification commonplace in Judea some 27 centuries ago.

What Went Wrong

Most developing countries have undertaken *high-spot* rather than *basic* modernization. This has generally involved a limited number of large physical projects: factories, roads, ports, educational institutions, irrigation facilities. Those who benefited by these projects were generally no more than a small fraction of the population. The projects were mainly capital intensive, in spite of the obvious need for labor-intensive projects in capital-short, labor-surplus developing countries. Some high spots of developing were thus created—sharp peaks rising out of a vast plain of unchanged basic agriculture.

On paper, most developing countries have agricultural development extension services, cooperatives, and production credit schemes. Countries usually gave lip service to priority for agriculture. On the whole, less than 20% of their planned investment was programmed for agriculture. Those countries which programmed more than 20% earmarked most of it for major irrigation projects.[3] The general agricultural services rarely reached more than 10-15% of the rural population.

The main causes of high-spot modernization are:

Fixation on Industrialization. Development was first viewed simplistically as a matter of building those things which developed nations have--if enough

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2. Robert S. McNamara, "Address to the Board of Governors of the World Bank Group" (Washington, D.C.: IBRD, September 25, 1972).

3. United Nations Department of Economic and Social Affairs, *Development Plans Appraised* (New York: United Nations, 1965), pp. 34-35, 51.

factories could be built, all the surplus labor could be hired off the peasant farms. It was found that even exceptionally high rates of industrialization did not create enough jobs to make a dent in a growing rural labor surplus.[4]

Fixation on Tractors. Another simplistic view was that modernization of agriculture could only take place by copying the farms of modern industrial nations. This meant that peasant farms were not considered a locus of development. Subsequently, we have learned that peasant farms can produce most crops just as efficiently as large-scale commercial farms, using less capital and employing more surplus labor.[5]

Management-by-Monumentality. Large and highly visible projects tend to move along better than small, scattered projects which deal directly with peasants. Management is a scarce resource in developing countries—perhaps scarcer than capital. Large construction jobs are run by high-priced foreign engineering firms. They also tend to command the attention of ministers and top civil servants when urgent decisions are needed. Projects rendering services to peasants are undramatic and easy to ignore at the top decision-making levels. Their limited local project management staff is rarely supplemented, except by a few foreign technical advisers.

Ignorance About the Peasantry. Projects providing services to peasants are generally undertaken without professional surveys of the existing state of agriculture in the area, such as crops, typical acreages, yields, and labor requirements.

Unadapted Transfer of Program Management Techniques. Across the Third World, technical assistance has sought to reproduce the institutions and the formal program management techniques in developed countries—the Danish cooperative system, the US Extension Service, the supervised credit system of the US Farm and Home Administration, etc. Young professionals from developing countries attend schools of agriculture in the US and the UK to learn how to manage extension, credit, and marketing. Institutions and management techniques suited to serve 200- to 400-acre farms in Iowa and Wisconsin are not suited to

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4. Edgar Owens and Robert Shaw, *Development Reconsidered* (Lexington: D.C. Heath, 1972), pp. 51-70; see also G. Hunter, *Modernizing Peasant Societies* (London: Oxford, 1969), pp. 99-101.

5. Owens and Shaw, *Development Reconsidered*, pp. 51-70; see also World Bank, *Agricultural Sector Working Paper* (Washington, D.C.: IBRD, 1972), pp. 25-30.

serve 5- to 10-acre farms in developing countries. Many of the failures to reach large numbers of farmers may be traced to the uncritical application of US or UK extension, credit, or coop doctrine.

Some Notable Exceptions

Several countries have achieved basic rather than high-spot modernization and have effectively concentrated on raising the productivity and standard of living of the peasantry.[6]

Taiwan has perhaps the most comprehensive institutions and services specifically adapted to peasant agriculture. Land pressure is intense; the average farm is less than one hectare. Yet the average farmer is installing electrical appliances in his brick home, sending his children to secondary schools, and riding a motorcycle or a rototiller-drawn wagon to town.

Korea has followed a pattern of development similar to Taiwan.

Egypt increased yields by over 30% in the decade following its comprehensive land reform of the 1950s.

Ceylon introduced a yield-raising package to 72% of its rice acreage in less than five years.

Senegal introduced a comprehensive food-and-cash crop improvement package to most of the farmers of its central Peanut Basin, plus fairly comprehensive service institutions, in less than five years in spite of a rural literacy rate of less than 10%.

Madagascar raised rice yields over 70% on 45% of the farms of its central Rice Basin in five years.[7]

These cases are instructive in several ways. Taiwan and Korea demonstrate that basic agricultural development can ultimately produce a decent standard of living on a one-hectare farm. They show the kinds of institutions and activities most appropriate to the advanced stages of basic agricultural development. They are the products, however, of more than six decades of development. While providing useful examples of the advanced stages of development, they do not offer many useful lessons about the preliminary and intermediate stages.

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6. Earl Kulp, *Rural Development Planning* (New York: Praeger, 1970), pp. 103-22 (on Taiwan) and pp. 170-86 (on Senegal and Madagascar); see also Owens and Shaw, *Development Reconsidered* (on Taiwan and other countries cited).

7. Republic of Madagascar, "Programme de développement de la productivite agricole: Note de synthese," mimeographed (Paris: Société d'Assistance Technique et de Coopération, 1970).

Senegal and Madagascar provide a useful guide for most developing countries. These programs achieved rapid results within the constraints and conditions typical of the least developed countries. Programs in both countries were conceived and managed by SATEC (*Société d'Aide Technique et de Coopération*) directed by Francis Bour. The concepts and techniques of this volume draw heavily on the Senegal-Madagascar experience and on the "action de masse" approach.

OBJECTIVES

Distilling the experience of those countries which have successfully modernized basic agriculture, this volume presents a new delivery system strategy and the techniques for managing it.

In its broadest compass, the system of concern to us is the whole complex of basic analytical concepts, policy, strategy, tactics, institutions, and procedures for providing all the necessary services that will induce and enable peasants to modernize, to overcome their technical and commercial backwardness, or, as Raanan Weitz puts it, to change from peasant to farmer.[8]

Within the framework of that concern, this volume presents essential management tools, the concepts underlying these tools, and a series of quantitative techniques and fairly rigorous decision tools. Also presented are a number of nonquantitative techniques—procedures for choosing between major options.

Quantitative techniques are provided for the following analyses:

Farm System Modeling. Assembling data to give a complete yet compact picture of a farm as a system.

Farm Programming. Determining the optimum program for a farm—the combination of crops and techniques that will maximize income (exercises provided).

Computing Project Outputs. With farm programming information and basic assumptions about the rates of adoption and expansion determining, year by year, the numbers of farmers to be reached and the increased production and income to be projected (exercises provided).

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8. R. Weitz, *From Peasant to Farmer* (New York: Columbia University Press, 1971).

Computing Storage Requirements. Determining seasonal peak multipurpose storage requirements for a multicrop project; determining working capital requirements using essentially the same procedure (exercises provided).

Computing Project Inputs. On the basis of projected adoption and expansion, determining project requirements for manpower, supplies, equipment, and budget (exercises provided).

Computing Credit Expansion. On the basis of the farm program and the rate of adoption and expansion, determining overall project credit requirements (exercises provided).

Computing Costs and Benefits. Combining all project figures to determine project net benefits (exercises provided).

Project Scheduling. Learning the basic arithmetic of CPM scheduling and the techniques of drafting a CPM network in agriculture (exercises provided).

Field Agent Work Scheduling. Determining field agent duties month by month and time required for them, and rescheduling to achieve the best work pattern (exercises provided).

Nonquantitative techniques are provided for the following analyses:

Choice of Innovations. Determining which yield-raising and bottleneck-breaking innovations should and should not be included in a standard zone package.

Marketability. Deciding which crops should and should not be considered for expansion in a farm program on the basis of prospective demand.

Phasing of Innovations. Considering whether the promising innovations for a zone should be introduced all at once or phased over several years.

Choice of Agents. Deciding what kind of field manpower is needed to service a package of innovations.

Choice of Extension Tools. Determining the most cost-effective mode of selling and training for a particular innovation package.

The emphasis is on saving management time and minimizing the need for scarce management resources by avoiding the needless paperwork, rewriting, reconsidering, conferencing, calculating, recalculating, and other similar activities.

Part I
Fundamental Concepts

1
Basic Systems Concepts

BACKGROUND

Over the past 30 years, a growing onslaught of increasingly novel and complex problems has overwhelmed the analytical capacity of traditional disciplines. To deal with these problems, a body of decision tools collectively called *systems analysis* evolved. Included are some highly sophisticated mathematical techniques that can only be performed on powerful computers, and some relatively simple analytical procedures.[1]

The Systems Approach

A general systems approach:

1. Defines the scope of the problem and its objectives
2. Defines the relevant system and builds a model of it
3. Formulates alternative solutions which may be either combinations of different activity systems or different systems configurations
4. Selects an optimum solution by applying the model and evaluating results on the basis of objectives and other criteria

The systems approach differs from the traditional, common-sense approach to decision making. Common sense tells us to plunge right into the problem and

1. For further discussion of any of the points in this chapter, see Earl M. Kulp, *Rural Development Planning* (New York: Praeger, 1970), pp. 5-7, 8-11, 631-32.

come up with an answer. For most day-to-day decisions, this is the right approach. The systems approach requires a rigorous exercise in definition, in abstraction. The problem is approached with a highly formal intellectual wardance, slowly closing in on the problem with decreasing concentric circles of analysis.

Traditional problem-solving approaches have not worked in basic agriculture. The problem of modernizing peasant agriculture is highly complex and still novel to many governments which have neglected it or failed in their first attempts. It certainly merits a systems approach.

Elementary Systems Terminology

SYSTEM	A set of *entities* and their *attributes* bound together by a defined set of *interrelationships* and a defined set of common *objectives* within a definable *boundary*.
ENTITIES or ELEMENTS	Objects, flows, activities, or events taken individually or as groups or classes. A single entity may constitute a *subsystem* with its own objectives contributing to the overall system objectives.
ATTRIBUTES	The mathematical or logical values of elements that are relevant to the objective of the system. The *internal variables* of the system are the set of values of attributes within the system boundary. Together they constitute the *state of the system.*
OBJECTIVES	The criteria for the optimum solution of the problem at hand, by which *system performance* is judged. The size and complexity of a system depend on the breadth of the problem being considered.
ENVIRONMENT	The set of all entities whose changes in attribute values may affect the state of the system, or whose attributes may be affected by changes in the state of the system. These attributes are the *external variables* of the system.
INPUTS	Changes in *external variables* which affect the state of the system or which are primary generators of changes inside the system.
OUTPUTS	Changes in *external variables* caused by changes in the state of the system.
MODEL	An abstracted, simplified statement of the system as it exists in the real world. It identifies those entities, attributes, and interrelationships relevant to the objectives.

Consider a farm as a system:

The ELEMENTS are crops, each a subsystem. Each crop and livestock variety raised on one farm is an enterprise.

The ATTRIBUTES of the crops are labor and input requirements, hectares cultivated, yield, and price. The ATTRIBUTES of the farm as a whole are land and labor available.

The OBJECTIVE is to maximize net income while guaranteeing enough food for the family.

The ENVIRONMENT includes the various institutions which serve the farm, providing it with supplies, a market, credit, etc.

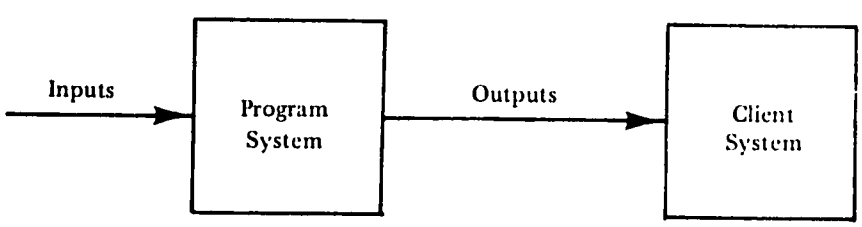
The INPUTS are capital, production supplies (e.g., seed and fertilizer), and possibly hired labor and irrigation water.

A SYSTEMS VIEW OF A DEVELOPMENT PROGRAM

Overview

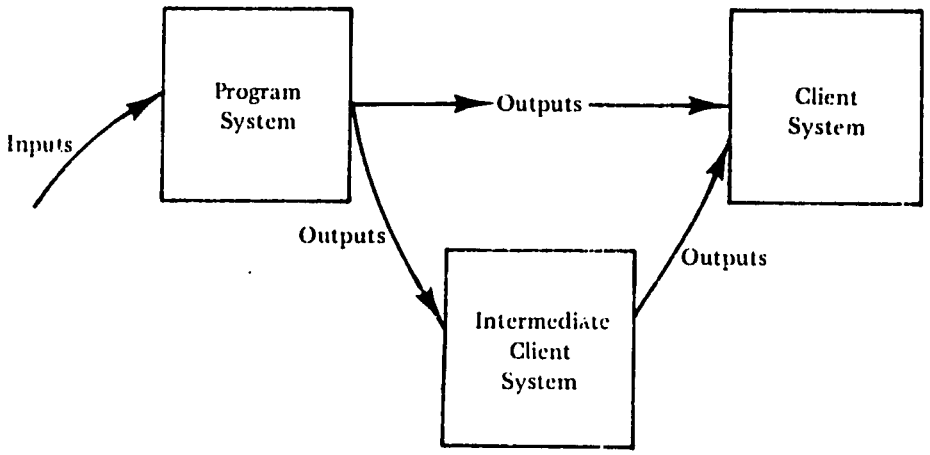
Every system must be defined in terms of its objectives. Only by knowing the objective can the relevant elements, attributes, and interrelationships be known.

To understand the objectives of a development program taken as a system, its *client system* must be understood. Every development program's objective is to change the state of the system of a set of clients, to make a group of people richer, smarter, healthier, more mobile, more secure from crime, or more tax-paying. The clients of an agricultural development program are groups of farmers. The client system of the agricultural program is composed of the aggregate of elements and attributes described above.



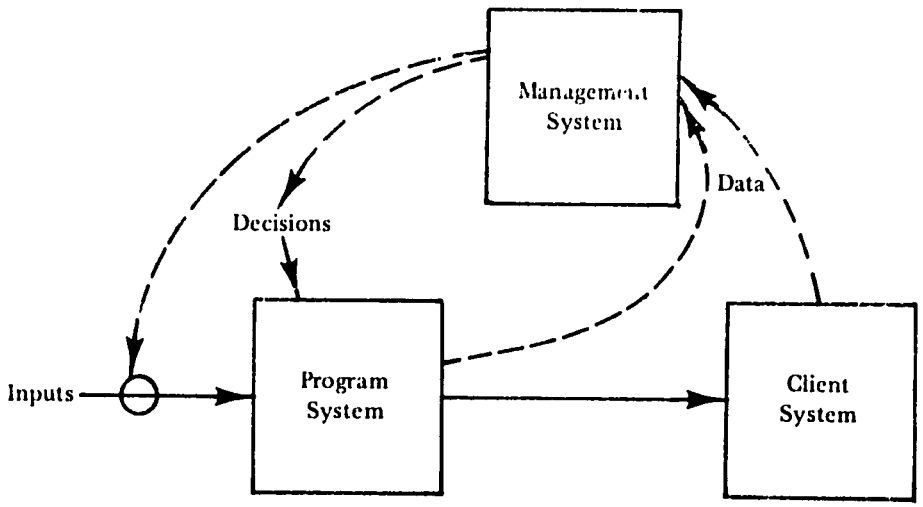
Often the program system achieves its ultimate objective of changing the state of the client system by working through *intermediate client systems.* An

agricultural program might deal with farmers directly, or it might deal with institutions such as banks, cooperatives, and agribusiness firms. These institutions, operating as systems, improve the state of the farmers as a system.



The principal inputs to the program system are resources, particularly money and manpower. Its outputs might be characterized as services. The outputs of program systems become inputs of the client systems.

Controlling the program system is a *management system*. Its inputs are data and its outputs are decisions.



Inner View

The structure of program systems can be identified by defining the elements, attributes, inputs, outputs, and interrelationships.

The elements of a program are generally *projects*; sometimes there are intermediate *subprograms*. Projects, taken as systems (subsystems of programs), have *tasks* as their elements. Projects, and in some cases tasks, can be divided into three basic types.

1. **Operations Projects or Tasks** generally have as their output a direct service to clients. In a basic agricultural zone project, some tasks might be to demonstrate, make loans, distribute supplies, train farmers, and collect crops. The relevant attributes might be numbers of farmers serviced, amounts furnished (loans, supplies, crops), numbers of agents, costs of agents, and costs of supplies. The key *output attributes* are:

Volume: the quantity of service transactions

Coverage: the number and percentage of clients and communities reached

The key *input attributes* of operations tasks are numbers and costs of personnel, supplies, equipment, and buildings.

2. **Supporting Projects and Tasks** sustain or increase operations and provide inputs other than money. Supporting tasks of a basic agricultural zone project might be to train staff, build warehouses, and procure supplies and equipment. Relevant attributes might be numbers of staff trained, number of instructors and training sessions, square meters of storage constructed, and the costs of these activities. Behind a basic agricultural zone project are supporting projects, such as supply processing (e.g., fertilizer mixing), crop processing, and staff education (schools for extension and coop personnel).

3. **Preparations Projects and Tasks** launch or improve the structure of supporting or operations projects or tasks. Quantities are irrelevant; their structure is a network of tasks or activities which must be accomplished by certain deadlines. Research projects, surveys, studies, revisions of regulations, design of major facilities, and construction of major facilities are examples of preparations projects. Their key attributes are events and deadlines.

Objectives, Efficiency, and Effectiveness

Objectives and outputs should not be confused. The objective of a factory as a system, for example, is not just to produce outputs but to produce them at a profit. The outputs are only part of the system's objective.

Objectives have been mentioned in terms of changing the state of the client system. For an agricultural program (and operations project) this means increasing farm income and/or production. Providing a given number of demonstrations or

loans or a certain amount of supplies or training does not *necessarily* increase farm income. Only an actual increase in farm income matters in determining the *effectiveness* of the system.

How is the performance of a system measured? Beginning at the task level, *efficiency* is measured by looking at the ratio of outputs to inputs. A task system which produces 20 demonstrations per extension agent is obviously more efficient than one which, with the same resources, produces 10 demonstrations per extension agent. But one task alone is not enough to produce the objective of increasing farm income. To measure *effectiveness*, the ratio of income increased to the total inputs of all the tasks is necessary to achieve the objective of increasing income.

Program Budgeting and Cost-Benefit Analysis

Government budgets have traditionally been structured along organizational lines, broken down by department, division, branch, etc. Studies show that it is generally impossible to judge effectiveness and often impossible to judge efficiency with such a structure. In agriculture, the services are often performed not only by different departments but also by different agencies.

A new kind of budgeting has attempted to overcome these and other resource allocation problems—the Planning-Programming-Budgeting System (PPBS). It features:

A new structure of government budget accounts

A multiyear planning exercise preceding the annual budget exercise

Special studies to consider major long-range alternatives

A stress on resource allocation based on cost-effectiveness and cost-benefit analysis

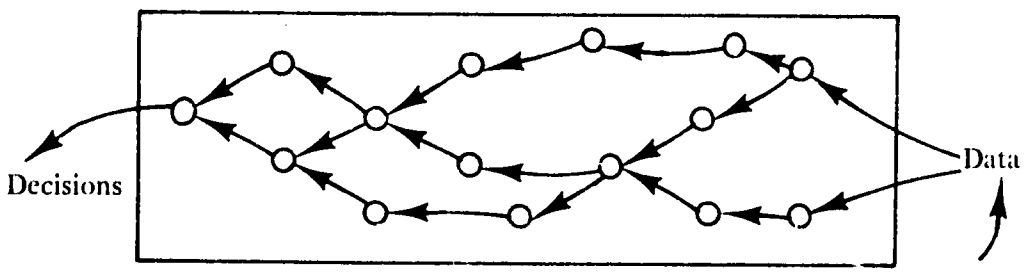
The first three elements make PPBS possible. The payoff comes with the fourth element—better resource allocation.

In program budgeting, programs and subprograms often cross organizational lines in order to organize all the resources necessary to achieve certain objectives. A key feature of this book is the *integrated* project which pulls together extension, credit, cooperative supply, marketing, storage, and whatever other services are necessary to get results on the farm. The integrated project permits evaluation of effectiveness, which is impossible in the conventional one-service agricultural project.

MANAGEMENT AS A SYSTEM

General Structure

Management is a system whose elements are decision nodes—separate decision exercises bound together in a network.



Each decision node has three kinds of attributes.

1. **Logical.** The processes involved in making decisions, interpreting data, comparing and testing, and determining the areas where judgment is to be exercised. Taken together, the logical attributes of all management system elements constitute the *logical subsystem.*

2. **Social.** The roles of various parties in decision making, which together make up the *social subsystem* of management.

3. **Data.** Gathering data, making computations, and developing the standard forms and documents required for decision making together make up the *data subsystem* of management.

The decision elements apply to three major categories of decisions.

1. **Policy.** "Whenever A occurs, do X." These decisions specify rules by which further decisions and actions are to be handled whenever certain conditions occur, no matter at what time.

2. **Planning.** "Assuming A, B, and C, do X in time period no. 1, Y in time period no. 2, etc." These decisions specify the activities and allocation of resources for specific time periods. Decision exercises which do not specify schedules and resource allocation constitute policy, not planning.

3. **Coping.** "Now that A has occurred, do X." These decisions specify what or how action is to be taken in response to unforeseen events. They deal with anticipated possible or probable deviations in policy and planning.

These three types of decisions make up the *policy, planning,* and *coping* subsystems, respectively.

These decisions are made chiefly on the basis of data inputs involving:

1. **Research.** These are data sought out initially for policy and planning.

2. **Feedback.** These are data continuously required on the program and client state of the system. Feedback involves:

> **Monitoring:** watching the program state of the system and its performance
>
> **Evaluating:** watching the client state of the system in regard to the objectives of the program

The outputs of the management system are decisions: (1) those acting directly on the program, characterized as *program design* decisions, establishing or modifying the elements, attributes, or interrelationships of the program; and (2) *resource allocation* decisions establishing or modifying the kinds and quantities of resources going into the program.

Objectives and the Measurement of Performance

Defining objectives and measuring performance in a management system is considerably more difficult than in a program system. Ideally, the objective of a management system is to optimize the state of the program system just as the objective of a program system is to optimize the state of the client system. One cannot argue with such a statement, but it leads to circular reasoning. The optimum state of a program system must be defined by the management system, putting us back where we started.

More simply, a "good" management system produces "good" decisions. Some assumptions must be made to determine what "good decisions" are. A good or sound decision is the result of irrefutable logic applied to adequate data. A sound decision, of course, may prove to be wrong. Sound decisions must be based on what will probably happen, and occasionally the improbable happens. Nevertheless, the logic must be as comprehensive and coherent as possible.

The first criterion of management system performance, then, is the application of irrefutable decision logic on adequate data.

The second criterion is timeliness: decisions are made when the program needs them.

The third criterion is input. In addition to a flow of data, a management system has inputs in the form of management time and talent. The number of people and the amount of talent and time available to give to decisions are limited. Management in less-developed countries is a scarce and fixed asset.

Keys to a High Performance Management System

Some management systems fail to perform in varying degrees because they waste management talent, substitute snap decisions for logic, fail to have necessary data available, and fail to make decisions when needed.

The following approaches can minimize these failures and improve the management system.

1. **Comprehensive Design.** There is a tendency to define a management system in terms of only one or two of the three attribute subsystems. Government manuals or circulars may lay out the system strictly in terms of who is to make decisions (the social subsystem) or the required forms (the paperwork element of the data subsystem). As a result, participants may misroute data or fail to provide crucial information. A comprehensive design can help eliminate these problems.

2. **Balance of Policy-Planning-Coping.** Policy-planning-coping form a pyramid. One effective planning decision eliminates the need for several coping decisions; one sound policy decision can eliminate several planning and coping decisions. In developing countries coping decisions take up most of the top administrator's time. Planning and a well-defined policy is needed to minimize coping and to allow it to occur at the lowest possible level. Many coping decisions must inevitably be referred to the upper echelons of management, particularly in the early stages of a program. Unless efficient troubleshooting procedures are laid out, projects will bog down in their early stages as the unexpected inevitably occurs.

3. **Minimum Participants and Paperwork.** One of the best ways to economize on management is to minimize the time that managers spend in meetings and in reading and analyzing documents. Equally important is paperwork discipline. Forms should be structured so that the data and analysis discussed at one meeting are confined to two sheets; it is usually impractical to work from more.

4. **Segregated Decision Steps.** To keep participants and paperwork to a minimum, the decision process should be broken down into as many separate steps as possible. Higher-level policy exercises should provide planners with guidance, and strategy options should be determined before much computation is done. Details should be carefully reviewed at the lower levels before broad plans are presented for high-level approval.

Limitations of the Systems Approach

Systems models and decision models can easily acquire a false aura of determinism. Systems models usually define stages or phases of activity, thus providing useful analytical and planning concepts. But the conceptual proposition that phase A is followed by phase B does not imply that phase B will *inevitably* follow phase A. Unless conditions and programs are right, phase B may not come for decades—indeed, phase B may never come.

Decision models present a similar paradox. A good decision model, when applied to valid data, will produce a sound decision. But a sound decision is not an assurance of desired results. (Note, however, that by definition an unsound decision leads to a failure.)

A sound decision followed by careful testing gives a high assurance of success. Sound planning should be interrelated with gradually broadened testing. Each stage of testing provides feedback for better planning and decision making. Testing improves the data base, reveals neglected aspects of problems, and confirms sound planning.

SUGGESTED READING

Cleland, D.I. and King, W.R. *Systems Analysis and Program Management.* New York: McGraw-Hill, 1968. Provides background on the program management approach.

Kulp, Earl. *Rural Development Planning.* New York: Praeger, 1970.

Mansfield, E., ed. *Managerial Economics and Operations Research.* New York: W.W. Norton, 1970. The most comprehensive, lucid, and inexpensive text on modern management tools.

2
Agricultural Development Systems Dynamics

INNOVATIONS AND INSTITUTIONS

Basic agricultural development involves the dynamic interplay between *institutions* and *innovations*. Innovations increase a peasant's income and his ability to assimilate further innovations. Yet unless there are institutions to support innovations, farmers cannot adopt them. Reciprocally, institutions require innovations to catalyze their own development.[1]

The Nature of Innovations

The basic means of agricultural development is innovation--an income-raising change in one of the interrelationships of the farm as a system. There are three general types of innovations:

1. **Yield Raisers.** New inputs such as improved seed or breeding stock and agricultural chemicals, or new practices such as earlier planting and sowing in rows—all related to a single enterprise.

2. **Bottleneck-Breakers.** New equipment or irrigation that overcomes labor and other bottlenecks and permits expansion of one or several enterprises with existing resources.

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1. Earl M. Kulp, *Rural Development Planning* (New York: Praeger, 1970), pp. 43-44.

3. **New Enterprises.** Planting a different crop or switching from primitive, casual production for home consumption to improved, expanded, cash-market-oriented production.

Factors of Development

Arthur Mosher has defined ten factors of agricultural development.[2] Five are *essentials,* factors which *must* be present before any farmer will adopt an innovation. The others are *accelerators,* factors which *may* or *may not* be necessary to get all suitable farmers of a community to adopt the innovation.

ESSENTIALS

1. **New Technology.** Innovation must start from a new technique of production or marketing which has been *proven feasible* on a peasant farm as well as on a research station. Agricultural development requires a constant flow of such new technology.

2. **Markets.** For any partial or complete enterprise innovation, there must be a market with three attributes:

a. *adequate demand* for the crop;

b. a *system* of collection and distribution; and

c. *farmer confidence* in the system and the demand.

3. **Supplies.** Improved seed, agricultural chemicals, or other inputs or equipment required by the innovation must be *available* in the community when needed, technically *effective* (i.e., dependable in quality), and *economically* priced.

4. **Transport.** Access to and from the farm must be adequate for the crop under innovation. If the innovation involves cattle with no bulky inputs, for example, no roads may be needed. If the innovation involves fresh tomatoes for the metropolitan market, a paved road must come close to the farm. The quality of the access needed in terms of year-round drivability, size of vehicle carried, and smoothness of the roadbed depends on the crop.

5. **Incentives.** The returns to the factors of production, land, labor, and capital must be adequate to motivate the farmer to innovate, in spite of the risks inherent in agriculture.

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2. Arthur Mosher, *Getting Agriculture Moving* (New York: Praeger, 1966).

ACCELERATORS

1. **Extension.** To get farmers in a community to adopt an innovation, an organized effort may be necessary to:

a. *inform* them about the potential innovation;

b. *sell* them individually the idea of trying it; and

c. *train* them in the necessary skills.

2. **Production Credit.** To finance an innovation, one or more of the following kinds of credit may be necessary:

a. *short term* for crop production inputs, repayable at harvest;

b. *medium term* for equipment or small farm improvements, repayable in two to five years; or

c. *long term* for irrigation or other major farm improvements, repayable in over five years.

3. **Group Action.** In developed countries where farms are from 50 to 500 hectares, one can economically send highly trained extension agents, supply salesmen, crop buyers, and bank loan officers to deal with individual farmers. It is not economical to do so for peasants on one- to five-hectare farms. Peasant agriculture needs a delivery system different from that used in modern commercial agriculture. Economical services can be provided only by dealing with peasants in organized groups.

4. **Land Development.** To promote an innovation or innovation package, it is sometimes necessary to expand available land or improve existing land, to build new roads, clear heavy trees and bush of malaria and tsetse fly, irrigate land, terrace it, or provide other conservation works.

5. **Project Planning.** It is sometimes necessary to establish an explicit project to promote an innovation package, outlining expected targets, responsibilities of various staff and institutions, resource allocations, and work schedules.

Some innovations need all the accelerators and some need none. Hybrid maize, for example, has spread across large areas of Thailand, Indonesia, and East Africa with no project planning, land development, group action, production credit, or specific extension effort. Cotton in Northeast Thailand and tea in East Africa, on the other hand, required all five accelerators.

Each proposed innovation must be examined to determine which accelerators are necessary. A few generalizations, however, are possible. Distribution of improved seed may require no accelerators. Distribution of other improved inputs

may require only a small amount of extension plus some production credit. Promoting a new crop may require extension, credit, group action, and planning. Horticulture generally needs all five accelerators.

Institutions and Services

For any innovation, the ten factors of development may be supplied by different institutions. For example:

Technology:	research departments of ministries, agribusinesses, agricultural faculties
Marketing:	cooperatives, local merchants, agribusinesses, marketing boards
Supply:	cooperatives, local merchants, agribusinesses, public enterprises
Transport:	national and local public works agencies, local authorities, railroads, shipping firms
Incentives:	governmental price support agencies, established markets, community social structures
Extension:	extension services, community development services, cooperatives, agribusinesses, voluntary associations
Credit:	banks, cooperatives, agribusinesses, moneylenders
Group Action:	cooperatives, extension, community development agencies, existing social structures
Land Development:	irrigation departments, agricultural engineering services, land cooperatives, settlement authorities
Planning:	ministries of agriculture, planning commissions, regional development authorities, interagency committees, local associations

For some innovations, each factor may be provided by a different institution. There are no set rules for the overall organization of necessary services. In principle, there are some organizational advantages to providing as many services as possible through multi-purpose cooperatives. In general, however, a variety of combinations may offer promise in any given country.[3]

Development of peasant agriculture requires a particularly strong institutional structure for *core services:* (1) extension, (2) supply, (3) marketing, and (4) credit. These services require continual interaction between the institution and the farmer. The development process can be viewed as one of building the capabilities of these service institutions through a series of catalytic innovations.

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3. Kulp, *Rural Development Planning*, pp. 72-76.

Certain *peripheral* services may be important in some regions. These fall into two major categories: (1) engineering, including soil surveys, irrigation, and tractor hire; and (2) protection, including spraying and innoculating animals.

SPATIAL ORGANIZATION

Administrative

The nomenclature of administrative subdivisions varies from country to country. The area and population of administrative subdivisions vary even more within one country. For purposes of this book, consider the following pattern of subdivisions:

Subunits	Provinces	Districts	Townships	Villages	Farms	Rural Population
Province	1	5	50	500	50,000	300,000
District		1	10	100	10,000	60,000
Township			1	10	1,000	6,000
Village				1	100	600

Country X is used as a consistent example throughout this book. The administrative structure and agricultural service organization is outlined in Table 2.1 and Diagram 2.1.

The four tiers of administration are:

1. **Provinces.** A level at which all administrative services are present. The provincial chiefs of services are generally professionally qualified. The headquarters town has a major market, warehousing facilities, and bank branches, and a main road connects with the capital.

2. **Districts.** Generally the lowest levels at which ministries post professional civil servants. The headquarters is usually a market town connected to the province center by an all-weather road.

3. **Townships.** Generally the lowest level of formally established local authority. There is a small market, and the administrative chief is usually a local notable rather than a professional administrator.

4. **Villages.** Compact settlements or subdivisions of townships covering scattered homesteads or small clusters of families.

The commercial and administrative services and staff at each level depend on and reflect the stage of evolution. As the rural economy evolves, increased

TABLE 2.1 COUNTRY X GENERAL BACKGROUND

ADMINISTRATIVE STRUCTURE

	Regions	Provinces	Districts	Townships	Villages	Farms	Rural Population
Nation	5	25	125	625	6,250	1,250,000	7,500,000
Region	1	5	25	125	1,250	250,000	1,500,000
Province		1	5	25	250	50,000	300,000
District			1	5	50	10,000	60,000
Township				1	10	2,000	12,000
Village					1	200	1,200

MINISTRY OF AGRICULTURE

Organization (see Diagram 2.1)

Field Staffing

Level	Position Title	General Education (in years)	Training (in years)	Coverage*	Base Salary	Total Cost/Year†
Province	Prov Agr Officer	12	4	90%	$3,000	$4,000
	Asst Prov Ag Officer	12	2-4	70%	2,000	3,000
	Prov Coop Officer	12	4	80%	3,000	4,000
	Asst Prov Coop Officer	12	2-4	60%	2,000	3,000
District	Dist Agr Officer	10-12	2	80%	2,000	2,500
	Dist Coop Officer	10-12	2	60%	2,000	2,500
T'ship	Agr Assistant	10	2	50%	1,500	1,800
	Coop Assistant	10	2	40%‡	1,500	1,800
	Monitors	7-10	1-3	#	600	700

* Percentage of units with staffing of specified education and training.

† Including housing, transportation, and other fringe items.

‡ Each Coop Assistant covers 1-3 communes depending on program.

As needed for specific projects.

OTHER AGRISERVICE INSTITUTIONS

Cooperatives: The Central Union imports and distributes.
Province Unions engage in both supply and marketing.
Primary Societies at sub-township level:

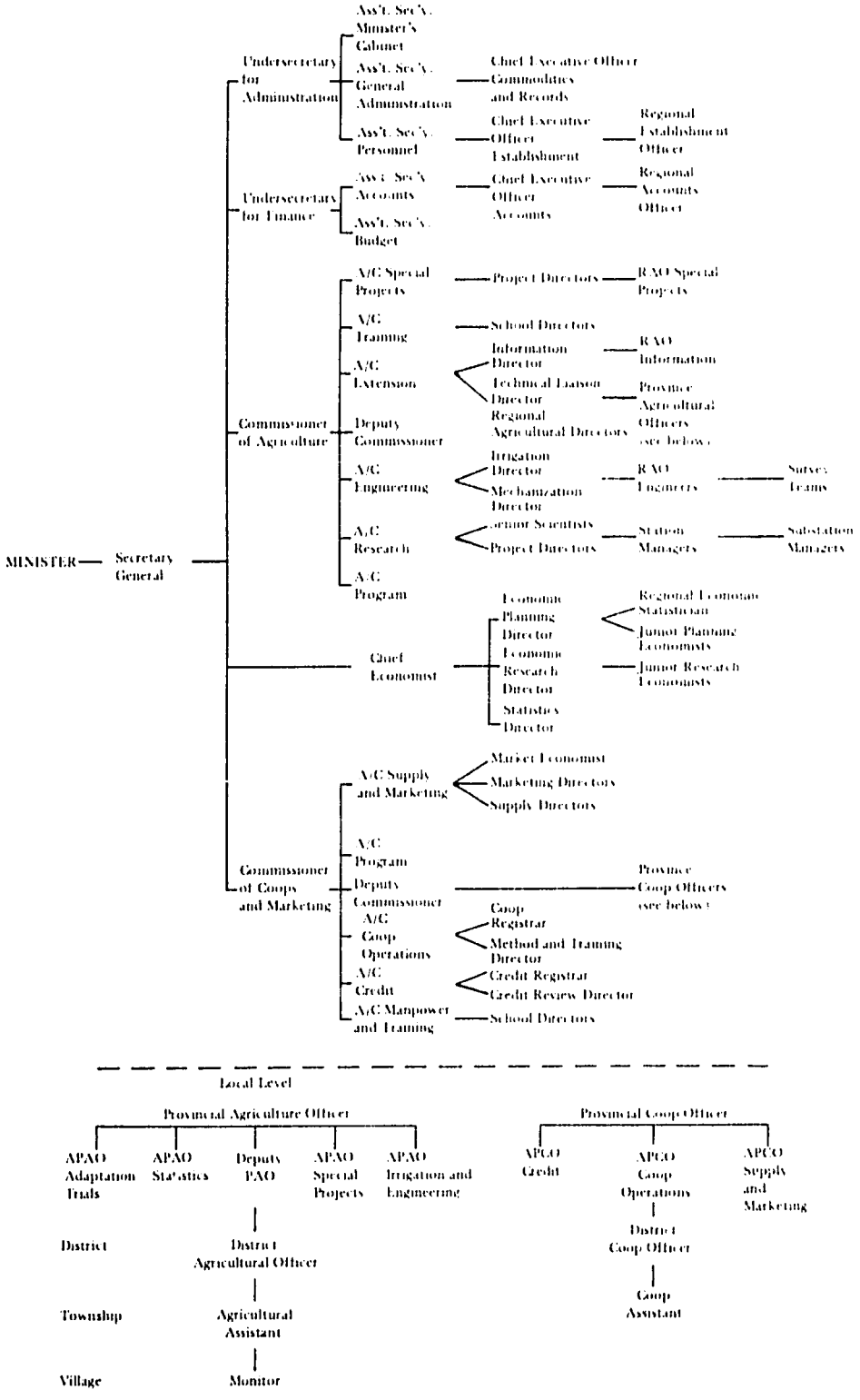
1. are found in 60% of the townships.
2. are rarely more than part-time export crop buying stations.
3. service 400-800 farmers.
4. have generally part-time, underpaid, inexperienced managers.
5. usually have a warehouse.

Marketing Boards handle marketing of export crops.

Private Firms import some agricultural chemicals and equipment and handle most of the commerce in food crops.

Zone Y covers 4 districts, 16 townships, 160 villages, 32,000 farms, and has 50 primary societies buying cotton.

DIAGRAM 2.1 ORGANIZATION OF THE MINISTRY OF AGRICULTURE OF COUNTRY X



numbers of staff and services tend to be centralized on the township level. Credit facilities, for example, may be found only at the province level in the early stages. As the volume of business in a township expands to warrant a resident credit staff, full credit facilities may be found at the township level. As communications improve with economic development, some of the functions of the village chief may move to the township level.

Agricultural Spatial Structure

Agricultural organization rarely conforms to administrative boundaries. For planning purposes, there are three tiers:

1. **Regions.** Areas generally covering or overlapping several provinces where the same major crops predominate.

2. **Zones.** Areas overlapping a few districts where the same farm system prevails consistently enough to permit one package of recommendations to apply to most farms.

3. **Communities.** Areas generally served by one crop collection point within which farmers can easily learn from demonstrations and each other. Depending on culture and communication patterns, a farming community may cover one village, an entire township, or some area in between.

In some countries a *farming district*, an area serviced by one market town and service center, may be important. Generally, the farming district is the same as the administrative district.

The zone is particularly important to planning. It is an area in which the farms are fairly homogeneous, use the same techniques, get the same range of yields, plant roughly the same proportional acreages of crops, and plan on the same calendar. Table 2.2 shows how the zone project forms the base of the total plan.

STAGES OF PEASANT AGRICULTURAL DEVELOPMENT

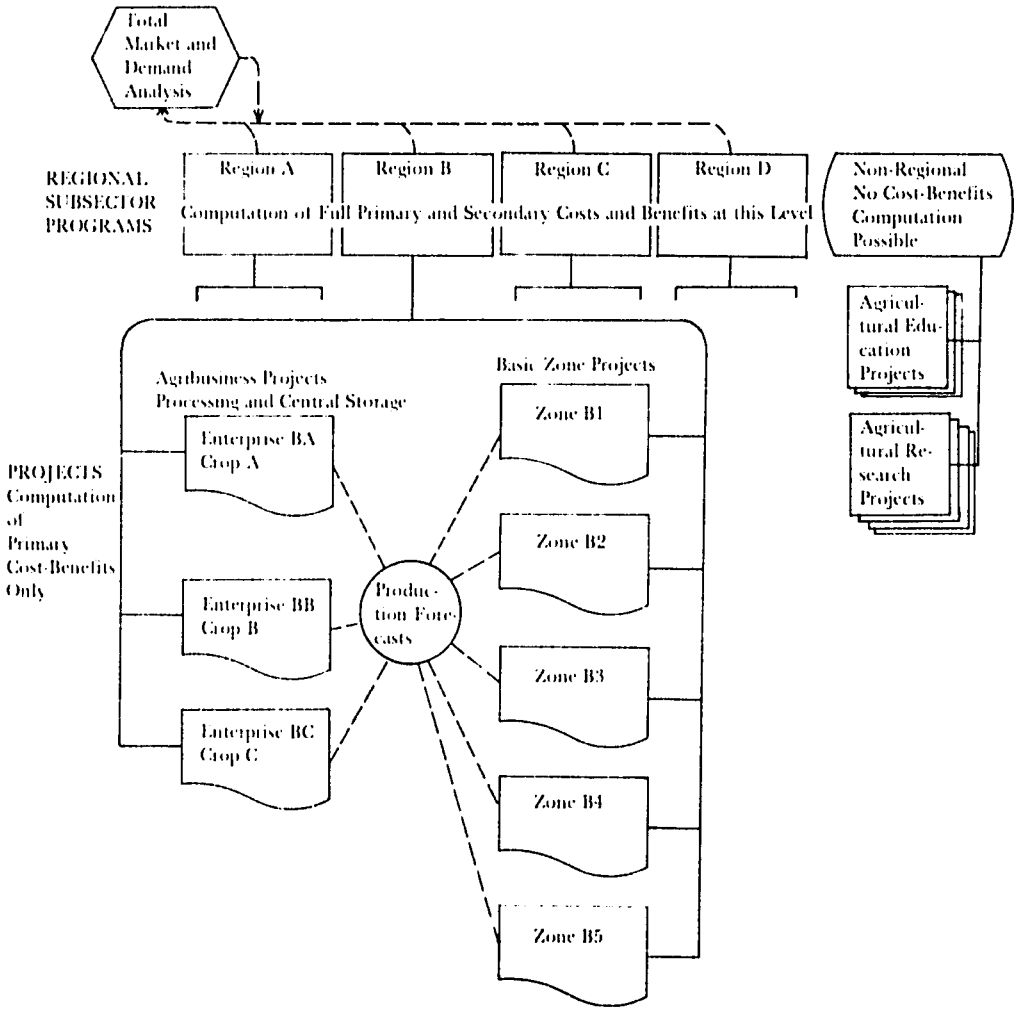
Peasant agriculture develops by stages within zones. Even within the same region, different zones may be at different stages of development. Here is an idealized and simplified scenario of these stages. It assumes the existence of a mass of generally homogeneous peasant farmers who are not primarily constrained from development problems or other positive institutional blockages.

TABLE 2.2 THE STAGES OF AGRICULTURAL DEVELOPMENT

Stages	PDV Predevelopment	Exp Experimental	MCI Major Crop Improvement	CFI Comprehensive Improvement	HVD High Value Diversification	CIn Capital Intensification
Coverage of Core Services*						
Extension	0%	1-20%	40- 80%	100%	100%	100%
Seed Distribution	0%	10-80%	70-100%	100%	100%	100%
Coop Supply—						
Agricultural Chemicals	0%	1- 5%	30- 80%	70-100%	100%	100%
Coop Marketing—						
Single Crop	0%	1- 5%	20- 80%	100%	100%	100%
Other Crops	0%		1- 10%	40- 80%	100%	100%
Credit—Short Term	0%	1- 5%	10- 60%	100%	100%	100%
Credit—Medium Term	0%		1- 5%	30- 80%	100%	100%
Typical Catalytic Innovations		Improved Seed ----------	----------	----------		Large Equipment
			Fertilizer ----------	----------		
				Small Equipment ----------		
					Horticuiture ----------	
					Livestock ----------	
Locus of Project Management		Center	Region Province	Province District	Township	Township Farm
Main Focus of Planning**						
Project Structure		==========	==========	==========		
Project Financing			==========	==========	==========	
Overall Supply of Agricultural Credit					==========	==========
Orientation of Farmers						
Subsistence	100%	20-90%	5- 40%	1- 5%		
Subsistence-Mixed		5-80%	50- 80%	10- 30%	1- 5%	
Mixed		1- 5%	5- 15%	60- 80%	80-90%	10-40%
Specialized					5-10%	60-90%
Cash Income of Farms	$10-$30	$20-$80	$50-$150	$200-$400	$300-$1500	$1200 plus

*Percentage of farmers reached by the service;
**Primary focus ====; Other focus ----

DIAGRAM 2.2 AGRICULTURAL PROGRAM STRUCTURE



Stage 0: Predevelopment (PDV)

This stage is defined by the lack of modern core agricultural services. For all practical purposes, there is no development effort at all. The orientation of farmers is to subsistence: their only cash is earned by marketing small food crop surpluses. Food crop acreages are sufficient to feed the family in the worst of years. Surpluses may be bartered with traditional local merchants for basic manufactured necessities. Change may occur; for example, several food crops were introduced into Africa in the three centuries before the appearance of professional agronomists. Such change, however, is slow.

Stage 1: Experimentation (Exp)

A government needs time to determine and establish the institutional patterns and the catalytic innovations that will carry development forward. A large part of the farming zones of developing countries is still in a stage of program experimentation. In this stage, the government may have pilot projects in scattered villages, but 80% of the farmers are not involved in new developments except improved seed.

Improved seed is one catalytic innovation that can take farmers out of subsistence in this stage. If improved seed can be planted without modern inputs or complex practices, it can spread with little or no extension effort or other core services. For example, farmers might grow a cash crop in an area where core services reach only a few. Usually the crop will have a high return even on low yields when first introduced: a tree crop such as coffee or cocoa, or a fiber crop such as cotton or jute. The orientation is then *subsistence mixed:* farmers are still concerned with producing enough to feed the family, but they are determined to maintain some cash crop production.

At this stage project management must be centralized to succeed. With limited experience of success, there is little basis for sound policy decisions. Top level officials make minor decisions and do a great deal of trouble-shooting. Province and district level officials do not have the training, experience, or authority to give planning and management the necessary drive.

Ministry officials may complain at this stage about the lack of money and budget restrictions, but finance is not the real problem. Zones in this stage cannot absorb significant amounts of investment.

Stage 2: Major Crop Improvement (MCI)

A careful combination of innovation and institutions is necessary to move out of the experimental stage to actually reach a majority of the farmers with new

practices and modern inputs. It takes a simple yet broadly applicable catalytic innovation—one that can reach most farmers with a minimum of institutional support. This usually means some improvement in the major cereal or cash crop.

Fertilizer is often a good catalytic innovation at this stage. It is easy to distribute, easy to finance, and easy to supply. It may invite the introduction of cooperative-run supply and credit services. Combined in a package with improved seed and improved marketing of the main crop, fertilizer can make a significant increase in farm cash incomes.

By the end of this stage, most farmers will have:

1. Adopted improved husbandry practices
2. Bought agricultural chemicals on credit
3. Marketed a cash crop
4. Adopted a subsistence-mixed orientation

Perhaps more important are the psychological transformations. Farmers and extension and cooperative field staffs have experienced success. They have applied the motivation and discipline to obtain results. Farmers have some confidence in the recommendations of the extension service. Above all, they have confidence in themselves and in their own ability to innovate.

Stage 3: Comprehensive Farm Improvement (CFI)

This stage completes the institutional superstructure of agricultural development with the following:

Extension	– fully qualified professionals at subdistrict level
	– village level demonstrations
	– highly localized recommendations
Supply	– equipment sales at the township level
	– sale of a variety of high-analysis agricultural chemicals
Marketing	– collection of several cash crops
	– local storage; holding crops off markets for better prices
	– buying on grade
Credit	– medium-term loans

Key catalytic innovations at this stage are high-analysis fertilizer, high-yielding crops requiring heavy inputs, and small equipment, such as pumps and improved, ox-drawn implements. The small equipment catalyzes medium-term

credit as well as improved supply services. It permits better water control, better husbandry, and more timely planning to achieve higher yields. Most important, it breaks labor bottlenecks and permits the peasant to make better year-round use of family labor.

In this phase, core services should expand coverage to over 70% of the farmers. This should transform most of the farmers from a subsistence-mixed orientation to a more purely *mixed* farming orientation, i.e., they should have a sufficiently high level of production and income to lose their preoccupation with growing enough food. They can plant whatever crops will maximize return on land and labor rather than concentrating on enough cereal acreage to feed the family.

In this stage, project activity and project investments approach a peak. Activity is so diffused throughout the countryside that province and district officials must function as fully qualified project managers. Activity is too diffuse and diverse to permit much trouble-shooting from the center. Planning should now be done at the provincial level.

At this point the primary focus of overall program planning is to obtain a massive inflow of project investment funds. Medium-term credit requirements are particularly high.

Stage 4: High-Value Diversification (HVD)

This stage requires sophisticated new farm enterprises, particularly commercial-level horticulture and livestock requiring substantial investments and production inputs and high husbandry skills.

Because of the precise technical requirements of these crops, extension recommendations must be village- or farm-specific. Fertilizer and seed recommendations may have to be based on the soil testing of individual fields. Marketing must operate with precision. In horticulture and dairy, for example, uniform deliveries must be scheduled for each day or week. Quality control must be tight, requiring substantial management competence at the community level.

At this point, farmers take over much of the development initiative. The community has acquired a growing appetite for innovation. Farmers give their confidence to the management of the local cooperative. Most are actively seeking new opportunities for diversification to make maximum use of land, labor, and community facilities.

Project activity in the conventional sense now peaks and tapers off. Development is no longer controlled by projects in the five-year plan. New exports may be initiated through projects originating at the center (but managed at the district level), but local cooperatives take more initiative to generate and

manage their own development. They are financed not by resource allocations to specific projects but by general resources made available for agricultural credit. The focus shifts to the overall supply of agricultural credit.

At this point, we can no longer speak of peasants. Farming is still labor-intensive, but it is no longer technically or commercially backward. Smallholders, organized in multipurpose cooperatives, are as technically and commercially sophisticated as large-scale commercial operators.

Stage 5: Capital-Intensive Development (CID)

At a point not controlled by the evolution of agricultural development, the urban economy draws off the surplus labor from the rural economy. If stage 3 has been reached, smallholders must substitute capital for labor to maintain or increase production. As some farmers leave for the city, others buy or sharecrop their land, and become larger-scale farmers. They must now invest in heavy or automatic equipment. At this point their orientation shifts from mixed to *specialized* farming. To maximize the return on heavy capital investments, they concentrate on one or two enterprises.

Each farm works out an optimum pattern of operation. Planning now takes place at the individual farm level. The interplay of institutions and innovations has ended. Projects are no longer relevant.

Lags between stages vary considerably, and stages do not emerge uniformly within given areas. Japan reached stage 4 in the early 20th century, yet by the mid-1950s it still had a rural labor surplus and little farm mechanization. Then the labor surplus disappeared in the late 1950s, and Japanese farms became fully mechanized in less than ten years. Israel, on the other hand, settled tens of thousands of new immigrants on stage 4 farms in the 1950s. By the mid-1960s it had to switch to specialized capital-intensive farming. The lag depends on such elements as the pace of urban industrial development relative to the overall surplus labor force.

KEY LESSONS

This pattern of basic agricultural evolution carries some important policy implications.

No Skipping

A zone cannot usually jump from stage 1 or 2 to stage 5 without going through intermediate stages. In a number of countries, rapid urban growth

alongside a stagnant agriculture has led to imports of food instead of increased agricultural production. Farmers cannot move immediately from subsistence to mixed or specialized operations.

A country can bring its major zones through stages 2 and 3 with one generation of projects in three to eight years, e.g., Senegal.[4] Usually, however, a first generation of projects carries a region through stage 2, and then a second generation carries various zones through stage 3. Israel, Venezuela, and Malaysia have demonstrated that it is possible to move directly from stage 1 to stage 4 if the following conditions are present: (1) ample financial resources; (2) ample trained leadership and field staff; (3) a high basic urban standard of living which can only be matched by a stage 4 farm; and (4) well-managed credit, supply, and marketing services. Even then, however, it may take four to ten years for an individual farm to reach full production.

Complex innovations cannot be pushed until the institutional coverage is ready to support them. Horticulture and high income livestock packages, for example, cannot be launched until core services can provide medium-term credit, high-analysis inputs, and buying on grade. Until a country is ready to move on to the proper level of institutional development, research on high-value innovations may be premature.

Stage 5 doctrines taught in developed countries cannot be applied to stage 2. In particular, one cannot apply the doctrines of dealing with individual farmers, independent program planning by every extension agent, and emphasis on mechanization.

Program Structure Oriented to Cost-Benefit Analysis

In stages 2 and 3, project financing is critical. Project planning must demonstrate a good return on investment to obtain the necessary allocations from development banks. Projects must be structured to show specific benefits and increases in income and production. They must also show *all* the costs necessary to realize those benefits. The typical single-service projects—extension, credit, coop—cannot claim specific benefits as a result of their efforts alone. Nor do they show the full costs of realizing any specific increases in income.

Zone projects are needed. Each must include all the local activities needed to induce the appropriate farms in the zone to adopt a particular package of innovation. Within the zone project, all primary costs and benefits can be calculated. The zone projects can then provide a basis for estimating the secondary project requirements of a region—the centralized processing and storage

4. Kulp, *Rural Development Planning*, pp. 170-83.

facilities needed for the projected increase in production. Taken together, the primary and secondary projects of a region can provide the data for cost-benefit analysis covering both primary and secondary costs and benefits.

Proper Use of Catalytic Innovations

Research should focus on those innovations appropriate to the stage and to the farming systems.

In early stage 1, focus on improved seed for main subsistence crops or easy-to-grow new cash crops.

In late stage 1, focus on low-analysis fertilizer inputs applicable across a wide region to prepare for stage 2.

In stage 2, focus on total farming systems and their bottlenecks, on small equipment to break those bottlenecks, and on high inputs of agricultural chemicals to prepare stage 3 packages.

In stage 3, focus on horticulture and livestock enterprises with a high return on land to prepare for stage 4.

Promotion of catalytic innovations should be oriented to peasants and to the average- or median-sized farm. In many countries the research and planning for catalytic innovations were promoted without any corresponding build-up of institutions. As a result only the large commercial farmers, those independent of supportive institutions, could take advantage of them; and capital-intensive farming expanded while peasant agriculture stagnated.

Concentration on labor-intensive innovation is needed. The developing countries need more jobs, and the cheapest place to create them is on the farm. The investment needed to create an additional job in a peasant farming community is much less than in a typical industrial project.[5]

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5. Edgar Owens and Robert Shaw, *Development Reconsidered* (Lexington, Mass.: D.C. Heath, 1972), pp. 51-69.

3
Policy Essentials

Six elements of policy are fundamental to any effective strategy of peasant agricultural development.

Analyze

Any planning for a zone must start with a thorough analysis of the existing farming system and the potential innovations.

Assemble a Model of the Statistically Average Farm of the Zone. Consult statistics, farm management surveys, various reports, and professionals who have been working in the area to estimate:

1. Average land and labor resources
2. Average acreages of various crops and percentage of farmers growing them
3. Percentage of farmers raising various types of livestock and the average size of their herds
4. Timing and labor requirements of various crops
5. Average yields, home consumption, prices, and cash income

Combining these data in terms of one average farm gives a relatively concrete basis of analysis which leads to an understanding of the present problems and

behavior of real farmers. Comparing the hypothetical average with information about a sample of actual farms provides a basis for determining the homogeneity of the zone.

Identify the Yield-Raisers That Have Proven to Be Profitable. Consult research and extension reports to discover which new cultural practices or applications of improved seed, fertilizer, and pesticides have profitably increased yields. For each crop, list the profitable practices and inputs and the amount by which they will raise income.

Find the Bottlenecks and the Bottleneck-Breakers. Analyze the economics of the bottleneck-breakers. Are farmers idle several months of the year? Is it because they are working to capacity during certain months? Or is it because they lack the water to put land to use during the off-seasons? Is there any small equipment or other moderate investment that could help break these bottlenecks? Would ox equipment or tractor hire be more cost-effective in breaking labor bottlenecks? Can minor irrigation works be cost-effective?

Identify New Crops. Find out which crops can be easily introduced into the system. Consider carefully the existing labor patterns and the returns on land and labor.

Compute the Optimum Total Improvement Program for the Average Farm. For a short-run improvement program, assume that all profitable yield-raisers and bottleneck-breakers are applied. Assume also that the farmer will not reduce acreages of present subsistence crops. Compute the acreages of each crop that will maximize gross margin. For a long-run improvement program, consider the market for each crop which appears in substantial acreage on the projected optimum short-run program. If every farmer in the zone or region grew that acreage, would it saturate the domestic market? Is there an export market, and would the quantity of increased production saturate the export market? Estimate likely saturation prices, i.e., likely lower future prices due to market saturation. Now relax the assumption that farmers will not reduce acreages and recompute the optimum program using saturation prices where appropriate.

Standardize

Assume That Most Farms in the Zone Are Similar to the Average Farm. Make the safe assumption that an optimum program good for an average farm in stage 2 or 3 is good for most of the farms in that zone. The average recommended

acreages can be scaled to the amount of land and labor available.

The best way to get mass volume in development, to reach the most peasants in a zone with cost-effective services, is to offer only one package in the zone.

Integrate

Do Not Plan Extension, Credit, or Coops as Separate Projects. These projects should be integral features of the effort. This makes cost-benefit analysis possible, which is essential to justifying development loan financing. Separate, uncoordinated efforts are signs of bad management.

Build the Zone Project and Service Programs Around the Standard Package. The objective of the project is to get all the farmers in the zone to whom the package is suited (some 60-80%) to adopt the standard package. The net benefits of the project are the net income increase for the average farm multiplied by the number of adopting farms in the zone. Include all expenses and investments of services required for achieving the project objective and clearly attributable to the particular zone. The standard package determines:

- routine and staff training of the extension agents;
- demonstrations and information materials;
- credit packages;
- coop marketing objectives; and
- supply inventory requirements.

The standard package determines the activities of all services in the zone, except those on certain multizone special projects; and a basis for close coordination is assured.

Saturate

Use More Than Enough Subprofessional Field Agents. Depending on the complexity of the standard package, during the first year it may be wise to have one field agent for as few as 100 new adopters. There probably will not be enough professional agents to do this; professional agents must have under them teams of monitors, men with five to nine years of education and a few months of training. Even at ratios tighter than 1:100, their cost will probably be a minor part of total project investment. A monitor might cost $700 a year—only $7 per new adopter. The "overlapping" will also help produce personnel for the expansion of the next phase.

Design Service Field Staff Routines Suitable for Poorly Trained and Educated Personnel. This is the key to breaking the trained manpower bottleneck that plagues all developing countries. Routines must be feasible without extensively trained manpower. They must be simplified, yet thorough.

Use all Possible Administrative Officials in the Zone to Sell the Package. The support of the civil administration and the province, district, township, and village chiefs is essential. Orders for cooperation should be secured from the province chief. All chiefs, community development workers, schoolteachers, and local religious leaders should be familiar with the package so they can answer the peasants' questions.

Provide All Necessary Credit for Production, Storage, etc. Do not launch a project in a given community unless sufficient resources can be allocated to enable all suitable farmers to adopt the package in three to five years (see p. 33).

Concentrate

Move the Project Through the Point-Line-Network Phases.

1. **Point Phase.** Begin in only one or two locations with about 10 to 40 farmers in each. Senior officials must spend time with monitors working with the first group of farmers to learn what problems are encountered and what routines work.

2. **Line Phase.** During the second year, expand the project to about five to ten locations to try the program under varying conditions. Some prior guidance and training will have been given to the field staff, but senior officials must still be available for solving problems.

3. **Network Phase.** Once the lessons of the line phase have been learned, expand the project as fast as resources will allow.

Resist Political Pressures to Begin on Too Large a Scale. Well-meaning but inexperienced political leaders may be impressed by a small pilot demonstration and may ask that resources and benefits be immediately expanded. Field staff soon encounter problems for which they lack guidance of personal authority. If locations are visited by trouble-shooting senior officials, the project may work in a few locations. In the others, the field staff loses self-confidence and the peasants are disillusioned by broken promises.

Resist Political Pressures to Start Everywhere at Once. Focusing on a few areas is a difficult political issue as it means treating some communities better than

others. There is a tendency to spread every project over all provinces, districts, and townships. This approach creates a number of problems: (1) scarce management is dispersed; (2) the volume of activity in each location is too small to make the necessary supporting services economical; and (3) the project is limited to the more prosperous members of communities because there are not enough resources to reach the majority of the farmers. So the bulk of the community resents and resists the special benefits given to the privileged few. To avoid this political pressure, approval and authorization of concentration must be obtained as a policy point.

Accelerate

Negotiate Major Financing As Soon As the Point Phase Succeeds. This strategy helps sustain the motivation, drive, and discipline of the project staff and the support of the community and politicians. Two years for negotiating development bank financing is normal; bankers may want the results of the line phase before giving final approval. If one waits until the end of the line phase to seek financing, the project may be delayed. This type of negotiation has three corollaries:

1. **From the beginning, work with a life-of-project plan showing full costs and benefits.** It is necessary to demonstrate whether the project will have an adequate return on investment; the negotiations cannot begin without a life-of-project plan.

2. **Consider asking for a major investment in a high-payoff project.** Many agricultural administrators used to working with small budgets are hesitant to ask for hundreds of thousands of dollars for each zone. If a package has enough return to the farmer to appeal to him, it probably has an overall return on investment that is higher than most industrial projects. For example, a farmer is not likely, in the early stages of development, to borrow money for fertilizer unless the increase in yield is worth $2 for every $1 he borrows. The natural risks are too high to accept a much lower return. Since production credit is likely to be the major cost of an integrated project, the overall return will be high.

3. **Consider high interest rates to attract adequate financing.** It is commonly felt that farmers should not be charged a high interest rate. But suppose that a farmer wants to borrow $20 to increase yields by $40. If he borrows for six months at 10% per annum, he repays $20 in principal, $1 in interest, and nets $19. If he borrows at 20% he repays $2 in interest and nets $18. Will the investment decision be much affected by that prospective 5% variance in potential net income? Which is worse, charging high interest rates and attracting enough

TABLE 3.1 A STRATEGY FOR EFFECTIVE DEVELOPMENT OF PEASANT AGRICULTURE

For each homogeneous farming area (zone):

1. **Analyze:** compute the best program for the *average* farm
   - assemble a model of the statistically average farm of the zone
   - identify the yield-raisers that have proven to be profitable
   - find the bottlenecks and the bottleneck-breakers
   - identify new crops that can easily be introduced into the system
   - compute the optimum total improvement program for the average farm

2. **Standardize:** adopt the above program as the standard package of the zone

3. **Integrate:** convince all suitable farmers to adopt the standard package
   - do not plan extension, credit, coops, etc. as separate projects
   - build the zone project and service programs around the standard package

4. **Saturate:** overpromote the package in each farming community
   - use more than enough subprofessional field agents
   - design service field staff routines suitable to poorly trained and educated personnel
   - use all possible administrative officials in the zone to sell the package
   - provide all necessary credit for production, storage, etc.

5. **Concentrate:** do not spread management and resources too thin
   - expand the effort in an orderly, rational manner
   - resist political pressure to begin on too large a scale
   - resist political pressure to start everywhere at once

6. **Accelerate:** each year build up speed
   - negotiate big financing as soon as the first phase succeeds
   - provide resources in each farming community to double or triple the number of new adopters each year until the community is covered
   - launch the project in double or triple the number of new communities each year until the zone is covered

investment to let all peasants have the chance to develop, or charging low interest rates and securing finances to let only a few develop?

Provide Resources in Each Primary Community to Double or Triple the Number of New Adopters Each Year Until the Community Is Covered. If a package is sound, every successful adopter will convince more of his friends and neighbors to adopt the package. The development strategy must help all farmers realize that they can participate, or the community as a whole will resist it.

Launch the Project in Double or Triple the Number of New Communities Each Year Until the Zone Is Covered. Each year's experience should facilitate adequate management of a larger-scale project the following year. If the project benefits the farmer, it will increase the interest of other communities.

But is it reasonable to count on a smooth upward path for a project? If acceleration is preceded by adequate analysis, standardization, integration, saturation, and concentration, the project stands a reasonably good chance of moving steadily upward. Project management can cope with setbacks if a proper foundation has been laid, but projects will stagnate if preparations for upward motion have not been laid in advance.

POLICY FORMULATION PROCEDURE

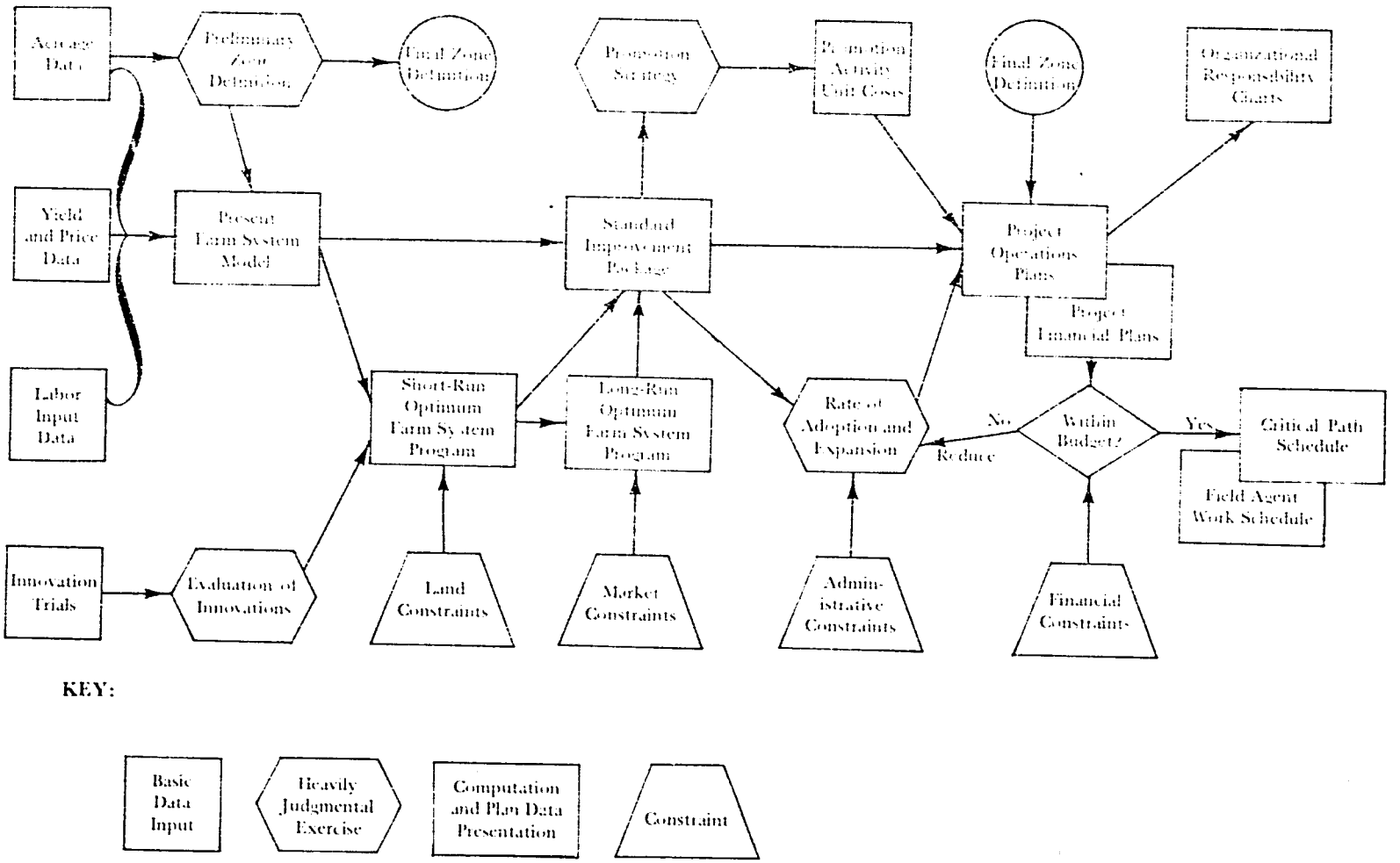
Planning is the core of the management process. Diagram 3.1 illustrates the six strategy points in this chapter, moving from the average farm to the community, the zone, the region, and the nation. This sequence facilitates the decision process: it is logical and it keeps the early decisions focused on something concrete before moving on to abstractions.

Pilot Projects

Policy can be decided best on the basis of concrete cases. Planners and would-be basic agricultural program managers are therefore advised not to raise policy issues until they have prepared a pilot project, i.e., one initial integrated zone project. The zone should have proven yet unadopted innovations available and should be representative in terms of biological potential. That is, it should be a zone with average soil and water conditions so that accomplishments can be attributed to management rather than to natural conditions.

Policy decisons at this stage should be kept as narrow as possible. Planners should ask only for the opportunity to try policy changes on a small scale. It is

DIAGRAM 3.1 BASIC AGRICULTURE INTEGRATED ZONE PROJECT PLANNING PROCEDURE



KEY:

easier for policymakers to authorize a small test in one zone than to make a major policy change to carry out an unproven strategy.

Comprehensive Planning and Policymaking

Once the strategy has proven itself in the point or line phase, the policymakers should be reasonably receptive to a broader adoption of the policies necessary for large-scale advances in agriculture. At this point the planners should prepare plans for all possible zones to show the total benefits and costs of the new policies.

The operation of the pilot project should demonstrate the feasibility of standardization and the impact of integration and saturation. A pilot project is, in itself, an example of concentration. A demonstrated high return should eliminate Ministry of Finance objections to integration and saturation. The interest of development bankers in the project should indicate that acceleration is feasible. Some political problems with concentration, however, will remain.

Regions with Different Potential

Mosher distinguishes three types of zones in dealing with the problem of biological and developmental potentials of different regions and zones.[1]

1. **Immediate Growth Potential (IGP).** Regions which have a set of proven but unadopted innovations.

2. **Future Growth Potential (FGP).** Regions which do not have a set of proven innovations, but which have good ecological conditions for increased agricultural production.

3. **Low Growth Potential (LGP).** Regions whose soil and water conditions offer very little prospect of increased agricultural production.

A basic agricultural development program can operate immediately only in IGP zones. Its operation automatically favors some zones over others. Such favoritism is generally politically feasible only if it is balanced by favoring FGP and LGP zones with a larger share of development expenditures in health, education, and transport facilities. In addition, research should concentrate on developing innovations for FGP areas. For LGP zones, a country should look to either researching and developing irrigation or arid-zone farming systems suited to their conditions, or to facilitating resettlement in more promising zones.

A final political hurdle of concentration remains: the reaction of officials

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1. Arthur Mosher, *Creating a Progressive Rural Structure* (New York: Agricultural Development Council, 1969), pp. 55-74.

and farmers within a zone in communities not initially reached by the project. To some extent, development expenditures in other sectors can be directed within a zone to balance the agricultural assistance given to the point and line communities. Objections might be met by requiring performance of the communities as a price for participation in the project, particularly performance with regard to organizing cooperatives, maintaining high active membership, etc. But visible acceleration is the most important element. If the people are convinced that the project is growing and expanding rapidly and that they will soon be able to participate, they will support it.

During the middle and late 1960s, *Société d'Aide Technique et de Coopération* (SATEC) conducted projects in Senegal and Madagascar which thoroughly applied the six essentials. Both projects reached a majority of the farmers of a region in five years or less, resulting in significant production improvements.

SENEGAL: THE PEANUT BASIN

In the heart of Senegal is the Peanut Basin, a Sahel-Savannah region in which farmers concentrate on peanut production for export. Some 40% of Senegal's population live here. The following case describes the agricultural development project in that region during the mid-1960s.

Analyze-Standardize

The Farming System. The unit of farming is the carre, an extended family unit of nine to ten members with holdings of about ten hectares. The 109,000 carres of the basin averaged less than one traction animal each; most land preparation was done with hoes. Roughly half the land was in peanuts and half in millet or sorghum. There were three zones: the northern zone planted sorghum, and the two southern zones planted millet. Cereal production was below subsistence level; farmers had to use a substantial part of their peanut earnings to buy cereal (generally imported rice) for food. Cultivation practices were primitive and were gradually ruining the soil.

The Innovation Package. The main elements of the innovation package were: use of selected, disinfected seed; sowing consistent with optimal density; proper application of fertilizer; and weeding with an animal-drawn hoe. Different seed varieties, densities, fertilizer application, equipment, and traction animals were recommended for each zone. The package covered peanuts and the principal

cereal crop of each zone. It promised a 25-40% increase in yield with an increase in income of about $220 per carre at 1964 prices.

Integrate-Saturate

The Institutional Framework. The early 1960s, the first years of independence, saw substantial institutional development in Senegal. The *Banque Sénégalaise pour le Développement* (BSD) and the *Office de Commercialisation Agricole* (OCA), a marketing board, were established at the national level. In each of the four regions a *Compagnie Régionale de l'Assistance pour le Développement* (CRAD) was established to handle supply and marketing services. The lower administrative structure was a district-like *arrondissement* averaging 2,600 carres in the Peanut Basin with no township unit. Villages averaged only about 18 carres. At the arrondissement level a *Centre d'Expansion Rurales* (CER) was established which included a branch office of the CRAD and several warehouses. Cooperatives were established for groups of ten villages.

Management of the project was under SATEC, with nine French regional engineers and one French technical assistant in each of the 42 arrondissements. Credit, supply, and marketing services were handled largely by the CRADs, with substantial coordination and contact at the grass roots by SATEC personnel who took full responsibility for extension services.

Operation at the Grass Roots. Because rural literacy runs to 10% in Senegal, the monitors hired by SATEC generally had only five to six years of education. By the second year some 850 were at work, about one per 130 carres. Their routine, training, and supervision followed closely the procedures described in chapter 11.

Concentrate-Accelerate

In 1964 SATEC tested the package and the mode of operation in a few arrondissements. Late in 1964 it proposed a three-year project to reach all carres of the Peanut Basin, a pace much faster than that suggested in this book. The target for 1967 was a 25% increase in peanut, millet, and sorghum production over 1964. Despite some dry weather, the target was reached. By 1967 a careful survey indicated that most carres had adopted most of the practices of a stage 3 package. French technical assistants had been replaced largely by Senegalese.

Since the mid-1960s, several disasters have hit the Peanut Basin. Almost every year, there has been a precipitous drop in either peanut prices or rainfall. The GNP of Senegal declined. The project's goal became the avoidance of greater

disaster rather than a major increase in income. In the early 1960s a kilo of peanuts could buy two kilos of rice; in the late 1960s a kilo of rice cost three kilos of peanuts. Because the farmers had become self-sufficient in cereals through an increase in production, this price change was not disastrous.

At 1964 prices, the 1967 production increase would have meant a $24 million annual increase in farm income at a total investment of $16 million. The drop in prices reduced the rate of return to a more marginal level. But the development of human skills and resources and the avoidance of human misery were as good or better than expected.

MADAGASCAR: THE CENTRAL RICE BASIN

Is such rapid development possible when farmers are not already into the cash economy as they were in Senegal? Madagascar's central plateau is a replica of the rice basins of Southeast Asia. Farmers with one-hectare farms sell small surpluses of rice to Indian and Chinese merchants. High demographic pressure was forcing Madagascar to import rice for the first time in the early 1960s, at a rapidly increasing rate.

Analyze-Standardize

The average farm on the upper plateau had .6 ha. in rice, yielding about two tons per hectare. An innovation package was developed which could raise rice yields to three to four tons per hectare. It consisted of the following elements:

1. Improved, selected seed: pre-Green-Revolution Japonica varieties
2. Fertilizer: three cwt. per hectare of NPK 11-22-16
3. Practices: on-time transplanting on line, weeding, etc.
4. Equipment: a rotary weeding hoe made by local craftsmen

The package also included small irrigation works and improvements. This advanced slowly, however, covering only about one-fifth of the new hectares put into improved practices each year. The package also included some improvements on upland cash crops. Unfortunately, the research and application on diversification crops was very limited.

The package was planned for step-by-step phasing on the average farm over a period of five to ten years, raising total income from about $180 to about $320—a 75% increase. The first phases, improving rice only, would raise incomes by about $35, a 55% increase.

Integrate-Saturate

The project operated as an autonomous integrated agency known as *Le Groupement pour l'Opération Productivité Rizicole* (GOPR), the Rice Productivity Operation Group. It combined the staff of French, German, and Italian technical assistance companies (primarily from SATEC) with Ministry of Agriculture staff. GOPR provided extension, credit, supply, and engineering services. It organized the farmers through private rice mill operators.

Organization. At the central level were a director and a variety of specialists. At the provincial level were a professional director and staff supervisors for agronomy, irrigation, supply and credit, and training. At the district level was an agronomist with assistants for extension and supply and credit. At the township level were a sector chief, a paraprofessional, a supplier, and six to seven monitors, one per 200-300 farmers. The sector had a warehouse with a capacity of 25 tons of fertilizer.

The unit at the grass roots was a cell of some 250 farms. The local agent-of-change was an 18- to 25-year-old monitor with a primary education. The farmers of the cell were organized as a pre-cooperative for combining their purchases and crop marketing into volume transactions.

Operation. The training and routine of the monitors closely followed the concepts and procedures presented in chapter 11, with some additional features. First, there was a planned phase-in. A farmer was asked only to plant a two-are demonstration the first year. Second, the farm record forms were maintained in a large book that had a page for each phase of the crop season with instructions on cultural practices and tear-off stubs for procurement of supplies. The monitor signed the tear-off stub authorizing procurement and certifying that the farmer had carried out the requisite practices.

Management methods were stressed. From the central to the sector offices, walls were covered with maps and bar charts showing day-by-day schedules, actual performance, etc. Training was *en cascade*, each echelon successively drilling the one lower in the themes, operations, and problems to be handled each season.

Concentrate-Accelerate

The project was conceived and approved in 1965. It called for using about 1,000 monitors to reach most of the 275,000 farms of the target regions and to achieve a production increase of 200,000 tons of paddy in about five years of network-phase operation. This would require an increased yield of 1.7 tons per ha. on an average of .6 ha. on 200,000 farms.

The point phase occurred in 1964-65 when methods were demonstrated in a pilot operation near the capital city. In 1965-66 the project moved to the line phase with widespread small demonstrations but statistically negligible results. In 1966-67 the project moved to the network phase and progressed as follows:

	1966-67	1967-68	1968-69	1969-70	1970-71
Farmers Involved	28,000	80,000	130,000	165,000	169,000
Hectares Improved					
Total	4,500	20,000	45,000	74,000	86,000
Average	.16	.25	.35	.45	.50
Increased Production					
Total Tons	7,000	37,000	83,000	117,000	121,000
Average per Ha.	1.55	1.85	1.85	1.58	1.41

The farmers' response was better than expected in the first years of the project due to good weather and prices. By the early 1970s the price of rice had dropped, and the package was no longer as attractive. Poorer weather brought some lower yields. Had the progression of 1966-70 continued into 1970-71, the target of 200,000 tons could have been achieved. After 1971 the project was at a standstill, although small irrigation continued to expand.

The initial focus on one crop was a mistake. In at least one year out of three, the market or the weather will eliminate potential gains on any one crop.

Nevertheless, the project must be considered a success. It eliminated most of Madagascar's food deficit, built a stage 3-level institutional network, rapidly reached a large number of farmers, and increased yields and income.

SUGGESTED READINGS

Earl Kulp, *Rural Development Planning* (New York: Praeger, 1970), pp. 170-86.

J. Mayer, *Riziculture traditionelle et Ameliorée, tome II: L'Opération "Productivité Rizicole" a Madagascar* (Paris: SATEC, 1971).

Other unpublished reports by SATEC.

Part II
Farm-Level Analysis

4
The Farm Model

The farm model brings together the following kinds of data on each of the predominant types of farm enterprises of each zone:

Scale of enterprise: average ares[1] or average head of livestock

Outputs: yields, production, cash, and gross income

Inputs: particularly labor requirements

Where relevant, the model will also give some indication of overall land and labor constraints.

SOME STATISTICAL ASSUMPTIONS

Data Gaps

Developing nations lack good statistics. The following kinds of data gaps are often found:

1. Data on acreages owned, but no data on acreages actually cultivated
2. Data on production and acreages of major export crops, but no data on other crops

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1. Land will be measured largely in *ares* (.01 hectares or about 1/40th of an acre). However, acreage will be used instead of hectarage to talk about unspecified quantities of land.

3. An out-of-date agricultural census, particularly with respect to crops that were recently introduced or are spreading rapidly
4. An agricultural census with data by province, but no detail for planning by agricultural zone

There are some shortcuts to filling in these gaps. Sometimes a simple exercise in *judgment* can lead from province-by-province data to reasonable zone-by-zone estimates. Sometimes a *professional consensus*, the estimates of agricultural officers in the field, can fill in some data gaps. Where this does not suffice, gaps can be filled with a *small-sample survey*.

Some Assumptions

The more primitive the economy in any ecologically and ethnically homogeneous zone, the more homogeneous are the agricultural practices. The earlier the stage of agricultural development, the less is the precision needed in planning. Thus, the more primitive the agriculture, the smaller is the sample needed to get a sufficiently reliable picture of it.

The pattern of crops grown depends on whether land or labor is the constraining factor. For example, consider two simplified examples of zones in which three main crops are grown: (1) a cereal to provide basic calories, (2) a legume to provide basic proteins, and (3) a fiber to provide basic cash. In one zone, land is limited; all available land is cultivated. In the other, there is ample uncultivated land, and available labor is the constraining factor. Certain patterns of land use can be expected.

Where land is a constraint, some farmers will be virtually landless. With what little land they have, they will attempt to guarantee the basic calories their families need, relying on outside labor opportunities for less urgent cash and proteins. Farmers with larger-than-average holdings will use hired labor and maximize their cash earnings by growing only enough cereal and legumes for their families.

There are some variations on this pattern. Sometimes farmers with very little land concentrate on crops which are highly labor-intensive. The minor crops, not illustrated in this example, are generally grown on small plots which do not vary much in proportion to the total land or labor available. Farmers with more land or labor will grow a greater variety of minor crops in small plots to diversify their risks. A further variation is cultivation of an inferior food, a root crop such as manioc or sweet potatoes, as a source of calories less desirable but more land-intensive than cereal.

Even greater homogeneity can be assumed in the target group of a basic agricultural integrated zone project. Such a project is aimed at the 60-70% in the three middle quintiles of the farming population. Initially it is feasible to ignore those farmers lying outside the 67% in the first standard deviation with regard to land and labor resources or other indicators of farming pattern. Taking these three middle quintiles as a separate population, considerably more homogeneity can be asssumed than in the five-quintile overall population. A sharply peaked normal curve of distributions can be expected around the mean and median acreage, land-labor ratio, specific crop acreages, yields, etc.

Errors of around 10% can be tolerated. Suppose the average farm in a small sample has one hectare of beans, and recommendations are to be based on a model including this information. If a larger sampling proves that the average farm has .9 or 1.1 hectares of beans, project decisions or recommendations will not be significantly affected.

In summary, there are three assumptions which can greatly simplify data collection problems:

1. Basic homogeneity of peasant agriculture
2. Particular homogeneity of the middle quintiles
3. Tolerance of a 10% error

Adequate Sample Size

Based on the above assumptions, the standard formula for determining a valid sample size shows that a rather small sample is sufficient. The standard formula for determining a required sample for any population over 1,000 is:

$$n = \frac{(kv)^2}{e}$$

where:

k is the number of standard deviations of the population to be covered: 1 if the statistics should be valid for 67% of the population, 2 if for 95%, and 3 if for 99%.

v is the measure of the population's homogeneity, the expected ratio of the range of values on one side of the mean within one standard deviation to the value of the mean itself. If, for example, the mean is 2.2 hectares of cultivated land and values within one standard deviation range from 1.65 to 2.75, this produces a range of .55 on each side of the mean--one quarter of 2.2. v, then, equals ¼.

e is the tolerable error in the resulting statistics. For example, if an error of 5% can be tolerated, then e = .05.

When collecting data for planning basic agricultural projects, take two elements of the formula as given. As noted, an error of 10% can be tolerated, so $e = .10$. A sample that is only valid for 95% of the population can also be tolerated, so a k-value of two can be used, that is, two standard deviations. Indeed, even if the sampling is stratified, taking only the middle two-thirds of the total farm population, 95% of 2.3, or about 62%, is still valid.

The size of this sample depends on the homogeneity of the farming population. A sampling of average acreage owned or cultivated in the zone (about 100-200 farms) might be used to get a basic measure of homogeneity. From such a sample, a value can be determined for the relative size of the range within one deviation to the mean. Then, if $e = .10$ and $k = 2$:

if $v = .3, n = 36$

if $v = .4, n = 64$

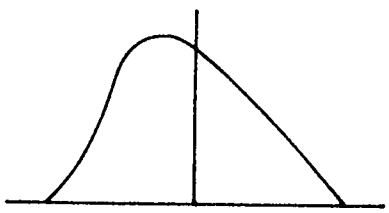
if $v = .5, n = 100$

if $v = .6, n = 144$

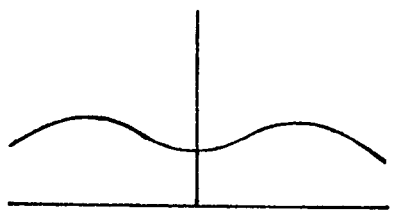
if $v = .7, n = 196$

if $v = .8, n = 256$

Suppose the basic measure of the population does not indicate a normal distribution, but is skewed or bimodal.



skewed distribution



bimodal distribution

In such cases the solution is to *stratify*, to break the total population into subgroups, each of which has a reasonably normal distribution. This would require, of course, further sampling to get the basic measure of homogeneity for the individual subgroups.

Each subgroup, however, might be more homogeneous than the total population of the zone, and overall sampling could still be kept to reasonably small numbers. Four subgroups with a v-value of .3 would only require a total of $4 \times 36 = 144$, less than that needed for a total group with a v-value of .7.

THE ENTERPRISE SCALE MODEL

The first model is a simple table of the size of each enterprise of the average farm in the zone. The size of the enterprise is measured either in ares for crops or in number of head for livestock. Sometimes it is best to measure a livestock enterprise by the number of breeding stock only: a hog enterprise may best be defined in terms of the number of breeding sows kept. The model is illustrated by the first three data columns in Table 4.1:

1. The percentage of all farmers who grow the crop
2. The average ares or head of livestock for that enterprise *per grower*, i.e., per farm actually growing that crop
3. The average ares or head grown on the average farm in the zone, i.e., column *a* times column *b*

For the sake of brevity, "crop" is used here to mean "crops and livestock varieties" or "crop and livestock enterprises." This book has few discussions or examples of livestock enterprise analysis and project planning. The main concern is with project planning and program management in stages 2 and 3. In these stages there are few opportunities for significant livestock innovations. Other than disease control, these innovations usually require a combination of farmer orientation and coverage of services that does not come before stage 4. Where such opportunities do arise, the same techniques that are valid for crops can be applied.

Preliminary Zone Definition

Planning zones must be established on a rough preliminary basis with professionals who are familiar with agriculture in various areas. As the discussion proceeds, zone differentiation lines should be drawn with increasing precision based on the following criteria.

Main Crops Grown. Determine the set of principal food and cash crops. For example, a zone differentiation line can be placed through the area where a predominance of one cash crop gives way to another. There will be transitional areas. Similarly, areas should be delineated in which certain food crops are preponderant.

Fertility. Distinguish areas which have marked differences in fertility and yields due to soil or rainfall conditions.

TABLE 4.1 PRESENT FARM SYSTEM WORKSHEET

Zone: Y Date:

Principal Crops Raised	% Farms Growing Crop	Avg. Ares or Head per Grower	Avg. Ares or Head per Farm	Yield per Hectare*	Total Produced per Farm*	Consumed at Home*	Net Marketed*	Price	Gross Cash Earned	Cash Costs	Net Cash Income	Gross Value of Product
1 Cotton-1	95%	80	75	500	375		375	$ .17	$ 64	$ 0	$ 64	$ 64
2 Cotton-2	80%	25	20	300	60		60	.17	10	0	10	10
3 Millet	85%	60	50	900	450	400	50	.06	3	0	3	54
4 Peanuts	60%	50	30	700	210	180	30	.10	3	0	3	21
5 Maize-1	60%	20	12	1200	140	100	40	.05	2	0	2	12
6 Maize-2	50%	16	8	1000	80	50	0	.06	2	0	2	5
7 Bananas	80%	30	25	3000	720	720		.03				15
8 Misc. Crops			20									5
9 Cattle	40%	5	2									
10 Chickens	60%	3	2									5
11 Total		2.40 ha.			2,035	1,450	555		$ 84	$ 0	$84	$191

Labor Inputs Crops	Ares	January Opn	Md	February Opn	Md	March Opn	Md	April Opn	Md	May Opn	Md	June Opn	Md
12 Cotton-1	75							P1 S-20%	34 2	S-70% T W1-50%	3 2 11	W1-50%	11
13 Cotton-2	20	F-60%	3							P1	9	S-70%	1
14 Millet	50	P2	20	S	6	TW1	15	W2	12	W3 H-30%	4 7	H-70% F-40%	17 5
15 Peanuts	30	P2-50%	5	P2-50%	5	SW1	8	W2	7	H-50%	4	H-50% F-40%	4 3
16 Maize-1	12	P2-70%	4	P2-50%	2	SW1	4	W2	3	H-20%	1	H-80% F-40%	3 1
17 Maize-2	8									P2	4	S	1
18 Totals			32		13		27		58		45		46

Labor Inputs Crops	Ares	July Opn	Md	August Opn	Md	September Opn	Md	October Opn	Md	November Opn	Md	December Opn	Md	Total Mandays
12 Cotton-1	75	W2	22	W3	22			H-40%	10	H-60% F-20%	16 5	F-80%	18	156
13 Cotton-2	20	ST W1	1 6	W2	6	W3	6			H-30%	2	H-70% F-40%	4 2	40
14 Millet	50	F-60%	7											93
15 Peanuts	30	F-60%	8											44
16 Maize-1	12	F-60%	1											19
17 Maize-2	8	TW1	2	W2	2	H-30%	1	H-70% F-30%	2 1	F-70%	1			14
18 Totals			47		30		7	F-30%	13		24		24	366

NOTE: opn = operations code; md = mandays.

Labor Operations Code: P1/2 = 1st and 2nd Land Preparations or Plowings
S = Sow
T = Thin or Transplant
W1/2/3 = 1st, 2nd, and 3rd Weedings
H = Harvest
F = Finish (thresh, sort, dry, clear land)

Calendar. Distinguish areas which plant major crops in different months. This may make a big difference in terms of what new enterprises can be introduced.

Farming Technique. Distinguish areas which have marked differences in farming practices. An area where farmers cultivate mainly with the hoe should not be mixed with an area where farmers are plowing with oxen. An area where farmers already use fertilizer or plant in rows should not be joined to a zone where these practices are almost unknown.

Ultimately, zone boundaries can cut across districts but should not cut across township lines. Cutting across township lines makes it difficult to charge costs of township-level personnel to zone projects. Initially, try to follow district lines in defining zones. Note, however, that zones do not have to cover contiguous territories. In hilly or mountainous areas, some zones may be a set of high-altitude pockets in other zones. A zone project can cover scattered townships in a province. Final zone definition should follow a re-evaluation of the criteria in light of the standard improvement package.

Data Sources

If the statistics on crop areas and percentages of growers are unavailable, there are three ways to fill the gap.

1. **Adjustment of Statistics.** Available statistics are usually broken down by province rather than by district or zone. Only approximate numbers of farms can be easily obtained by zone. Often, however, most of the acreage listed for a province in a particular crop is grown in one zone. By attributing 80-100% of the acreage of a particular crop to one zone, one can estimate the average acreage of that crop per farm in the zone.

2. **Professional Consensus.** Professionals familiar with the area can often give a fairly good estimate of average acreages of various crops. A planner should meet with a group of professionals in the province, cite existing statistics, and determine how statistics should be modified to reflect current patterns.

3. **Small-Sample Surveys.** As described above, a small sample can provide adequate data. Special enumerators or the regular professional and subprofessional staff can actually measure the fields of the sample farms. The burden need not be significant. A zone covering 40,000 farms might be spread over five districts. If a sample of 100 is needed for the zone, each district-level officer might have to cover about 20 farms. Or they might be handled by township-level agents in scattered townships, each handling only three or four.

Such shortcut techniques can give adequate data for initial planning at the point stage of the project. As the project evolves through its initial stages prior to major financing, rough data can and should be augmented by further data collection.

Special Problems

Early and Late Crops. When one crop is planted early and the other late, they differ in yields and in labor requirements per month and must be treated as separate enterprises (see Table 4.1). Farmers sometimes plant crops over a period of a few months. In such cases arbitrary decisions must be made on how to divide the total planting into separate enterprises.

Mixed Croppings. Farmers working without draft animals often interplant crops or sow them mixed. The millet and early maize crops illustrated in Table 4.1 were interplanted on plots averaging about 75 ares per grower. Make an arbitrary decision on how to separate these interplantings into pure-plot equivalents. In this case, because of the characteristic spacing, this interplanting was the equivalent of 60 ares of pure millet and 20 ares of pure maize. If the typical interplanted proportions are uncertain, divide the mixed-plot average ares into 70-80% for the dominant crop and 20-30% for the nondominant crop.

Minor Crops. There is no need to give details of crops grown by less than 40% of the farms of a zone or on less than 2-4% of the cultivated land of the average farm unless the crop is the object of a major innovation. Group minor crops under miscellaneous.

Livestock. Livestock statistics in developing countries tend to be particularly unreliable. Livestock populations in some countries change drastically from year to year and from season to season. Basic agricultural projects can be planned, however, with crude estimates for livestock enterprises. Solid data are needed only if livestock is a factor in a significant innovation.

Land Differentiation. Plans can be made on the basis of all land being roughly the same. It is often necessary, however, to distinguish the type or grade of land on which each crop is planted. This is particularly true if some crops are grown on irrigated land, or if some crops are grown only on fertile bottom lands and others on less fertile uplands. Columns for each type of land must then be added to the worksheet to total the cultivated land *by season* for each type.

THE OUTPUT MODEL: PRODUCTION AND INCOME

Determining the outputs of the average farm requires some data that are even more difficult to obtain.

Yields

Sometimes the typical yields on main crops are well known. Farmers may traditionally count on a certain yield. Yields for export crops may also be easy to obtain. If there are reliable acreage figures, there are usually reliable figures on the total crop, even district by district, so that average yields can be determined.

In other cases it may be difficult to estimate current yields. Farmers may refuse to supply accurate data. Data may be available from control plots of demonstrations in the area; but these yields, although nominally based on current typical methods, tend to reflect the extra care a farmer has given to a small display plot.

A professional consensus becomes the only quick way to fill this gap. Yield measurements must be made at harvest, which may be some time away. As the project progresses, however, the field staff should sample yields on unimproved farms to get a better data base for larger-scale project operation.

Consumption

In some countries the quantities of the main crops consumed on the farm are traditionally well established. If data are lacking on the number or size of rural households, an average of six members seems to hold true in several countries.

If consumption requirements are not traditionally established, however, reliable statistics are difficult to obtain. Some shortcut assumptions and educated guesses can nevertheless be made. Suppose that a country is 90% rural (e.g., in East Africa). It can be assumed that 90% of the basic staple crop is consumed on the farm. In Table 4.1, it was assumed that 90% of the millet, 85% of the peanuts, and 80% of the maize was consumed on the farm.

Consumption is a data element on which precision is particularly *un*important for farm-level planning. At this level, errors of 25-30% should not affect planning decisions. In estimating the potential cash market for food crops, however, better estimates of consumption are necessary.

Prices

Ideally, future prices for planning purposes should be projected. At this stage of the planning process, however, the present farm system is the focus, and price analysis should be as simple as possible. The planning process can be easily

delayed by disagreements about assumptions and procedures used in sophisticated price projections. Prices used in planning should be kept conservative, as low as can be simply justified. Even if prices have been rising steadily, higher-than-current prices for initial planning should not be used. Higher prices make innovations look more attractive by raising the value of the outputs relative to the costs of the inputs. Therefore, take the current year's at-harvest price to the farmer, unless it was distorted by a very high or very low crop. If the price was distorted, take the average price of the past three years.

Cash Costs

On an average, peasant farmers rarely have significant cash costs of production before the end of stage 2. The average farmer may often hire some labor at certain times of the year, but he may also hire out as labor at other times. On balance he will have no cash labor costs. (This is not true in areas of large numbers of landless laborers.) Other cash inputs (such as fertilizer and pesticide) may be used only by a minority of the farmers. For a picture of the average farmer, cash costs of the minority should not be averaged.

Synthesis

Yield, consumption, and price and cost data can be combined with the enterprise-scale model to derive cash and gross income (see Table 4.1). The steps in the computation are simple:

(average ares per farm) x (yield*) = production per farm (in kgs.)

(production per farm) - (quantity consumed) = quantity marketed

(kgs. marketed x price per kg.) - (cash costs) = net cash income

(kgs. produced per farm x price per kg.) - (cash costs) = gross income

*Yields are stated in kgs. per hectare; divide them by 100 to get kgs. per are.

Token values are used for gross income on miscellaneous crops and livestock on which no consumption data are available.

The final results are found in the bottom right-hand columns of Table 4.1. The average family in the zone earns $84 a year in cash and grosses $191 at current market prices. The average family size in the area is five and seven-tenths members, giving a per capita income of about $37. This zone is typical of the country in which it is located, yet this figure is less than half the per capita income generally quoted for that country.

Farm income and the role of peasants in an economy is, as the figures above illustrate, generally undervalued. A city dweller in that country would have to spend another $150-180 to eat and be housed as well as the farmer in zone Y. These peasants have a higher standard of living in most respects than peasants in many countries with much higher per capita GNPs. Hence, GNP growth rates and GNP targets mean little in terms of the lives of the rural masses who make up the bulk of the population of developing countries.

THE LABOR INPUT MODEL

Data on labor requirements are lacking in most regions of developing countries for most peasant crops. If the only innovations being considered are yield-raisers which do not require significant additional work, then labor data are unnecessary. Or if there is obvious year-round gross labor surplus, as in Java or Bengal, data are not required.

If, however, planning is for a zone with substantial uncultivated land or the introduction of a new enterprise, labor input data are vital. Attempts to introduce a new crop have failed because of a conflict with the labor requirements of the basic crop at some particular season. Attempts at irrigation or mechanization have been misguided because they were not based on a sound analysis of the labor requirements of the zone.

The conventional method used to collect data on labor requirements has been the Farm Management Survey which requires close, expensive surveillance of sample farms. An enumerator must visit them every few days for a full year to record how all labor is used, with results often full of anomalies. Some studies have shown that a crop which was easy to harvest took far longer to harvest than a crop which was more difficult to harvest. Methods are needed to make reliable labor data collection more feasible.

Shortcuts to Labor Data Collection

Eliminate Minor Operations and Activities. Data collection can be limited to those operations which:

- Concern major crops
- Cannot be postponed for more than a few weeks
- Are generally scheduled by the farmer for a full basic workday

The duration of a full basic workday varies from region to region and from operation to operation. Take into account what farmers in the area consider the

customary workday for each operation. Then measure labor requirements, for planning purposes, in mandays per hectare rather than in manhours.

Certain operations are done piecemeal during days when no major operations are scheduled or for a brief period following the basic workdays. Picking bananas for home consumption, for example, may take dozens of manhours per year, but only a few minutes a day. Applying a fertilizer top-dressing may take less than a manday or may be carried out along with the thinning or weeding operation. Harvesting manioc may be postponed until idle days. For planning purposes these operations and the daily tending of the family livestock (if herds are small) and the garden plot can be ignored.

Consult Farmers. As with yield and consumption data, there are often traditional standards for certain operations. If asked how long they should take, almost every farmer will give the same answer. This is particularly true of operations frequently performed with hired equipment or labor. Farmers may often agree, for example, that the first plowing of a cleared field takes ten days per hectare with a one- or two-man team. If they are accustomed to hire or trade labor for it, they can often agree on how long it should take to do sowing or weeding. They are least likely to agree on how long it should take to harvest a crop, since harvesting labor requirements depend partly on the yield.

Sample the Daily Workload. A sampling of the number of ares farmers harvest or weed in one manday may be arranged. If harvesting is being studied, it is important to segregate and measure the yield obtained. With harvesting, a dual correlation is necessary: a basic harvesting time per hectare plus a variable element of mandays per 100 kgs. of yield per hectare.

Initially the sample size might be small (15 to 20). If the results are close to each other, and if the *v*-value is low, the small sample will suffice. If results vary widely, a larger sample will be necessary.

Time-Study Certain Operations. Farm operations are highly repetitive. Once a farmer is at the field and is ready to work, the actual work done comes in short cycles: the farmer plows the length of the field, turns around, and repeats the motion. Each cycle should take about the same time. The full day's work need not be observed if one has timed the preparations period plus enough cycles to get an adequate statistical sample. It is best to measure cycles in the middle of the basic workday, however, when fatigue is at the average point.

Preparing a Standard Labor Data Table

Data should be compiled in a format similar to that used in Table 4.2. Note that the time required by different methods should be determined. Obviously, preparing land by oxen is faster than preparing land by hoe. Also, distinguish times required for different types of hoes or different methods of handling tools which may vary from zone to zone.

To the extent that methods are consistent across a region, the same data can be used for different zones. Differences of soil or weed growth may require different standards for individual zones on some operations. Heavier soils may slow up plowing, or heavier weed growth may slow up weeding or require more frequent weeding.

A combination of shortcut methods can be used to compile the data. First, ask the farmers and visit their meetings in various zones. Unavailable data should then be obtained by measuring work done or time-study, whichever is easier. Where conditions in neighboring zones are similar, one figure can be used for several zones or for an entire region. Where methods and conditions differ, measurements and time-studies should be used to obtain separate data for different zones.

Check the table for anomalies. Do weeding and harvest times look proportional among crops? If not, further study may be needed.

Compiling the Labor Input Model

The bottom of Table 4.1 illustrates a labor input model. Under each month are codes for the operations performed during that month on that crop. Where operations are performed over a period of two or more months, a figure follows the code indicating what percentage of the work is done that month. The figure under "md" indicates the number of mandays required in that month for that operation. Sometimes two or three operations are accomplished during the month. These are generally entered on separate lines. Thus, under November, for cotton-1, we read:

H-60% 16

F-20% 5

This indicates that during November, 60% of the harvesting is completed, requiring 16 mandays for the 75 ares of Cotton-1. In addition, 20% of the finishing operations—cleaning, sorting, and field clearing—are completed. Both manday times are based on a yield of 500 kgs. per hectare.

Minor operations, those taking less than one manday for the small acreages indicated, are often combined. Under March, for the 12 ares of Maize-1 on line

TABLE 4.2 STANDARD LABOR MANDAYS PER HECTARE FOR ZONE Y

Crop	Method	Preparation* 1st	Preparation* 2nd	Sowing	Thin or Transplant	Weedings 1st	Weedings 2nd	Weedings 3rd	Harvest	Finish†
Cotton	hoe	45	35	7	3	30	30	25	25/2‡	15/3‡
	ox	22	20	7	2	6	6	5	25/2	15/3
Millet	hoe		40	6	1	28	25	9	30/2	5/2
	ox		22	7	1	6	6	4	30/2	5/2
Maize	hoe	45	30	5	2	25	25		10/2	5/1
	ox	22	20	5	2	6	6		10/2	5/1
Peanuts	hoe	40	32	6		25	25	9	20/1#	10/4
	ox	20	20	7		5	5	4	20/1	10/4

* Includes initial breaking of land, ploughing, and harrowing (with oxen by 3-man team).

† Threshing, husking, shelling, clearing the field, and hauling from the field.

‡ Twenty-five mandays per hectare plus 2 mandays per 100 kg. net harvested.

H includes lifting the peanuts from the ground and hauling them back to the farmstead; F includes picking the peanuts from the vines and all other operations to finish them.

16, "SW1 4" indicates that the sowing, thinning, and first weeding of the 12 ares take 4 mandays.

Preparing the Calendar. Enter the calendar on the worksheet. This information can usually be gathered from the professional agricultural staff working in the area. First, ask that the staff members tell when the *bulk* of the operation is done. Otherwise they will report that planting cotton runs from February to June and harvesting runs from September to February. Indeed, they may have observed some small amounts of such work over several months, but the small amounts are irrelevant. Second, specify that the timing is based on the assumption that the rains come on time. If the rains come late, the whole calendar will be delayed.

Computing the Mandays. There is a simple formula for computing the mandays per operation per month: number of ares times percentage of the operation performed that month times the standard mandays per hectare for that operation and that crop. Round off all figures to the nearest manday. Any further precision would be misleading. Fractions of mandays should be rounded upwards, particularly on small plots.

Resource Availability and Constraints

How much land and labor is actually available to an average farm in a particular zone?

The quantification of employment on a peasant farm is complicated. How much do women and children contribute? The labor force of a farm is therefore counted in terms of adult male-equivalents (MEs).

The work contribution of women and children relative to adult males will vary from region to region according to several factors: the balance of heavy and light work in the farming system, the time the children are in school, whether the children are on school holiday at harvest times, the traditional division of male and female farm tasks, etc. Various scales have been applied to convert household members of various ages into MEs. Ruthenberg used a rather simple scale to put data from a number of different countries on a common basis.[2] I used a more detailed schedule in the field in East Africa (see Table 4.3).

Peasant farms, no matter what reasonable scale is applied, tend to have between two and three MEs available. Consider the farm depicted in Table 4.1 as having 2.5 MEs. The workload varies widely with the seasons from less than 3

2. H. Ruthenberg, *Farming Systems in the Tropics* (London: Oxford University Press, 1971), p. xv.

TABLE 4.3 MALE-EQUIVALENT SCALES

		Kulp		Ruthenberg	
	Age	Male	Female	Male	Female
Full-time workers	20-60	1.0	.8	1.0	.67
Full-time workers	60+	.6	.5	.67	.5 (50+)
Children	16-19	.9	.7	.67	.50 (15-19)
not in school	13-15	.5	.4		
	10-12	.3	.2	.25	.25 (10-14)
Children	16-19	.4	.3	.67	.50 (15-19)
in school	13-15	.2	.2		
	10-12	.1	.1	.25	.25 (10-14)

NOTE: Ruthenberg's age divisions differ slightly from mine.

days per ME in September to 23 days per ME in April. The yearly average is about 12.5 days per month of work per ME. Does this reflect gross under-employment? Only in part. In addition to the work shown, there is the postponable or piecemeal work done on .45 hectares of bananas and minor crops.

What, then, is the maximum amount of labor that might be made available on this farm? There is no clearcut formula, and some judgments about behavior are necessary in order to obtain a figure. This farm rises to 23 mandays per ME in one month, but it could never sustain that workload for more than one month at a time. Plan conservatively when determining what a farm might be *able* and *willing* to do with the labor at its disposal.

Suppose that the farmer prefers to limit his peak workload to about 50 mandays per month, 20 per ME, and that he would be willing to sustain such a workload for only 4 out of 12 months. The rest of the year he prefers a lighter workload to allow time for work he has postponed during peak months. Assume that for the rest of the year he would be willing to put in about 40 mandays per month, 16 per ME, on the main crops. Working 50 mandays in peak months and 40 mandays in off-peak months, the farm family would put in a total of about 520 mandays a year, an increase of about 40%.

If all land is being used, then the land availability and constraints are obvious. Often one type of land is constrained but another is not. Bottomland or irrigated land may be completely under cultivation, while uplands are only partly under cultivation.

It is very difficult to estimate the *amount* of additional land that might be available. Even if there is good soil and land-use mapping so that figures are available on the total arable and actually cultivated land, it is still difficult to estimate the full amount of land that farmers can typically obtain and handle.

Arable but uncultivated land may or may not be distributed so as to place it within reach.

The land constraint can best be judged by asking farmers, "Do you feel that you can get an additional hectare (or two or three) of land to cultivate if you can break such-and-such bottleneck?" Their reaction, a prompt or a hesitant answer, is perhaps the best indication of the probable land constraint.

It is essential to communicate with farmers. The planner must talk and listen to them. They are the ultimate decision makers.

A NOTE ON PLANNING HARDWARE

In the mid-20th century, *hardware* assumed a meaning quite different from the traditional wares of the ironmonger. In administration and management parlance, hardware means computers and computer-peripheral equipment; *software* encompasses the systems, procedures, and computer programs.

This book, in a sense, is devoted to the software tools of agricultural program management. But what hardware is needed to accompany all this software?

Although planners and program managers in developing countries often have access to computers, it is not recommended that they be used at the beginning. The procedures in this book have been specifically designed for the following hardware:

accounting spreadsheets, 14 columns by 35-40 lines

soft pencils and erasers

pocket calculators with memory

wide-carriage typewriters with 12 point (elite) type

mimeograph machines

Economy is, of course, the watchword of every good manager. Supply and equipment requirements should be kept at a minimum. Paperwork economy is particularly important. Planning paperwork should be kept on single-page formats with a minimum of additional descriptive material until the plan is approved within the originating agency. Then the more formal project submissions can be written.

5
Selection of Innovations

When compiling data for farm systems, the planner should explore data on farming innovation. There are three basic types of innovations:

1. Yield-Raisers
2. Bottleneck-Breakers
3. New Enterprises

At this stage of planning, consider present and potential market demand--a major factor in considering yield-raisers and new enterprises.

YIELD-RAISERS

This category includes all innovations that can raise net income per hectare on a given crop. Basically, these innovations are physical yield-raisers:

Inputs: fertilizer, pesticides, improved seed

Practices: better timing, better spacing, pruning, weeding, etc.

For convenience, innovations can be included here which raise prices for the farmer by improving the quality of the product: sorting and grading, better packing, etc. With some notable exceptions, these innovations are not important until stage 3.

Solos and Packages

In a sense, each input or practice is a separate innovation. However, such separate innovations generally cannot *solo*. Innovations often need complementary innovations to work. When fertilizer is applied without pesticide or improved weeding, the fertilizer often feeds the pests or weeds instead of raising yields. Improved seeds often require new practices to realize improved yields.

A solo innovation may not increase yields enough to interest farmers. For example, in one monocultural area trial data showed that treatment of seeds before planting could prevent rust which was taking 10% of the rice crop. The cost of the application was negligible and the work required less than one manday. Even though the innovation offered a 10% annual raise to farmers for one day's work, they would not accept it. The vagaries of weather are such that a farmer would never know whether or not he was realizing a 10% increase due to an innovation or due to weather conditions. Every innovation carries unknown elements that present some risk in the eyes of the farmer, particularly when he is not used to innovating. To induce farmers to adopt an innovation, at least in stages 2 and 3, the innovation should offer at least a prospect of a 20% increase in yield with normal weather conditions. Therefore, innovations must often be presented and promoted in *packages* which promise significant returns.

Attractive solo innovations are scarce but particularly relevant in stage 2. Here the inexperience of the field staffs of the core services and the farmers puts simplicity at a premium. An improved seed that can get a 30% increase in yield with existing practices or a fertilizer application that can get a 30% increase in yield with the seeds and practices farmers are already using are ideal catalysts for stage 2.

Evaluation

Does an innovation give a return adequate to cover the cost and the risk? Begin with the assumption that for every dollar invested in inputs, yields must rise by two dollars. In stages 2 and 3, most innovations that give less than a 100% return on capital should not be promoted, particularly if the farmer must borrow the capital. If prices fall, the farmer may be seriously burdened with a nonproductive debt. This 100% margin must cover not only the risks but the additional labor. For most yield-raising inputs the additional labor is small, but the farmer trying something new may make time-consuming mistakes.

This rule can be relaxed under favorable circumstances. If a crop has a steady price or runs less risk of failure due to drought or late rains, the farmer can participate with a smaller probable net return. On the other hand, if the farmer is

the first in his community to try an innovation, he needs an even higher return to cover his risks. The first adopters may need a special subsidy for the first year to make a risk acceptable.

Table 5.1 presents data on feasible innovations for zone Y and illustrates the evaluation of those innovations. The cost data are rounded off to clarify presentation and to avoid the false impression of precision. In addition to such a table, it is advisable to document the technical details of the spray or pesticide and improved seed applications.

In Table 5.1 the first fertilizer application on cotton "Fertilized-2," a 2 cwt. application, gives a total increase from the present yield of 300 kgs., netting an increase of $21 above a cost of $30. The feasibility of such an innovation depends on the prospective stability of the cotton price and the risks from irregular rainfall.

EXERCISES (based on data in Tables 4.1 and 5.1)

1. In zone Y the average farmer cultivates an average of 75 ares of cotton-1, 20 ares of cotton-2, 50 ares of millet, 12 ares of maize-1, 8 ares of maize-2, and 30 ares of peanuts. Taking only those innovations realizing over 85% net return, how much can the average farmer increase his income by adopting the recommended innovations?
2. What gain in yields is necessary to produce a 100% return on investment on applications of N2 on cotton-1, millet, and maize-1?

Sources and Source-Data Problems

Yield-raisers are generally tested and proven on research stations and then tried on actual farms. Test records are a basic source of innovation data. But these data present three problems:

1. **Uneconomic Trials.** Spectacular yields are often achieved on research stations under conditions infeasible or uneconomical on peasant farms. Land at research stations may have a buildup of residual fertility from repeated high applications of fertilizer during previous trials. Stations may prepare seedbeds using heavy tractors in a way no ordinary farmer could afford. They may use hired labor to do meticulous weeding. Their records often do not reflect the extra costs which might make the increased yields unprofitable.

2. **High-Yielding Control Plots.** In zone Y, where farmers get 500 kgs. per hectare, a nearby research station may achieve a yield of 1800 kgs. with a high application of fertilizer (e.g., N2P2) costing $50. Where the average farmer nets

TABLE 5.1 INNOVATIONS FOR ZONE Y

Yield Raisers		New Inputs and Costs per Ha. Fertilizer		Spray	Seeds	Total	Yields (Kgs./Hectare) New	Old	Increase	Price per Kg.	Net Gross Margin New	Old	Increase[a]	
Cotton-1:	on-time sprayed			$4		$ 4	550	500	50	$.17	$ 90	$85	$ 5	125%
	fertilized-1	N1[b]	$13	4		17	700	500	200	.17	102	85	17	100%
	fertilized-2	N2	26	4		30	800	500	300	.17	106	85	21	70%
Cotton-2:	sprayed			4		4	330	300	30	.17	56	51	5	125%
	fertilized	N1	13	4		17	360	300	60	.17	61	51	10	60%
Millet:	fertilized	N1	13			13	1300	900	400	.06	65	54	11	85%
Maize-1:	hybrid seed				$7	7	1450	1200	250	.05	66	60	6	85%
	fertilized-1	N1	13		7	20	2000	1200	800	.05	80	60	20	100%
	fertilized-2	N2	26		7	33	2400	1200	1200	.05	82	60	22	67%
Maize-2:	hybrid seed				7	7	1220	1000	220	.06	66	60	6	85%
	fertilized	N1	13		7	20	1500	1000	500	.06	70	60	10	50%
Peanuts:	hybrid seed spray			3	8	11	1100	700	400	.10	99	70	29	265%
	fertilized-1	P1	10	3	8	21	1400	700	700	.10	119	70	49	235%
	fertilized-2	N2P1	33	3	8	42	1600	700	900	.10	118	70	48	104%

[a] Percentage of net increase (after deducting costs) over new input costs.

[b] N1 = sulphate of ammonium, 1 cwt.; P1 = single superphosphate, 1 cwt.; N2 = sulphate of ammonium, 2 cwt.

$85 a hectare, the research station nets $225 [(1800 x .17) - 50] or 300% of what the farmers receive. But the yield on the research station control plot may be about 1000 kgs., giving an actual response to the fertilizer application of 80%, with a net increased return of $85. This is still a good return on an investment of $50.

Starting from a base of 500 kgs., an average farm will not increase yields by 800 kgs. At best it might achieve an 80% response to the fertilizer application, raising yields to 900 kgs., grossing about $155 and netting $105, an increase of only $20 from a $50 investment. It is problematical whether the farmer can in fact achieve that 80% response since his complementary practices are inferior to those found on the research station.

So what looks like a spectacular opportunity on a research station may not look very profitable on the average farm. Actual methods must be studied to judge which complementary practices are necessary.

3. **Lack of Packaging.** Innovations are often demonstrated in isolation. One set of trials may show that planting in rows will increase yields by 15%. Another set may show that a certain application of fertilizer will increase yields by 15%. If the farmer plants in rows *and* applies the fertilizer, what increase in yield can he expect? Perhaps more, or perhaps less, than the sum of the two.

Given these conditions, how can research and demonstration data be translated into planning data? How can realistic estimates of potential new yields be derived?

First, carefully check the methods used in the trials. Visit the research stations and demonstration farms and talk to the people involved. Check not only the featured practices but the other practices which were used. Then determine whether all the practices which contributed to the increases in yields would be economical and acceptable on the average farm.

Second, where high-yield results look unrealistic in terms of the average farm, use a more conservative approach and see if research to date would justify the estimate. Suppose that research trials have shown that N1 gives a 50% response, and that in a group of trials yields have averaged 1500 kgs. with an application of N1 compared with yields of 1000 kgs. on control plots. Can an application of N1 be recommended? If the application, plus complementary pesticide, costs $17, an increase of $17 in net gross margin is necessary to justify it. This would require a 40% increase in the yield from 500 kgs. to 700 kgs. (see Table 5.1). The estimate appears defensible in view of the 50% response achieved in research trials.

The conservative application of broad judgment is adequate for planning prior to the point phase of a project. Realistic yield data should then be acquired during implementation of the point and line phases to provide a sound basis for the heavy financing needed for the network phase.

BOTTLENECK-BREAKERS

Table 4.1 (page 50) shows labor requirements month by month. Bottlenecks in April, May, and June prevent the average farmer in zone Y from expanding his acreage. Here are possible ways to break these bottlenecks:

Change Timing of Crops by Irrigation. Are there any significant savings if timing is changed? If early cotton is advanced by one month, the April bottleneck would be relieved. April cotton-1 labor is now 36 mandays against 16 for May. This would create a new bottleneck in March, however, and add 10 mandays to the June bottleneck. Suppose millet were advanced for one month. This would aggravate the July bottleneck. Irrigation would not break any bottlenecks for existing crops. If, however, a new enterprise could be planted in September and harvested in February through irrigation, a substantial increase in income might be possible.

Eliminate Plowing in Peak Months by Hiring Tractors. Hiring tractors would eliminate the April bottleneck, but it would not help the June and July bottlenecks. Hire-plowing of early cotton combined with an effective herbicide to reduce cotton weeding labor, however, could make it possible to handle more acreage.

Use Oxen and Improved Equipment to Reduce Plowing and Weeding Labor. Note that the zone Y figures in Table 4.1 are based on use of the hoe for all cultivation. Oxen could reduce plowing labor by 50% and weeding labor by 75% (see Table 4.2). The three peak months have substantial weeding as well as plowing labor requirements. In April the savings would be particularly high, bringing labor requirements from 58 to about 25 mandays. In August the farmer could reduce weeding labor from 30 mandays to about 6. But this would only reduce the June labor bottleneck by about 8 mandays.

Use Oxen Plus a Millet Seed with a Different Maturity. This combination seems the best alternative. If oxen are used, a shift of the millet harvest either to May or to July would bring June level with the other months. Against previous peaks of 58 mandays in April, 46 in May, and 47 in July, the farmer would now

need 31 in April, 40 in May, and about 30 in June, if an earlier millet variety were used. If a later variety were used, the new peak would be in July with about 38 mandays; the rest would be below 30.

This illustrates the nature of bottleneck-breakers and the preliminary analysis leading to decisions about them. The *preliminary* procedure is to:

1. Identify bottleneck points in the present system
2. Identify innovations that might break them
3. Make a rough analysis of possible bottleneck reductions
4. Identify the most promising choice and "test" these through a realistic planning exercise

Does the elimination of bottlenecks alone increase income? Labor requirements at peak periods have been reduced, but has anything been done to bring in cash to pay off the investments? Will millet seed of a different maturity enable the farmer to make more money from his existing acreage?

The only way to determine the benefits and actual profitability of a bottleneck-breaker is to plan a revised optimum program for the entire farm. Shifting a number of crops can enable a farmer to realize the full benefits of a bottleneck-breaker.

More than a paper exercise is involved. Developing countries are littered with the debris of bottleneck-breaker schemes which failed for lack of analysis plus comprehensive packaging and promotion: herbicides which demonstrated well but never sold because they were not promoted along with the expansion of the crops; small tractors which were merchandised exclusively as labor savers and never sold; irrigation projects which only succeeded in pouring more water on existing single cropping because there was no effective promotion of double cropping.

The final selection of bottleneck-breaker innovations depends on the outcome of the programming analysis. This is the only way alternatives can be compared to determine which is more profitable. The aim is to identify the one which provides a greater increase in net income, i.e., in increased gross margin less cost or amortization of the bottleneck-breaker investment. The bottleneck-breaker investment can rarely be charged to a single crop; generally it must be charged against the gross margin of the entire farm.

In preparing for this analysis, consider these factors:

1. Bottleneck-Breaking Supplies. These supplies are financed out-of-pocket or with short-term loans. Consider only the actual cost and the interest per

hectare of application. Improved seed is often a yield-raiser as well as a bottleneck-breaker. The two benefits must be analyzed separately.

a. *Improved seed.* Varieties with earlier or later maturities will change the timing of labor inputs.

b. *Herbicides.* Particularly on perennials, effective weed-killers can reduce weeding labor by up to 80%.

2. **Cultivation Equipment**

a. *Draft animals.* Consider draft animals (ox, water buffalo, ass) together with the improved equipment available. Improved seeders and weeder equipment can be equally important. There are two aspects of cost: amortization and loan payments. Loans for cultivation equipment might typically be for three years; amortization will vary according to the durability of various elements of the equipment set. The animals often have a substantial resale value when they are too old to plow but not too old to be eaten; this resale price should be deducted from the cost to be amortized. Possibility of death or incapacitation of the animals may offset this. It is useful to set the interest rates higher than expected levels.

A few further considerations may be included. Two families might share a set of oxen and equipment if the optimum program shows that the average farm will not be using the oxen more than 12 days a month. In evaluating the investment there are intangible benefits, such as reduction in risk due to the ability to work faster and earlier. There are also some risks involved in owning draft animals; there could be a shortage of feed before the first plowing.

b. *Two-wheel tractors.* The small tractors popular in Japan (often called rototillers) sell from $500 to $1200 with basic attachments. They can generally work at least twice as fast as draft animals and do not need 2- or 3-man teams.

Where draft animals have net costs of over $400 per pair, the two-wheel tractor can compete favorably even in some labor-surplus situations.

It is most economical for one person in the community to own the tractor and do custom plowing for his neighbors. The cost per farm then depends on the length of the tightest work season. If, in a 4-week period, the average farm needs a tractor for 2 mandays, 10 farms can be serviced in 20 mandays. If, however, the task must be completed in two weeks, one tractor can only service 5 farms.

c. *Large tractors.* Conventional tractors with basic attachments sell in developing countries at prices ranging from $2,000 to $7,000. They are too expensive and are beyond the needs of one peasant farming community. Yet they are widely used in countries such as Thailand. The key to their economy is in moving them from zone to zone to take advantage of different seasonal requirements.

Suppose that the amortization and the general cost of operating a tractor is $2,000 a year. If the average farm needs it for one manday during a peak season which lasts 20 mandays, the cost per farm would be $100 if the tractor were used in that zone alone. If, however, the tractor can be used in three other zones with similar requirements at staggered seasons, the cost per farm would be only $25, plus some share of "moving" costs.

Large tractors do deep plowing and clearing work that smaller equipment cannot do. On the other hand, foreign exchange is initially required to purchase them and to keep them in fuel and spare parts. They also require a higher level of maintenance and management competence than smaller equipment.

3. **Irrigation.** Irrigation is generally a yield-raiser as well as a bottleneck-breaker. In computing the optimum use of the equipment, consider the increases in gross margin due to higher yields as well as the changes in labor requirements by month due to changes of crop timing.

a. *Small pumps.* Small pumps may provide economical irrigation for an individual farm, but it is sometimes more economical to have a small pump serve several farms. Amortization is charged to the whole farm gross margin or split among several farms.

b. *Community irrigation projects.* Sometimes part or all of a farming community finances and builds a small irrigation system with a small diversion dam or pump plus ditching and piping. The total cost must be spread over a number of farms. Charges to each farm on the basis of amount of water used or hectares irrigated will encourage the farmers to try to include as many farms as possible in the system.

c. *Major irrigation projects.* For these projects, planning techniques are generally different from those outlined in this book. They may extend over several zones. The true benefits of such projects, however, can only be determined by a programming analysis of average farms in each zone.

NEW ENTERPRISES

A new enterprise involves the introduction of a new crop or the upgrading of a crop from a minor to a major cash crop. If a farmer has been growing 100 kgs. of maize a year for home consumption, inducing the individual farmers of a community to grow 1000 kgs. of maize for market and helping them do so involves all the complications of introducing a new crop.

Sometimes the analysis of such a proposal is simple. If a new crop must be harvested at the same time as the primary subsistence crop, it will probably not fit, even on a small scale. If all the work on a new crop is during off-seasons, or if the gross margin per hectare is twice that of any other crop in the present system and the timing is such that the competition for peak labor is minimal, it will almost certainly be a welcome addition.

In addition to gross margins, labor requirements, and competition for land and labor, new enterprises present three special problems:

1. **Marketing System.** What off-farm services and infrastructure are needed to market the crop? Investments may have to be planned in:

a. local crop collection facilities, buying stations, etc.

b. transport access

c. more hauling capacity on the roads at peak seasons

d. processing and storage facilities

These investments may or may not be economical or profitable depending largely on the expected total volume. Yet, a new enterprise may improve the use of existing facilities and make them more economical. If cash crops arrive during only one season, a new enterprise harvested at a different season may utilize idle collection, storage, and truck and railroad capacity at relatively little out-of-pocket cost.

2. **Minimum Volume Startup.** Suppose a new crop (e.g., soybeans) is introduced which requires special processing unavailable in a region's rural areas. This crop is attractive to farmers because the prospective gross margin is high and the harvest time is during an off-season. Extension agents extol the virtues of the crop. Individual farmers plant enough to harvest a few hundred kilos.

There is likely to be no market. It generally does not pay to send out a truck to a village during an off-season to pick up a few hundred kilos of a crop. Local merchants and cooperatives will probably not know what to do with a few hundred kilos of something new. It is not worthwhile to maintain marketing linkages between central processing facilities and villages. It may not be

worthwhile to build and operate a processing facility for even a hundred tons which have to be collected from scattered suppliers. Moreover, if the new crop needs a special pesticide, it will probably not be available locally when needed.

A new enterprise requires either an assurance of an initial economical minimum volume or special arrangements to compensate for the lack of that initial volume. From the beginning, farming communities should produce enough for shipment in truckload lots. Adequate marketing can be provided through:

a. *Saturation and concentration.* The policies outlined on pages 31-33 are vital to marketing new crops.

b. *Extension service marketing guarantees.* If the promotion strategy calls for initial demonstrations on single farms, the extension service will have to arrange for buying the crop of the demonstrator. Beyond that, for the first year or two a guaranteed price may be necessary to induce farmers to grow a new crop.

c. *Insistence on minimum participation.* It may be necessary to insist that a minimum number of farmers from a community participate in a new package before farmers receive assistance.

d. *Subsidization of initial operation of processing facilities.* It may be necessary to subsidize processing facilities for the first few years until the volume of the new crop reaches the breakeven point for the facility.

3. **Sophistication.** Is the overall institutional capacity of the zone ready to accommodate the requirements of the new crop? New enterprises may have requirements for supply and marketing quality control, credit discipline, and production discipline that can only be expected in stage 3. For example, horticulture may require buying on grade, the precise timing of application of fertilizer and pesticide, careful and complex rotation and staggering of plantings, and irrigation.

PRICES

The Problem of Market Saturation

Innovations aim at increasing production. Their analysis is based on current or recent prices. Therein lies a potential contradiction: increased production may saturate the market and depress prices.

This problem is generally not relevant to the first two to four years of a project. The number of farmers who adopt an innovation package during the first three years is not sufficient to increase the volume of a marketable crop enough

to depress prices. After that, a successful project may rapidly saturate a market. The package often includes crops which farmers have been growing in small quantities, mainly for home consumption. Now they will each be marketing several hundredweight. For some crops the demand is such that the market will not be saturated. For others, price elasticities must be considered and saturation prices determined for planning beyond the third or fourth year.

The initial programming exercises for several or all zones should determine whether such saturation is likely to occur. This will indicate the volume which will probably come onto the market as a direct result of project activity.

The resulting relations of supply and demand can be determined in light of the price elasticities of the commodities. The analysis will vary according to whether the crop is:

- for export
- for domestic use
- for livestock feed, foreign or domestic

Export Markets

The Commodity Analysis Branch of FAO has projected worldwide consumption and production of major agricultural commodities for 1980.[1] A two-volume compendium projects country-by-country and region-by-region production and demand, per capita and aggregate, for 28 different agricultural commodities or commodity categories. The data are indispensible to any agricultural planning office.

On the demand side the data are particularly authoritative. A planning office might want to match domestic demand with the figure currently used for national planning. For international projections, however, it might be advisable to use the FAO indices of per capita demand in the absence of in-country studies.

On the supply side the FAO data are not as authoritative. Projections for each country are based on assumptions about the content and effectiveness of the country's development plan over a number of years. Certainly the FAO projections cannot be used for one's own country. For other countries and for regionwide and worldwide supply projection, however, the FAO's projections are likely to be sufficient.

Suppose that the initial programming for the average farms of a set of zones has been completed. It indicates that if all the suitable farms adopt the recommended packages, 80,000 tons of crop A will be available for export. Compare that figure with the FAO projection for exports of crop A. If the FAO

1. Food and Agriculture Organization, *Agricultural Commodity Projections, 1970-1980*, vols. 1 and 2 (Rome: FAO, 1971).

projects only 30,000 tons for export in 1980, an additional 50,000 tons must be added to the supply available to importing countries. Will this affect export prices? If another 50,000 tons are only 5% of the imports projected for those countries, then the project activity will probably not affect prices significantly.

If the project acitivity amounts to more than 5% of the imports of a prospective export market (say, Western Europe), then there is a strong possibility that it will depress the market. At this point communicate with the Commodity Analysis Branch of FAO to learn the price elasticity for that crop in that group of countries.

If the price elasticity is .8, for example, then a 2% increase in overall supply on the markets of those countries would mean a drop in price of 1.6%. If the 50,000 tons additional supply of crop A amounts to a 10% increase, then a price drop of 8% can be expected. On this basis, use a price 8% below the current price for long-term planning.

FAO projections show that almost all crops will be in some oversupply. Moderate general world oversupply should not in itself discourage a country from planning expanded exports. When African countries began exporting coffee on a large scale in the early 1950s, Brazil was burning surplus coffee. Prices that are discouraging to one country may be highly advantageous to farmers in another country, depending on their production conditions and their alternate production opportunities.

Domestic Markets

As with export markets, the analysis of opportunities must estimate how much the supply of various crops on the domestic market will be increased if all suitable farms adopt the package. Comparing these results with FAO projections (or modifications of the FAO projections), see whether the domestic market will be saturated as a result of the projects. If the increased production will only keep up with growth in demand, a continuation of current prices can be assumed.

If, however, the projected demand is substantially lower than the projected supply, a drop in prices can be expected. FAO can provide some useful price elasticity figures for most crops in most countries. From these calculate the possible drop in domestic prices as a result of saturating the market.

There may be some alternatives to saturating the domestic market. It may be possible to export the projected excess of supply over demand. If the projected crop is not presently being exported, examine shipping costs to determine the price at which the crop can be landed in potential export markets. If the crop can be landed at a competitive price, it can be marketed abroad at the same price the farmer currently receives. If, however, the "analysis" price exceeds the current

import price, exports will have to be at a somewhat lower price in order to make them competitive. The market analysis must be repeated to take into account the effect of the possible export volume on the supply-demand balance of importing countries. This may further reduce the potential export price.

Feed Grains

In developed countries, most coarse grains are fed to livestock. In developing countries, coarse grains are generally used for human consumption. Grain-fed livestock require the kind of preparation and core services that generally only come in stage 3.

Nevertheless, for countries considering expansion of production of coarse grains such as maize or sorghum, it is useful to examine the possibility of feeding them to livestock. This may be a complex process requiring several years of experience to determine what feed operations are most economical. Marketing of livestock must be carefully planned. In spite of these complications it may be possible to get a quick estimate of the price at which it would be economical to feed coarse grains to livestock. Such a price could then be used as the long-range planning price.

The United States Department of Agriculture's Economic Research Service has done useful work on the world market for feed grains.[2] An agency planning possible export of feed grains should contact the USDA Economic Research Service for the latest projections of markets, prices, and price elasticities.

Ironically, it is often recommended that governments promote increased production by offering better prices to the farmers. Sometimes it is possible to improve farm prices by eliminating certain export taxes, unrealistic controls, or market inefficiencies. But the long-term trend in agricultural prices has been down for some years. As farmers adopt new technology and make substantial increases in production, prices inevitably go down. Nevertheless, it is possible to profit from new technology in spite of substantial drops in prices.

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2. See "Growth in World Demand for Feed Grains: 1980," Foreign Agriculture Economic Report Number 63 (Washington, D.C.: USDA Economic Research Service, 1970).

6 Programming Technique

Once basic data for project formulation have been developed, the next step in the planning process is to determine an action plan for the average farm in the designated zone. Given our understanding of that farm and the proven available technology, what is the best method of operation? How should a development project change the operation of the average farm? What package of innovations is best suited? What crops, what inputs, and how many ares of each crop will net the most income for the farm? To help answer these questions, this chapter presents a technique known as linear programming, using simplified, practical illustrations based on real zone data.

CONCEPTS OF MODEL FARM OPTIMIZATION

The objective of any program is to maximize the individual farmer's income from his farm operation without exceeding any of the physical limits he faces. These limits or constraints are inherent in the farmer's circumstances. Sensible action must always take account of those constraints. For example:

1. Operations on crops require labor input; these operations are required in certain months.

2. Land area in general, or of specific types, may be limited.

3. Small farmers generally dedicate production resources to raising their own food crop regardless of its relative profit.

4. Irrigation water may be required at certain times; quantities may be limited.

5. The availability of special equipment may be restricted.

In most cases the gross productivity of the individual farm is bound by one or more of these constraints, be it manpower available for plowing or land on which to plant crops.

Given these circumstances and constraints, the problem is to determine the combination of acreages of various crops which will earn the most gross margin and thus the most net income. This objective can be stated mathematically:

1. Maximize $\sum_c$ (gross margin of c) x (ares planted in c)

where Σ = "the sum of," and c = crop.

This equation expresses the ideal objective of any program to maximize farm income. The circumstances and constraints mentioned above can also be expressed in equation form.

2. Subject to $\sum_c$, (mandays per hectare per month)$_c$ x (ares$_c$)
$\leqslant$ maximum mandays in the month

3. Subject to $\sum_c$, ares$_c$ x minimum ares$_c$

4. Subject to Σ, ares$_c$ x total ares available for all crops

Other constraints would assume similar equations. Limited water for irrigation would be expressed:

5. Subject to $\sum_c$, (water required per are$_c$) x (ares$_c$ planted$_c$)
$\leqslant$ total water available per month

The objective of the analysis is to determine the value (acreage of crop planted) for each crop which gives the highest summed gross margin (1) without exceeding any of the constraints (2-5).

An Introductory Example

The following information has been gathered on a farm in transition from subsistence to subsistence-mixed farming. The farm grows 1 hectare (100 ares) of cereal and 50 ares of legume. Ample land is assumed and natural rainfall is sufficient. Monthly manpower supply and subsistence crop production are the

primary constraints. Labor is the principal constraint. August is virtually an idle month, so it is omitted from the model

The first step in analyzing an optimization program is to construct a worksheet with columns labeled as shown below. Enter the basic or "given" coefficients (per hectare numbers): gross margin and mandays required for various operations in a specific month.

	Ares Programmed	Gross Margin	May	June	July	Sept	Oct	Nov
			Labor Input as Mandays					
Cereal		$60/H	30/H Plow-Sow	20/H Thin-Weed	10/H Weed		30/H Harvest	10/H Finish
Legume		80/H	16/H Plow	16/H Plow-Sow	9/H Thin-Weed	20/H Harvest	20/H Harvest	

Next calculate the *gross margin per manday* for each month and enter it in the worksheet. The gross margin per manday is obtained by dividing the gross margin per hectare by the mandays of labor required in a given month. Gross margin per manday for cereal in May is $60 ÷ 30 = $2.

"Gross margin per manday" is not a direct statement of actual income, but rather an indication of the relationship of monthly manpower to the overall profitability of the crop.

In practical terms, for every additional manday devoted to cereal in May the farmer can handle additional acreage that will earn a gross margin of $2.

	Ares Programmed	Gross Margin	May	June	July	Sept	Oct	Nov
Cereal			$2	$3	$6		$2	$6
Legume			5	5	9	$4	4	

NOTE: Fractions of dollars and mandays are rounded to the nearest whole number (legume, July).

Current Situation

The next step is to determine the number of mandays required each month to produce the minimum ares the farmer insists on growing. The current situation (or minimum solution) reflects the farm's subsistence requirements.

In the column labeled "Ares Programmed," list the actual number of ares (minimum ares) for each crop planted. For each month multiply the ares

programmed by the manday coefficients for each crop. (The coefficients tell us that legume requires 16 mandays/hectare for plowing in May. This farm plants 50 ares of legume [½ hectare] and therefore requires 8 mandays labor in May.) To obtain the gross margin for this situation, multiply the ares programmed by the gross margin/hectare of that crop. (The gross margin of legume is $89/hectare. The gross margin of 50 ares of legume is therefore $40.)

	Ares Programmed	Gross Margin	May	June	July	Sept	Oct	Nov
			Labor Input as Mandays					
Cereal	100	$ 60/H	30	20	10	0	30	10
Legume	50	40/H	8	8	5	10	10	0
Total	150	100/H	38	28	15	10	40	10

The next step is one of the most important in the analysis: computing the slack time for each month. After computing the entries for the minimum solution it is necessary to assign maximum mandays of labor available for each month: 50 mandays in each of the months requiring the highest number of mandays to cultivate minimum ares (May and October), and 40 in the remaining months.

The actual mandays required for each month's operations are then subtracted from the maximum available mandays assigned to determine the amount of unused labor which is available. Numbers in parentheses indicate number of mandays actually required in each month (from previous step).

	May	June	July	Sept	Oct	Nov
Maximum Mandays Available	50 (38)	40 (28)	40 (25)	40 (10)	50 (40)	40 (10)
Slack Mandays	12	12	15	30	10	30

Initial Slack Allocation

The next step in programming this farm is to use the slack mandays to obtain the greatest possible increase in gross margin over the current situation. First identify the *key month* (the month with the fewest slack mandays) and the *key crop* (the crop with the highest gross margin per manday) within the key month. In this example, October has the minimum slack—10 mandays—and the legume has the highest gross margin per manday ($4).

Before allocating the additional mandays in October to the legume, we must make a quick check to assure that labor demands for the legume do not exceed

the manpower supply available in any other month. This is done by determining the *constraint month* on the crop being considered for expansion.

The constraint month is the month with the highest ratio of key crop mandays per hectare to available slack.

From the worksheet we obtain the legume labor requirements, slack mandays in each month, and compute the *constraint ratio.* In this analysis, the constraint ratio has been converted to a decimal fraction in order to facilitate comparison.

	May	June	July	Sept	Oct	Nov
Legume Mandays/H	16	16	9	20	20	0
Slack Mandays	12	12	25	30	10	40
Legume Constraint Ratio	1.3	1.3	0.4	0.7	2.0	0.0

In this example, both the key month and the constraint month are October. Given the labor constraint, the circumstances of a commitment to food crops, knowledge of crop labor requirements, and given the assumption that land is available, we determine that 50 ares of legume could be added to the present enterprise (10 mandays at 20 mandays/hectare = 50 ares).[1] It is then necessary to enter on the worksheet the requirements for the additional 50 ares of legume and to recompute the slack (following the steps outlined above). Numbers in parentheses on the "Total" line are the maximum available mandays assigned to the month.

	Ares Programmed	Gross Margin	May	June	July	Sept	Oct	Nov
			Labor Input as Mandays					
Cereal	100	$ 60/H	30	20	10	0	30	10
Legume	100	80/H	16	16	10	20	20	0
Total	200	140/H	46 (50)	36 (40)	20 (40)	20 (40)	50 (50)	10 (40)
Slack Mandays Available			4	4	20	20	0	30

Slack has now been reduced considerably. The constraining month, October, shows no slack. The ares of crops requiring labor in October are at a maximum, as

1. This calculation takes the form: Additional acreage = slack mandays in constraint month ÷ mandays/H required in that month: 10/20 = ½ ha. = 50 ares.

labor, the limiting resource, is depleted. Any planned increase in the ares of legume would require increased mandays in October, violating the constraint of 50 available mandays.

A Second Round Allocation of Slack

Let us now introduce into our analysis information about a fiber crop. Assuming that additional legume production has been programmed, we will work within the established labor supply constraint. We begin by noting that fiber does not require any labor in October. Taking the slack figures from the preceding computation, proceed to figure the fiber constraint ratio.

	Gross Margin	May	June	July	Sept	Oct	Nov
Labor Input as Mandays/H		10 Plow	16 Plow-Sow	10 Weed	10 Weed	0	30 Harvest
Gross Margin/ Manday	$100/H	$10	$ 6	$10	$10		$ 3
Slack Mandays Available		4	4	20	20	0	30
Fiber Constaint Ratio		2.5	4.0	0.5	0.5		1.0

Both May and June are key months (low slack), but June is the constraint month. The constraint ratio of 16:4 (4.0) in June limits production and indicates that 25 ares of fiber could be programmed. The June fiber requirement is 16 mandays per 100 ares. With only four mandays available, one-fourth of that acreage could be handled. Incorporate 25 ares of fiber into the analysis and once again recompute the slack.

	Ares Programmed	Gross Margin	May	June	July	Sept	Oct	Nov
			Labor Input as Mandays					
Cereal	100	$ 60/H	30	20	10	0	30	10
Legume	100	80/H	16	16	10	20	20	0
Fiber	25	25/H	3	4	3	3	0	8
Total	225	165/H	49 (50)	40 (40)	23 (40)	23 (40)	50 (50)	18 (40)
Slack Mandays Available			1	0	17	17	0	22

We have now exhausted the possibility of increasing productivity through simple slack allocation. All the crops in the model require labor in the month of June, and they exhaust the entire labor supply in that month.

Analyzing Trade-Off Possibilities

It may still be possible to increase the total gross margin by shifting resources in zero-slack months from a crop with lower gross margins to a more profitable one.

The gross margin per manday per month gives us a guideline for identifying trade-off opportunities. Two conditions must be met by a successful trade-off: there must be both a reducible crop and a crop with a higher gross margin which can be augmented. In October, the constraint month for cereal and legume, the calculated payoff for labor is twice as high for the legume as for the cereal ($4 for legume, $2 for cereal; see gross margin/manday, page 79). Should we consider a shift from the production of cereal to the legume? The answer is no, because another constraint is at work here. We are committed to a minimum of 100 ares of cereal for food, so we cannot touch that labor requirement.

Let us shift the inquiry to June, the other zero-slack month. The favorable gross margin per manday for fiber ($6) compared with the legume ($5) looks promising. Legume could be reduced from 100 ares to 50 ares without violating a constraint (without using more of a constrained resource than is available), and fiber could be increased. Reducing ares of legume from 100 to 50 would free 8 mandays of labor in June which would allow an increase of 50 ares of fiber. Would this be profitable?

	Ares Programmed	Gross Margin	May	June	July	Sept	Oct	Nov
			Labor Input as Mandays					
Cereal	100	$ 60/H	30	20	10	0	30	10
Legume	100	80/H	16	16	10	20	20	0
Fiber	25	25/H	3	4	3	3	0	8
Total	225	165/H	49 (50)	40 (40)	23 (40)	23 (40)	50 (50)	18 (40)
Slack Mandays Available			1	0	17	17	0	22
Trade-off, Legume for Fiber								
Cereal	100	$ 60/H	30	20	10	0	30	10
Legume	50	40/H	8	8	5	10	10	0
Fiber	75	75/H	8	12	8	8	0	22
Total	225	175/H	46 (50)	40 (40)	23 (40)	18 (40)	40 (50)	32 (40)
Slack Mandays Available			4	0	17	22	10	8

We have now reached a "best possible" solution for our average farm, given the assumptions and constraints of our model. Looking at the remaining slack in the labor supply, we see that June remains the constraint month and no crop can be augmented. Cereal and legume production are nonreducible, given the

commitment to food production. Any change in the programmed ares would result in a decrease in the gross margin.

Someone might want to argue that this analysis produces solutions which are "too neat"—that it overlooks the vagaries of the weather, of the farmers' willingness to actually do the projected work, of the sureness of the technology (e.g., for the fiber crop), and the availability of markets. Such arguments are misplaced.

First of all, the analysis is based on practical information about agricultural realities. It is a basic, sequential analysis, focusing on the interplay of constraints, identified possibilities, and the practical and important aim of optimization. Other factors can be added to this analysis, as we shall indicate in the following sections of this chapter. As for the vagaries of nature and the soundness of technologies, they must of course be taken into account in judging potential production feasibilities. Peasant farmers are as responsive to the combination of self-interest and reasonably safe opportunities as anyone else. Within that perspective, there is simply no adequate alternative to systematic analysis as the basis for practical farm planning.

Table 6.1 represents all the steps in the analysis of the model farm performed thus far. Basic coefficients for fiber are entered at the beginning of the worksheet as part of step 1.

Mechanized Model

In the above analysis the bottleneck months (least slack) are May and June, when most of the labor required is for plowing. The effect of a small single-axle tractor, hired to plow half of the farmer's land, can be demonstrated through revised coefficients and further analysis. The steps and computations in the analysis are the same as those performed earlier:

1. Enter the basic coefficients for all three crops. Note that labor requirements have been reduced: cereal, from 30 mandays to 20 in May; legume, from 16 to 8 in May and 16 to 10 in June; fiber, from 10 to 5 in May and 16 to 10 in June.

2. Compute the gross margin per manday per month.

3. Enter the current situation; that is, 100 ares of cereal, 50 ares of legume. The only difference between this and the original analysis is the reduced labor requirement and the corresponding increase in gross margin per manday.

4. Assign maximum mandays available. Note that mechanized plowing shifts the month requiring maximum mandays of labor from May to June.

5. Compute the slack.

TABLE 6.1 FARM PROGRAMMING: AN INTRODUCTORY EXAMPLE

Basic Coefficients	Ares Programmed	Gross Margin	May	June	July	Sept	Oct	Nov
			Labor Input					
1 Cereal		$ 60/H	30	20	10	0	30	10
2 Legume		80/H	16	16	9	20	20	0
3 Fiber		100/H	10	16	10	10	0	30
Gross Margin/Manday								
4 Cereal			$ 2	$ 3	$ 6		$ 2	$ 6
5 Legume			5	5	9	$ 4	4	
6 Fiber			10	6	10	10		3
Current Situation			Labor Input					
7 Cereal	100	$ 60/H	30	20	10	0	30	10
8 Legume	50	40/H	8	8	5	10	10	0
9 Total	150	100/H	38	28	15	10	40	10
10 Maximum Mandays Available			50	40	40	40	50	40
11 Slack Mandays Available			12	12	25	30	10	40
12 Legume Constraint Ratio			1.3	1.3	0.4	0.7	2.0	0.0
Addition of 50 ares of Legume								
13 Cereal	100	$ 60/H	30	20	10	0	30	10
14 Legume	100	80/H	16	16	10	20	20	0
15 Total	200	140/H	46 (50)	36 (40)	20 (40)	20 (40)	50 (50)	10 (40)
16 Slack Mandays Available			4	4	20	20	0	30
17 Fiber Constraint Ratio			2.5	4.0	0.5	0.5		1.0
Addition of 25 ares of Fiber								
18 Cereal	100	$ 60/H	30	20	10	0	30	10
19 Legume	100	80/H	16	16	10	20	20	0
20 Fiber	25	25/H	3	4	3	3	0	8
21 Total	225	165/H	49 (50)	40 (40)	23 (40)	23 (40)	50 (50)	18 (40)
22 Slack Mandays Available			1	0	17	17	0	22
Trade-off Legume for Fiber								
23 Cereal	100	$ 60/H	30	20	10	0	30	10
24 Legume	50	40/H		8	5	10	10	0
25 Fiber	75	75/H	8	12	8	8	0	22
26 Total	225	175/H	46 (50)	40 (40)	23 (40)	18 (40)	40 (50)	32 (40)
27 Slack Mandays Available			4	0	17	22	10	8

6. Identify the *key crop* and *key month* (legume in October).

7. Compute the *constraint ratio* (mandays required : available slack) and identify the *constraint month* (highest constraint ratio). October is again the constraint month.

8. Allocate the slack (slack mandays available ÷ mandays/hectare, or 10 ÷ 20 = .5 h. or 50 ares). Ten days slack time in October allow for the addition of 50 ares of legume.

9. Recompute slack. Comparison of the slack days available with the labor requirements for fiber reveals that it is possible to add 100 ares of fiber without violating labor constraints. (May is the key month, November the constraining month. 30 ÷ 30: 1 ha. or 100 ares).

Are there trade-off opportunities from this solution? The two zero-slack months are now October and November. October again offers no trade-off possibilities due to the production requirement of 100 ares of cereal. Is there a possible trade-off in November between fiber and cereal? Cereal shows a gross margin of $6 vs. $3 for fiber. Increasing cereal requires a decrease in legume production due to the zero-slack in October. Proceeding with the suggestion, we find:

	Ares Programmed	Gross Margin	October	November
Cereal	100 + 20 = 120	$60 + 12 = $ 72	30 + 6 = 36	10 + 2 = 12
Legume	100 - 30 = 70	$70 - 12 = 58	20 - 6 = 14	
Fiber	100 - 6 = 94	$100 - 6 = 94		
Total	284	$222	50	40

The shift of labor in November from fiber to cereal, with the accompanying need to reduce legume production, causes a decrease in gross margin ($240 to $232). The solution contained in the second slack allocation of Table 6.2, therefore, remains the optimum plan.

Comparing Table 6.1 with Table 6.2 reveals the realistic possibility—within the stated assumptions—of increasing the gross margin of the farm from $175 to $240 by hiring the plowing of half of the farm's 300 ares. At a plowing cost of $20 per hectare, the net increase in profitability would be slightly more than 100% of the additional cash investment: $240 - 175 = $65; $65 - (20 x 1.5) = 35. Gain from spending $30 for plowing is $35 above cost. Would it be profitable to have more land plowed by hire? The manpower limits of October and November say no; the farmer cannot harvest additional land.

TABLE 6.2 ANALYSIS ASSUMING MECHANIZATION OF PLOWING

	Ares Programmed	Gross Margin	May	June	July	Sept	Oct	Nov
			Labor Input as Mandays					
1 Cereal		$ 60/H	20	20	10	0	30	10
2 Legume		80/H	8	10	10	20	20	0
3 Fiber		100/H	5	10	10	10	0	30
Gross Margin/Manday								
4 Cereal			$ 3	$ 3	$ 6		$ 2	$ 6
5 Legume			10	8	8	4	4	
6 Fiber			20	10	10	10		3
Current Situation			Labor Input as Mandays					
7 Cereal	100	$ 60/H	20	20	10	0	30	10
8 Legume	50	40/H	4	5	5	10	10	
9 Total	150	100/H	24	25	15	10	40	10
10 Maximum Mandays Available			40	50	40	40	50	40
11 Slack Mandays Available			16	25	25	30	10	30
Slack Allocation Legume								
12 Legume Constraint Ratios			0.5	0.4	0.4	0.7	2.0	1.0
13 Cereal	100	$ 60/H	20	20	10		30	10
14 Legume	100	80/H	8	10	10	20	20	0
15 Total	200	140/H	28 (40)	30 (50)	20 (40)	20 (40)	50 (50)	10 (40)
16 Slack Mandays Available			12	20	20	20	0	30
Second Slack Allocation Addition of 100 ares of Fiber								
17 Fiber Constraint Ratios			0.4	0.5	0.5	0.5	0	1.5
18 Cereal	100	$ 60/H	20	20	10	0	30	10
19 Legume	100	80/H	8	10	10	20	20	0
20 Fiber	100	100/H	5	10	10	10	0	30
21 Total	300	240/H	33 (40)	40 (50)	30 (40)	30 (40)	50 (50)	40 (40)
22 Slack Mandays Available			7	10	10	10	0	0

Summary of Analytical Procedures

The operations and computations outlined on the preceding pages and shown in complete form in Table 6.1 present the concept of linear programming as applied to the analysis of actual farm data. To complete the following exercises, the same procedures must be followed. These procedures are outlined on page 88 for easy reference.

TABLE 6.3 BASIC AGRICULTURAL PROGRAMMING PROCEDURES

I. Basic Coefficients
   A. Enter gross margin per hectare (for each crop)
   B. Enter labor input as mandays per hectare (by month)
II. Gross margin per manday per month (gross margin/hectare ÷ mandays/hectare)
III. Current Situation
   A. Enter actual ares of each crop planted
   B. Compute mandays labor required (by month)
   C. Assign maximum mandays available (50 to that one-third of the months requiring the greatest number of actual mandays labor; 40 to the remaining two-thirds)
   D. Compute the slack time for each month (subtract mandays required from maximum available mandays)
IV. Initial Slack Allocation
   A. Identify key month (least slack)
   B. Identify key crop (largest gross margin per manday)
   C. Compute constraint ratios (mandays required : slack)
   D. Identify constraint month (highest constraint ratio)
   E. Compute new acreage for key crop (additional acreage = slack mandays in constraint month ÷ mandays/hectare in constraint month; e.g., if the key crop requires 20 mandays/hectare and there are 10 slack days available in the constraint month, the new acreage is 10 ÷ 20 md/h or .5 hectares, 50 ares)
   F. Compute new solution based on increased production of key crop
V. Subsequent slack allocation—repeat IV.A through F until all crops are fixed
VI. Trade-Offs
   A. Identify zero-slack months indicating possible trade-off opportunities
      1. Crop can be reduced without exceeding constraints
      2. Crop with higher gross margin per manday can be expanded
   B. Verify profitability of trade-off
      1. Check other zero slack months
      2. Determine ares available for trade-off
      3. Insure new program does not exceed labor constraints
      4. Recompute *total* gross margin
   C. Compute manday allocations and determine new slack
   D. Allocate slack (as in IV above)

Computations continue until trials of further trade-offs and slack allocations all produce less profitable programs. When this occurs an optimum solution for this set of constraints has been reached.

EXERCISES

1. After some years farmers over a wide region have adopted the package suggested by the introductory example completed above. As a result of market saturation, the price of fiber has fallen and the gross margin is now only $80 per hectare. At the same time, new varieties of fiber and cereal have been made available permitting altered labor allocations and breaking the l... est bottleneck. The basic coefficients and the ares programmed, the gross margin, and the July labor requirements for the current situation have been entered on the sample worksheet. Determine the optimum non-mechanized solution under these circumstances.

	Ares Programmed	Gross Margin	May	June	July	Sept	Oct	Nov
			Labor Input as Mandays					
1 Cereal		$ 60/H	30	20	10	5	25	10
2 Legume		80/H	16	16	10	20	20	0
3 Fiber		80/H	10	12	10	15	0	30
Gross Margin/ Manday								
4 Cereal								
5 Legume								
6 Fiber								
Current Situation								
7 Cereal	100	$ 60/H			10			
8 Legume	50	40/H			5			
9 Total	150	100/H			15 (50)			
10 Maximum Mandays Available								
11 Slack Mandays Available								
12 Constraint Ratio								
13								
14								
15								
16 Total								
17 Slack Mandays Available								

2. A year later the legume price has dropped to yield a gross margin of only $70/H. The government now assists farmers by providing a tractor *for legume plowing only,* cutting the labor in half. Using the same conditions as in exercise no. 1, with the exception of line 2, determine the optimum semi-mechanized program.

	Ares Programmed	Gross Margin	May	June	July	Sept	Oct	Nov
			Labor Input as Mandays					
1 Cereal								
2 Legume		$70/H	8	8	10	20	20	0
Gross Margin/Manday								
4 Cereal								
5 Legume								
6 Fiber								
Current Situation								
7 Cereal								
8 Legume								
9 Total								
10 Maximum Mandays Available								
11 Slack Mandays Available								
12 Constraint Ratio								
13 Cereal								
14 Legume								
15 Total								
16 Slack Mandays Available								
17 Cereal								
18 Legume								
19 Fiber								
20 Total								
21 Slack Mandays Available								
Trade-Off								
22								
23								
24								
25								
26								

ZONE Y PROGRAMMING

Turning now to zone Y, it is possible to apply linear programming on a realistic scale, using data from a real situation. This will provide answers to some questions on the benefits of bottleneck-breaking innovations. The result will be a comprehensive improvement package for zone Y, which will serve as the basis for formulating a project.

Preparations

The first steps in computing the zone Y farm program are to define the various crops available for production and to determine their labor input. The information has been entered on lines 1-6 of Table 6.4. Sowing and harvesting of cotton-1 have been advanced to an earlier month; in the region on which the data are based, earlier sowing of cotton is one of the keys to high yields. An improved system using oxen for sowing and weeding will require two plowings for cotton-1 rather than the single plowing in the present system. (Machine sowing in rows requires a much smoother seedbed than hand broadcast.) Some other changes have been made in the timing of various operations to distribute the work more evenly.

This rescheduling emphasizes an important point about farming innovation. It is not enough simply to teach the farmer how to handle and apply new supplies and equipment. To take full advantage of them he must often make significant changes in his work schedule.

Next the gross margin per manday is calculated (lines 7-12). The minimum ares reflected in the current situations (line 13-21) are based on the average-ares-per-farm. The maximum mandays (line 20) are taken from the analysis in chapter 5 and are assigned to those months showing peak activity in the current situation.

Slack Allocation

June is the key month for the first computation, with a slack of only 15 mandays. The key crop for June is cotton-1, with a gross margin per manday of $25. The constraint ratios for cotton-1 indicate that November is the constraining month, allowing an increase of 70 ares (18 ÷ 26 x 100). This fixes not only cotton-1, but also cotton-2 and maize-2.

Considering the non-zero months of the remaining crops for the second slack allocation, October, with 3 slack mandays, appears to be the key month. The two crops with activity in October, however, are both fixed by November, so October is ruled out as a key month. Both March and April show 9 mandays slack and the most profitable crop is peanuts in April ($24/H). The constraint ratios for peanuts

reveal that June, with 12 days slack, is the constraining month, allowing for an increased production of 44 ares (12 ÷ 27 x 100). The combination of zero slack in June and November now fixes all crops.

Trade-Off

In June, the relative gross margin per manday for cotton-1 ($25) compared to peanuts ($4) suggests a trade-off. Since peanuts and cotton-1 are the only reducible crops, the scope of trade-off pairs is logically limited. Simulating the increase in cotton-1, however, creates an impass in the other zero-slack month, November—as neither cotton-2 nor maize-2 is reducible.

In November, cotton-2 can be profitably augmented at the expense of cotton-1, which is reducible. The relative gross margin per manday of $9 to $4 encourages this trade-off. However, comparing the margins of these crops in June ($25 for cotton-1 vs. $3 for cotton-2) is discouraging. A trial computation of cotton-2 for cotton-1 proves that this trade-off is not profitable.

Current Situation	Ares	Gross Margin	June Mandays	November Mandays
Cotton-1	145	$148	6	38
Cotton-2	20	11	4	1
Total	165	159	10	39
Add 10 ares Cotton-2				
Cotton-1	100	102	4	26
Cotton-2	30	17	6	2
Total	130	119	10	28

As can be seen, small increases in cotton-2 production cause large decreases in cotton-1 due to the conflict in June.

There remains the possibility of a trade-off of maize-2 for cotton-1 in November. Maize-2 has a higher gross margin per manday, and cotton-1 is reducible with the trade-off encouraged by the lack of activity for maize-2 in June. Comparison of the constraint ratios shows October as the constraint month. Adding the current 2 mandays in October for maize-2 plus the 3 mandays of slack from line 39 plus 1 manday trade-off produces line 42. Summing the new program demonstrates a final solution, as no further slack allocation can be made.

Treatment of Other Constraints

Based on the conditions in the region from which zone Y data were taken, it has been assumed that the maximum area available to each farm could exceed 4

TABLE 6.4 INITIAL FARM OPTIMIZATION PROGRAM FOR ZONE Y

	Ares Programmed	Gross Margin	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
			Labor Input as Mandays											
1 Cotton-1		$102/H		18	14	17	9	4	6	5	8	24	26	18
2 Cotton-2		56/H	20					20	15	6	10		6	31
3 Millet		65/H	16	15	7	6	26	31	18					
4 Peanuts		119/H	10	10	13	5	17	27	21	21				
5 Maize-1		80/H	14	6	13	6	8	37	20	5				
6 Maize-2		65/H					20		13	6	7	23	13	
Gross Margin/Manday														
7 Cotton-1				$ 6	$ 7	$ 6	$11	$25	$17	$20	$13	$ 4	$ 4	$ 6
8 Cotton-2			$ 3					3	4	9	6		9	2
9 Millet			4	4	9	11	3	2	4					
10 Peanuts			12	12	9	24	7	4	6	6				
11 Maize-1			6	13	6	13	10	2	4	16				
12 Maize-2							3		5	11	9	3	5	
			Labor Input as Mandays											
Current Situation														
13 Cotton-1	75	$ 77/H		13	11	13	7	3	5	4	6	18	20	13
14 Cotton-2	20	11/H	4					4	3	1	2		1	6
15 Millet	50	33/H	8	8	4	3	13	16	9					
16 Peanuts	30	36/H	3	3	4	2	5	8	6	6				
17 Maize-1	12	10/H	2	1	2	1	1	4	2	1				
18 Maize-2	8	5/H					2		1	1	1	2	1	
19 Total	195	$172/H	17	25	21	19	28	35	26	13	9	20	22	19
20 Maximum Mandays Available			40	50	40	40	50	50	50	40	40	40	40	40
21 Slack Mandays Available			23	25	19	21	22	15	24	27	31	20	18	21
Key Month June, Crop Cotton-1														
22 Constraint Ratios of Cotton-1				.7	.7	.8	.4	.3	.3	.2	.3	1.2	1.4	.9

TABLE 6.4—*Continued*

Constraint Month November														
Add 70 ares Cotton-1														
23 Cotton-1	145	$148/H		26	21	25	13	6	9	7	12	35	38	26
24 Cotton-2	20	11/H	4					4	3	1	2		1	6
25 Millet	50	33/H	8	8	4	3	13	16	9					
26 Peanuts	30	36/H	3	3	4	2	5	8	6	6				
27 Maize-1	12	10/H	2	1	2	1	1	4	2	1				
28 Maize-2	8	5/H					2		1	1	1	2	1	
29 Total	265	$243/H	17	38	31	31	34	38	30	16	15	37	40	32
30 Slack Mandays Available			23	12	9	9	16	12	20	24	25	3	0	8
Second Slack Allocation														
Key Month March, Key Crop Peanuts														
31 Constraint Ratio of Peanuts			.4	.8	1.4	.6	1.1	2.3	1.1	.9				
Constraint Month June														
Add 44 ares peanuts														
32 Cotton-1	145	$148		26	21	25	13	6	9	7	12	35	38	26
33 Cotton-2	20	11	4					4	3	1	2		1	6
34 Millet	50	33	8	8	4	3	13	16	9					
35 Peanuts	74	88	7	7	10	4	12	20	16	16				
36 Maize-1	12	10	2	1	2	1	1	4	2	1				
37 Maize-2	8	5					2		1	1	1	2	1	
38 Total	309	$295	21	42	37	33	41	50	40	26	15	37	40	32
39 Slack Mandays Available			19	8	3	7	9	0	10	14	25	3	0	8
No further slack allocation possible														
Trade-Offs														
Maize-2 for Cotton-1														
40 Constraint Ratio, Cotton-1				2.3	.0	2.4	1.0		0.6	0.4	0.2	8.0		2.3
41 Constraint Ratio, Maize-2							2.3		1.3	0.4	0.3	7.7		

October becomes the constraint month in the trade-off
Use (2+3+1) mandays for Maize-2

42 Maize-2	26	$ 17					5		3	2	2	6	3	
43 Cotton-1	138	141		25	19	23	12	6	8	7	11	33	36	25
44 Cotton-2	20	11	4					4	3	1	2		1	6
45 Millet	50	33	8	8	4	3	13	16	9					
46 Peanuts	74	88	7	7	10	4	12	20	16	16				
47 Maize-1	12	10	2	1	2	1	1	4	2	1				
48 Total	320	$300	21	41	35	31	43	50	41	27	15	39	40	31
49 Slack Mandays Available			19	9	5	9	7	0	9	13	25	1	0	9

NOTE: Fractions of dollars and mandays are rounded to the nearest whole number (legume, July). Rounding simplifies the computations and avoids a false sense of percision.

TABLE 6.5 LONG-TERM OPTIMUM FARM PROGRAM FOR ZONE Y

Basic Coefficients	Ares Programmed	Gross Margin	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
			Labor Input as Mandays											
1 Cotton-1		$102		18	14	17	9	4	6	5	8	24	26	18
2 Cotton-2		56	20					20	15	6	10		6	31
3 Millet		65	16	15	7	6	26	31	18					
4 Peanuts		91	10	10	13	5	17	27	21	21				
5 Maize-1		80	14	6	13	6	8	37	20	5				
6 Maize-2		60					20		13	6	7	23	13	
Gross Margin/Manday														
7 Cotton-1				$ 6	$ 7	$ 6	$11	$25	$17	$20	$13	$ 4	$ 4	$ 6
8 Cotton-2			$ 3					3	4	9	6		9	2
9 Millet			4	4	9	11	3	2	4					
10 Peanuts			9	9	7	18	5	3	4	4				
11 Maize-1			6	13	6	13	10	2	4	16				
12 Maize-2							3		5	10	9	3	5	
Minimum Solution (Long-Term)			Labor Input as Mandays											
13 Cotton-1	75	$ 76		14	10	13	7	3	5	4	6	18	19	14
14 Cotton-2	0													
15 Millet	40	26	6	6	3	2	10	12	7					
16 Peanuts	25	23	3	3	3	1	4	7	5	5				
17 Maize-1	12	10	2	1	2	1	1	4	2	1				
18 Maize-2	8	5					2		1	1	1	2	1	
19 Total	160	$140	11	24	19	17	24	26	20	11	7	20	20	14
20 Maximum Mandays Available			40	50	40	40	50	50	50	40	40	40	40	40
21 Slack Mandays Available			29	26	21	23	26	24	30	29	33	20	20	26

Key Month October														
Key Crop Cotton-1														
22 Constraint Ratios, Cotton-1			.7	.7	.7	.7	.3	.2	.2	.2	.2	1.2	1.3	1.7
Constraint Month November														
Add 75 ares Cotton-1														
23 Cotton-1	150	$153		27	21	26	14	6	9	8	12	36	39	27
24 Total Mandays Required	235	$222	11	37	29	30	31	20	24	15	13	38	40	27
25 Slack Mandays Available			29	13	11	10	19	21	26	25	27	2	0	13
Key Month April														
Key Crop Peanuts														
26 Constraint Ratio			.8	.4	.6	.2	.7	3.9	1.3	.9				
Constraint Month June														
Add 70 ares Peanuts														
27 Peanuts	104	$ 95	10	10	14	5	18	28	22	22				
28 Total	314	289	18	44	40	34	45		41	32	13	38	40	27
29 Slack Mandays Available			22	6	0	6	5	0	9	8	27	2	0	13
Trade-off Maize-2/Cotton														
Add 14 ares Maize-2														
Reduce 8 ares Cotton-1														
30 Maize-2	22	14					4		3	1	2	5	3	
31 Cotton-1	142	145		26	20	24	13	6	9	7	11	34	33	25
32 Total all Crops	320	290	18	43	39	32	46	50	43	31	13	39	40	25
33 Slack Mandays Available			22	7	1	8	4	0	7	9	27	1	0	15

hectares. Now let us assume that the size is constrained to 3 hectares. In the tabular solution, this limit would have prevented the full allocation of 44 additional ares of peanuts (line 31), restricting peanuts to 65 total ares.

A second type of restriction might apply to certain regions and farming situations: an upper limit to the amount of land suitable for the production of certain crops. This constraint would appear as a check operation for each computation to assure that the sum of ares for these crops did not exceed the land available.

Other constraints, such as irrigation water, are locally unique and require additional attention in the programming solution.

The Long-Range Zone Y Program

A final zone Y example will simulate the adoption of the previous model over a wide area causing changes in both prices and minimum production for home consumption. In this example, cotton prices are held constant, based on worldwide control, while peanuts drop from 10 to 8 cents a kilogram, maize-2 from 6 to 5½ cents; minimum production is reduced from 20 to 0 ares for cotton-2, from 50 to 40 ares for millet, and from 30 to 25 ares for peanuts. Table 6.5 demonstrates the effect of this set of changes.

Slack Allocation

Initial inspection of line 21 shows October and November with 20 slack mandays and maize-2 as the key crop ($5/H in November vs. $4/H for cotton-1) despite the fact that it is on the whole a much less profitable crop than cotton-1. The author performed the operations with November as the key month and maize-2 as the key crop, and with October as the key month and cotton-1 as the key crop. The final gross margin was the same in each case, but the November/maize-2 situation required three times as many computations as the other. In such a situation, it is advisable to choose the crop with the highest gross margin per hectare as the key crop.

Trade-Offs

A trade-off opportunity between cotton-1 and peanuts appears possible in June, but the other crops requiring labor in that month are already fixed at their minimum and cannot be reduced. The trade-off is between maize-2 and cotton-1 in November. October is the constraint month. Zero-slack months are the same as before; there are no more trade-off possibilities.

EXERCISES

1. Suppose that the zone Y farmer has a land constraint allowing a maximum of 295 ares. Determine the optimum solution with this limit beginning at line 22 of Table 6.5.

   (Substitute the land constraint for the January labor column, which is not really a binding constraint.)

	Ares Prog.	Gross Margin	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Slack Allocation														
22 Constraint Ratio														
23 Cotton-1														
24 Cotton-2														
25 Millet														
26 Peanuts														
27 Maize-1														
28 Maize-2														
29 Total														
30 Slack Mandays Available														
Second Slack Allocation														
31 Constraint Ratio														
32														
33 Total														
34 Slack														

2. Add a dairy enterprise to a farm beginning with the same basic constraints on lines 1-21 of Table 6.5. The enterprise is limited to 2 head requiring 40 ares per cow and producing $200 gross margin per hectare (2 cows). The labor requirement is 5 mandays per head in each of the 12 months. What will be the gross margin and optimum program for the farm?

	Ares Prog.	Gross Margin	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Cattle, Basic Requirements/ Head														
22 Cattle (2)		$200	10	10	10	10	10	10	10	10	10	10	10	10
23 Gross Margin/Manday Month			$20	$20	$20	$20	$20	$20	$20	$20	$20	$20	$20	$20
Slack Allocation														
24 Cattle														
25 Cotton-1														
26 Cotton-2														
27 Millet														
28 Peanuts														
29 Maize-1														
30 Maize-2														
31 Total														
32 Slack Mandays Available														
33 Constraint Ratios														
34 Cotton-1														
35 Total														
36 Slack Mandays Available														
Slack Allocation														
37 Constraint Ratios														
38														
39 Total														
40 Slack Mandays Available														

3. Beginning with the same basic information on lines 1-21, determine the effect of a new variety of maize with a longer maturation period replacing the current maize-2. In anticipation of greater production, reduce the gross margin to $54/H for maize-2, with new labor requirements of: January (9), May (20), June (6), July (7), August (6), September (7), October (0), November (13), and December (17). What will be the optimum program, given these factors?

	Ares Prog.	Gross Margin	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Corrected Lines														
6 Maize-2		$ 54	9	0	0	0	20	6	7	6	7	0	13	17
Gross Margin/ Manday														
12 Maize-2			$ 8				$ 3	$11	$10	$11	$10		$ 5	$ 4
18 Maize-2	8	$ 4	1				2	1	1	1	1		1	1
19 Total	160	$139	12	24	19	17	24	27	20	11	7	18	20	15
20 Maximum Mandays Available			40	50	40	40	50	50	50	40	40	40	40	40
21 Slack Mandays Available			28	26	21	23	26	23	30	29	33	22	20	25
Slack Allocation														
22 Constraint Ratios														
23 Cotton-1														
24 Total														
25 Slack Mandays Available														
Slack Allocation														
26 Constraint Ratio														
27 Peanuts														
28 Total														
29 Slack Mandays Available														
Trade-Off														
30														
31														
32 Total														
33 Slack Mandays Available														

4. Finally, a semi-mechanized program can be determined for the postulation of a government tractor pool available to do half of the plowing work. Retaining the minimums and prices of Table 6.5, recompute the optimum program using the following labor requirements.

	Ares Prog.	Gross Margin	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1 Cotton-1		$102	0	9	7	12	7	4	6	5	8	24	26	18
2 Millet		65	16	12	7	6	26	31	18					
3 Peanuts		91	10	5	13	5	17	27	21	21				
4 Maize-1		80	14	3	13	6	8	37	20	5				
5 Maize-2		60					10		13	6	7	23	13	
Gross Margin/Manday														
6 Cotton-1														
7 Millet														
8 Peanuts														
9 Maize-1														
10 Maize-2														
Current Situation														
11 Cotton-1	75	$ 76		7	5	9	5	3	5	4	6	18	19	14
12 Millet	40	26	6	2	3	2	10	12	7					
13 Peanuts	25	23	3	2	3	1	4	7	5	5				
14 Maize-1	12	10	2	3	2	1	1	4	2	1				
15 Maize-2	8	5					1		1	1	1	2	1	
16 Total														
17 Maximum Mandays Available														
18 Slack Mandays Available														
Slack Allocation														
19 Constraint Ratios														
20														
21 Total														
22 Slack Mandays Available														
Slack Allocation														
23 Constraint Ratios														
24														
25 Total														
26 Slack Mandays Available														
Trade-Off														
27														
28														
29 Total														
30 Slack Mandays Available														

Part III
Project Formulation

7
Project Policy Options

We now turn from the analysis of the individual farm to the design of the project. The aim of this multi-year integrated zone project is to get all the suitable farms in a zone to adopt a package.

As a beginning, several policy decisions must be made. The policies described as *essential* (see page 14) are necessary to the success of any basic agricultural project. In addition, certain policy *options* must be selected—by making choices between equally feasible alternatives. These options deal with the following issues:

1. Which institutions will provide which services?
2. How much training and specialization should be specified for the staff of the institutions at various administrative levels?
3. Should the entire program be promoted at once, or should it be introduced in phases?
4. What approaches will most effectively sell the improvement package to farmers?
5. What procedures will most effectively and economically train farmers in the new skills required by the package?

6. What conditions should be attached to government assistance under the zone projects to assure:

   a. mass participation;

   b. businesslike selection and payment of local coop managers;

   c. businesslike management of local coop assets;

   d. farmer application of recommended practices; and

   e. on-time repayment of production loans?

Decisions about the policy options and the six essential points comprise the *policy framework* for project planning.

CENTRAL INSTITUTIONAL OPTIONS

Variations

In principle, a variety of public and private institutions may be used to provide core services.

Government Departments usually furnish extension services. They may also provide supply services, particularly the distribution of improved seed and credit. Such credit and supply services, however, are generally and properly considered temporary. The roles of extension and credit agents conflict: the extension agent must be at all times the farmer's friend, while the credit agent must coldheartedly reject some applicants and collect loan payments.

Regional Autonomous Authorities are often set up for the integrated development of water basins and new settlement areas to provide special engineering and core services (except marketing). Where special large-scale engineering services are needed, such authorities are particularly useful. Care must be taken, however, to avoid conflict and duplication which may vitiate the development of other normal service institutions.

Marketing Boards, for one crop or a group of crops, may offer marketing, supply, credit, and extension services. In some countries, particularly for export crops, marketing boards have very effective management. There are two problems with marketing boards providing integrated core services: (1) the danger of duplication of other institutional services, and (2) the neglect of crops not serviced by marketing boards.

Agricultural Development Corporations, like those found in Pakistan and Bangladesh, may function as government corporations providing complete supply services through local cooperatives or merchants. They may also provide some short-term credit in connection with supply sales.

Apex Cooperative Federations may provide comprehensive supply services and marketing and credit services. They may even undertake some extension in the form of sales promotion for certain supply items. These extension activities may duplicate or contradict governmental extension activities.

Agricultural Development Banks may provide, in addition to credit, some extension services in the form of intensive field promotion of credit packages and supervision of farmers with comprehensive loans. Such attention, highly successful in more advanced economies, is usually too expensive for developing countries.

Private Banks usually confine their credit services to larger commercial farmers because of the risk and high administrative costs involved in approving small loans to peasants. If, however, standardization and saturation (pp. 30-31) can reduce these risks and costs, private banks can be an effective means of moving domestic savings into basic agricultural investments.

Agribusinesses, or private corporations applying international financial and technical resources to marketing (particularly processing) and supply, may also be valuable sources of private investment in basic agriculture. In some countries they provide credit and extension with some of the same limitations as governmental bodies.

The Problem of Professional Outreach

To understand the fundamental nature of the institutional development options, consider the typical status of agricultural service institutions in stage 2 (p. 23)—the stage at which most zones of most developing countries now stand. Typically, there is already a full range of central core institutions even in this early stage. Many of them have been operative for years, with central office staffs and professionals in regional, provincial, and perhaps even district branches. At this stage, however, such institutions (with the exception of marketing boards) actually reach only about 1% to 10% of the farmers. Agribusinesses typically work only with substantial commercial farmers. Government supply corporations and cooperatives generally provide modern production inputs to the commercial

farmers and the top 5% of the peasant farmers in scattered communities. Extension services typically work with only the larger farmers who can innovate without credit assistance from the government.

Field staff professionals are reaching only 100-300 farmers each, about the same number that a subprofessional in a highly concentrated area should service. This partially reflects a misapplication of doctrine for capital intensive agriculture (see pp. xix and 25) and the ignoring of certain policy essentials, particularly standardization, integration, saturation, and concentration. It is necessary to expand *professional outreach* through the use of local institutions and subprofessionals.

The Fundamental Options

The specific options for central institutional development require answers to these questions:

1. **Division of Functions.** Which core services should be provided by which institutions?

2. **Degree of Specialization.** To what extent should institutions specialize in certain crops or types of supplies or credit?

3. **Interface with Local Institutions.** How far down the administrative hierarchy should central institutions penetrate, and at what level should they deal with local institutions? Should community cooperatives or other local organizations be federated at the district, the province, or the regional level? Should the agricultural development bank loan money to a provincial cooperative federation, or should its agents approve individual loans at the community level? Should the agricultural development corporation sell to provincial federations, or should it deal with community-level outlets?

LOCAL INSTITUTIONAL OPTIONS

The Long-Term Goal

Central institutions can be organized in a variety of ways which work well. By contrast, there is one superior type of local organization for stage 3 and beyond, namely the multipurpose cooperative illustrated by the Japan-Taiwan-Korea model. The farmers' association, as it is called in the Far East, provides core services for all crops in the community, except for those few which require specialized village-level packing facilities. Extension agents are employees of the farmers' associations with salaries subsidized by the Ministry of Agriculture.

Such an association has clearcut advantages over special-purpose local institutions or community-level branches of central institutions.

Professionalism of Community Management. When e: 'ocal institution earns all the gross margin from providing core services, it can afford to pay professional managers who are close to the community.

Synergistic Incentive to Diversify. Every innovation package can provide revenue to the farmers' association from several sources. If the association promotes new horticultural crops, for example, it may add to its total gross margin by (1) selling seed, (2) selling agricultural chemicals, (3) providing production credit, (4) selling low-lift pumps for irrigation, and (5) marketing the crops with an extra markup for packing services. If the farmers' association promotes hog production, it can increase its total gross margin by (1) medium-term loans for construction of improved pigsties, (2) sale of breeding sows, (3) innoculation of piglets, (4) livestock insurance, (5) mixing and sale of feed, (6) short-term credit for feed, and (7) marketing of hogs.

In this model, the extension service functions as the *sales force* of the local association's money-making branches. Many farmers' associations have found it profitable to add extension agents without government subsidy. Association managers are always on the lookout for suitable innovation packages which can increase gross margin and thus increase the manager's bonus. The farmer-directors on the board of the association encourage their managers to investigate all possible innovations to increase gross margin and the annual membership bonus.

Sellir g Through Planning. Farmers think of these community institutions as *their* associations, and take an active part in policy deliberations and planning. By participating in planning, they learn about the advantages of the innovations which the association decides to promote. Those who participate support the innovations and convince their friends and neighbors to adopt them, thus adding to the association's business.

The advantages of this organizational arrangement are summed up in one vital word: *incentives.* A profound and common impediment to agricultural development efforts is the assignment of responsibilities to units of organization —bureaucratic organization in particular—whose members have little or nothing to gain from a successful peasant development effort.

It can only be noted in passing that the establishment of effective farmers' associations is no simple, speedy undertaking, Cultural factors, social conditions, and political considerations have important effects upon feasibility. Yet time and resources devoted to this sort of effort, whenever it shows the promise of success, will generally yield far greater economic and social returns than attempts to work through ponderous, ill-motivated, and quite frequently incompetent and unsympathetic bureaucracies.

Long-Term Options

Given a decision to work toward multipurpose primary societies on the farmer association model, there are still some options concerning the long-term structure of local institutions.

Level of Primary Society. Should the primary society, the ground-level multipurpose cooperative, be established at a village level to serve 100-200 farmers, at a multi-village level to serve 400-800 farmers, or at a township level to serve 1,000-2,000 farmers? Ideally, the primary society should be established at the level of the farming community (p. 20), the level at which farmers interact easily with each other. In a particular region, depending on the settlement pattern, the farming community may be at the village or multi-village level. Elsewhere farmers may interact only at the market-town or district level.

If interaction at the community level is weak, or if the potential business volume from one community will not provide enough gross margin for professional management, the primary society will have to serve a number of farming communities. The ideal test of location is one which provides ample gross margin while remaining close to the farmers. In some areas this may require a multi-township primary society with village-level branches.

Level of Federation Business. Primary societies may be organized into province- and national-level unions, with perhaps a district- and regional-level organization. The higher echelon at which the federations actually do business will depend on the nature of the crops, their supply and marketing requirements, and their business volume. It will also depend on what central organizations are providing services out of provincial and district branches.

If the primary societies are weak and serve farmers with limited business volume, a strong federation at the district level may be necessary. If the cooperative structure handles milling, ginning, or other processing at the province or sub-province level, a strong province-level federation is necessary. If the cooperative structure has a major central supply responsibility, the central apex cooperative may be a major business enterprise. The degree of farmer control above the district level, however, is tenuous. At the province and national or regional level, a cooperative federation functions much like other parastatal bodies.

Transition Options

The farmer association model is the ideal local institution to serve mixed and even specialized farmers in stages 3 and 4, but it may be grossly premature in

stage 2 (see pp. 23-25). It requires a high volume of local supply and marketing business to provide enough gross margin to maintain a diversified staff. It requires a great deal of discipline, experience, regulation, and guidance. The high initiative of local farmers' associations in the Far East occurs within an extensive framework of regulation and standard procedures and policy guidance.

Under certain circumstances it is possible to start with a complete primary society on the farmer association model. Malaysia launched such primary societies at the township level by assigning a team of four to five fully trained professionals to each association for a few years. Malaysia could do this because (1) it had ample trained manpower; (2) it had ample financial resources; (3) ecological differences meant that each township could constitute a separate zone; (4) many farmers were ready to move into advanced innovation packages such as horticulture and small livestock; and (5) local organizations had experienced success in managing brick-and-mortar development projects. Lacking some or all of these conditions, a country would be advised to start the development of local institutions more modestly.

There are several ways to begin modest local institutional development.

Start with One or Two Functions. Primary societies might begin with supply business only, while direct agents of the banks provide credit and local merchants provide marketing (as in Thailand). Or primary societies might start with marketing, as buying stations, or with a modest supply activity such as seed distribution (as in Uganda).

Start with Private Agents for Some Functions. In Bangladesh, the township-level primary societies developed substantial local control of extension while local merchants handled supply functions as agents of the agricultural development corporation.

Start with All Functions on a Single Package. This was successfully done in Senegal with a very strong basic agricultural project applying all six policy essentials.

Start with a District-Level Society Federating Township-Level Clubs. District-level business functions can later be delegated to lower-level primary societies. Thailand established its farmer organizations in this manner.

The initiation of primary societies requires strong *personal* direction by teams of government officials. Gradually the government controls can become

more impersonal, with policy guidelines and regulations providing a framework for local initiative.

Alternate ways of starting primary societies are not mutually exclusive. The best strategy may combine elements of several options.

CHOOSING AMONG INSTITUTIONAL OPTIONS

Principles

A number of criteria can be applied to guide policy on institutional options.

Maintain Consistency with the Six Policy Essentials. Analysis, standardization, integration, saturation, concentration, and acceleration are necessary. No organizational arrangement should conflict with these points, at least in stages 2 and 3.

Keep to the Long-Range Goal of Multipurpose Primary Societies. As a temporary or transitional arrangement, other institutions can provide services at the local level.

Avoid Over-Specialization. One-crop marketing, supply, credit, or extension arrangements should be avoided at the local level unless the technical nature of the crop makes use of multipurpose staff and facilities clearly impossible.

Avoid Duplication, Particularly by Default. Credit, supply, or marketing institutions will often argue that, although in theory the extension service is supposed to be acting as their promoter or sales force, it is not doing so; and these institutions therefore need their own extension field staff. Extension services very often fail to "do the job" because of missing policy essentials. A competing extension service is not going to compensate for this.

Maintain Discipline. In agricultural development, the lack of discipline leads to a failure to get work done in the field, to have the real situation reported, and to have required conditions of government assistance to farmers enforced. To help eliminate this problem, services should be provided by organizations which are free to hire, fire, transfer, promote, and demote on the basis of effective performance.

Minimize Organizational Change. Change is the essence of development, but unstable organization can impede development. Basic agricultural development

should be launched with as little change as possible from the current organizational structure. As long as consistency with the six policy essentials is maintained, other changes should be avoided as long as possible.

Minimize Costs. Where two alternative options meet the above criteria equally well, the more economical arrangement should be adopted.

Procedure

Basic policy decisions cannot be made zone-by-zone; they must be at least regional and preferably national in scope. Policy decisions should be structured by stage, with different policies for stage 2, 3, and 4 programs (pp. 23-25). Policies appropriate to one stage may be inappropriate for another.

Securing approval of policy decisions on institutional options is difficult. Power, careers, and jobs are often at stake, and opposition may be tenacious.

Two general tactics can help avoid delays over jurisdictional disputes:

1. **Pilot-Test Organizational Modifications.** New organizational arrangements often require high-level decrees or legislation. Small experimental operations can often be carried out without such authorization. Rather than establish a new parastatal body, for example, a government department can set up an "informal" local branch of such a body using departmental staff. This follows the general principle of using a pilot project to gain acceptance of policy essentials (pp. 36-38).

2. **Settle for Second-Best.** A second-best organizational structure can work provided it does not violate any of the policy essentials. Staff officials charting a basic agricultural program should be ready to compromise on organizational matters to avoid delays over jurisdictional disputes.

The Decision Matrix Technique

Below is a sample of a decision matrix analysis of a typical issue which might arise on a project based on the package in Table 6.4. Assume that there is already a network of coops marketing cotton. The package requires a food crop marketing network as well. How should additional food cash crops be marketed? Should a food marketing board be established, should the coops sell to private merchants, or should the coop network handle the food crop marketing itself?

A number of factors should be considered, including relative quality of personnel and facilities, relative economy, and relative ability to meet changing conditions. Set up a table with a column for each alternative option and a line for each criterion. Then judge each option against each criterion. If an option should

be given favorable consideration, rate it +1. If an option should be given very strong consideration, rate it +2. Conversely, if an option should be given unfavorable consideration, rate it -1 or -2.

TABLE 7.1 DECISION MATRIX ANALYSIS SAMPLE

	Alternative Marketing Channels				
	Township Coop Society		Province Coop Union		National Coop Federation
Criteria	To Pvt*	To MB*	To Pvt	To MB	
Experienced Field Personnel	+1	-1	0	0	-1
Experienced Top Management	+2	-1	-1	0	-2
Economies of Volume Trading	-2	0	+1	+1	+1
Flexibility (especially on prices)	+2	0	+1	0	-1
Appropriate Talents	-1	0	+2	+1	0
Logistical Facilities	0	-1	+1	+2	0
Option Chosen			x		

*Pvt: private merchants; MB: marketing board

There will usually be a clear pattern: one option will appear to satisfy most criteria better than the others. In the above example, the township coop societies would sell to the provincial coop unions, which in turn sell food crops to private merchants (perhaps on a fixed commission basis, rebating to the societies and the farmers any extra profit made).

The decision matrix is particularly useful as a group exercise. After discussion, there will tend to be consensus on individual ratings. If a strong pattern emerges, there will be consensus on the choice.

When a strong pattern does not emerge, the choice has to be somewhat arbitrary. The matrix can then be submitted to a higher authority with appropriate notes explaining the ratings.

PHASING

Spans of Development

How much should a project seek to transform an average farm in one year? Using Table 6.4 as the basis of a project, it appears that the average farm can be moved from stage 1 to stage 3 (see pp. 22-25) in a year. But it is possible that this kind of package first requires some intermediate stage of development.

Assuming that adaptive research supports a stage 3 package, the option is whether to skip stage 2. These options can be broken down further, into choices between "light" and "heavy" packages. The light package (stage 2a) might consist of a few inputs on one crop only. The heavy package (stage 2b) might consist of several inputs and improved practices on several crops. In stage 3, there might initially be a light package using improved equipment to address the principal bottleneck.

Another option suggests that farmers initially apply the package to a fraction of their crop. A project might be based on a planned two- to four-year transition by a group of individual farmers from the old to the new system. Such a gradual transformation considerably reduces the perceived risks of innovation.

The basic issue in a phasing decision is the trade-off of project simplicity against potential income gains. The faster the project moves, the greater the potential income--and the greater the risk that complexity will overwhelm the project staff or farmers. A wide variety of factors must be examined. After a detailed consideration of the data, the final decision might be explored and assessed through the use of a decision matrix.

Package Phasing Analysis

Table 7.2 shows how a package for zone Y may be broken down into subpackages. The package in Tables 5.1 (p. 64) and 6.4 (pp. 93-95) can be split into three alternative subpackages. The table lists the data necessary for a decision about phasing options. The packages are as follows:

Package A (stage 2a): Fertilization and spraying of existing cotton acreage

Package B (stage 2b): Improved practices on existing cotton and peanut acreage, including improved peanut seed and planting in rows plus commercial marketing of peanuts

Package C (stage 3): Expanded acreage through ox plowing and weeding, plus improved practices and inputs on four main crops

To analyze potential phasing options, first examine the packages from the farmer's point of view to determine which are *financially feasible* and *financially attractive*. Then examine them from the point of view of the servicing institutions to see what difficulties and expenses are involved in servicing them.

Financial Feasibility. The key question is: will the increased cash earned as a result of a package cover the necessary repayment, even if yields are reduced due to lack of rain, etc.? In Table 7.2, line 8 indicates that all three packages promise to yield substantial cash after repayment. Package C has less cash-after-repayment

TABLE 7.2 PACKAGE PHASING ANALYSIS FOR ZONE Y

			Package A		Package B		Package C	
1	Crops innovated (and ares)		Cotton	75	Cotton	75	Cotton	133
					Peanuts	30	Peanuts	74
							Millet	50
							Maize	38
	Total			75		105		295
	Package Costs							
2	Seasonal Production Loans			$13		$20		$ 51
3	Medium-Term Loans							240
4	Amortization on Medium-Term Loans							38
5	Maximum Annual Repayment			13		25*		131
	Income Realized from the Package**							
6	Gross Increased Income			25		46		215
7	Net After Costs and Amortization			12		26		126
8	Net After Maximum Repayment			12		21		84
9	Increase in Total Cash Income		*15%*		*30%*		*250%*	
	New Practices Required							
10	Yield-	Fertilizer	X		X		X	
11	Raisers	Pesticide	X		X		X	
12		Row Planting			X		X	
13		New Timing					X	
14	Bottle-	Spray pump	X		X		X	
15	neck	Ox plow					X	
16	Breakers	Seeder-weeder					X	
	New Services							
17	Supply	Chemicals	X		X		X	
18		Spray pumps	X		X		X	
19		Ox equipment					X	
20	Marketing	Principal crop	X		X		X	
21		Secondary crops			X		X	
22		Special Storage‡					X	
23		Milling‡					X	
24	Credit	Short-term	X		X		X	
25		Medium-term					X	
	Field Agent Requirements							
26	Peak	Activity	Loan		Planting		Ox training	
27	Season		application		supervision		followup	
28		Duration	5 weeks		6 weeks		4 weeks	
29		Clients/day	30		10		6	
30		Maximum clients	750		300		120	
31	Other activity of field agents				20 weeks		40 weeks	
32	Type of agent required		Part-time e.g., Teachers		Full-time Monitors		Full-time Monitors	
	Primary Society Gross Margin							
33	Per 100	Marketing @ 2½%	$ 225		$307		$750	
34	Growers	Supply @ 3%	40		60		150	
35		Total per 100 growers	$ 265		$367		$900	
36	Growers required per $3000 gross margin		1,160		820		330	

Sources: Tables 5.1 and 9.1

*Includes 1 pump @ $10 per 2 growers.

**Over $84 present zone Y cash income for maize.

‡For maize.

relative to the maximum annual repayment, but it still promises to generate sufficient cash to make the proposed investment sound.

Financial Attractiveness. Is the increase in total cash income (line 9) big enough to attract farmers? Packages B and C are, but package A is questionable. A 15% increase in total cash income may not be sufficient. Farmers who first adopt the package will not make enough additional income to be visibly better off than before. Package A is, however, based on a cotton yield increase of 40%, which will be highly visible (Table 5.1).

New Practices. Package A requires only the application of agricultural chemicals. Package B also requires planting in rows, a new technique for this zone. Package C requires a whole range of new skills, and involves an intensive training effort over a short period of time (lines 10-16).

New Services. Packages A and B have many of the same requirements, except that package B involves marketing of a secondary crop. Because this brings in off-season business, it can facilitate the development of primary societies. Package C also requires equipment sales and service, special handling of the maize crop in storage, maize milling, and medium-term credit (lines 17-25).

Field Agent Requirements. How many farmer-level field agents does a package require, and how much training do they need? A fuller analysis of this problem is presented in chapter 11. Lines 26-32 of Table 7.2 illustrate a preliminary analysis which should be sufficient at this stage of decision making.

1. **Peak Season Activity.** What activity requires the agent to spend the most time with each farmer or small group of farmers (lines 26-28)?

2. **Adopter Ratio.** How many farmers can one agent serve in a season? This depends on the duration of the season (line 28) and the number of farmers an agent can service per day during that season. Package A has the lightest requirement; meeting 30 farmers a day in small groups, an agent can fill out the loan applications for 750 farmers during the five weeks of the loan-application season. By contrast, an agent working on package C can only service about 120 farmers in a season (lines 29-30).

3. **Type of Agent.** Could the package be promoted by part-time workers or volunteers? This depends on how many weeks a year an agent must work with the farmers (line 31). Package A, involving only easy-to-apply inputs, requires no work other than during the loan application season. It can be handled by

part-time workers. Package B requires more careful and timely spraying, row planting, and loan application. Full-time workers are required. Package C also requires full-time workers.

Size of Primary Society. How many adopters does a package require to make a primary society self-sufficient with a professional manager? This depends on the gross margin the package can generate (lines 33-35) and the minimum gross margin needed for self-sufficient operation. Making a rough assumption that a primary society needs a $3,000 gross margin, there is a big difference between packages (line 36). Packages A and B would require involvement of almost half the farmers in a township if a society is to be self-sufficient. Package C provides enough gross margin to operate a primary society with the farmers of two villages.

Final Decision. Which package should country X choose for zone Y and its region? How much of a span should it undertake initially? Package A has the advantage of not requiring full-time monitors, but compared to package B it has the disadvantage of low increase in total cash income.

Other elements may enter into the decision. Is the existing professional staff capable of handling package B or package C? Is an adequate budget available for the more complete packages? Is adequate credit available? Is there a political or economic advantage in getting a modest package adopted more quickly? Or do the overall political and economic considerations favor the package that produces substantially more income over a few more years? Once the basic analyses are done, these questions merit high-level attention.

PROMOTION STRATEGY

Consider the following questions:

What is necessary to *sell* the package, to convince farmers to adopt it?

What is necessary to *train* farmers in the skills required by the package?

What is necessary to get farmers to *market* their crops through the primary society?

Sales

Demonstration is one key to selling innovation in agriculture. The issues to be decided regarding demonstration are:

Proximity. Must demonstrations be in farmers' villages, or can they be conducted in a central location?

Seasonality. Can demonstrations be conducted in the normal cropping season to fit in with the timing of the campaign, or must they be off-season?

Attendance Incentives. What measures must be taken to assure that a substantial number of farmers witness the demonstration?

Content. What are the key points to be emphasized?

A package must be carefully analyzed to determine the points on which the farmers need the most convincing. First, what *results* must the farmers see? If they see a mature stand of maize, will they be sufficiently impressed, or must they witness the harvesting and weighing of the yield? Second, what *practices* may be the hardest to accept, either because farmers doubt their feasibility or because they fear they will be too time-consuming? The new package must be considered in relation to the farmers' present practices and past experience with innovation.

In the actual region on which zone Y is based, for example, the farmers were convinced that the input recommendations were profitable by looking at a mature crop. Their main reservation regarding the use of ox equipment was the feasibility of sowing millet in rows so it could be weeded by oxen. Millet was considered the most unlikely crop for row planting.

The demonstration field day had to be somewhat out of season. When certain crops were mature, special plots had to be planted late to demonstrate the advantages of millet weeding, and other plots had to be plowed and seeded out of season at the same site. Irrigation was unnecessary, and the demonstration could be conducted at a farm close to the primary society warehouse.

In principle, most farmers might be expected to attend a demonstration. In practice, often only a small fraction of the farmers arrive. In some countries local chiefs can compel full attendance. Where they cannot, consideration should be given to providing entertainment and refreshments.

Use of Nonagricultural Officials (see p. 32) is related to this issue. Local administrative officials should be organized as part of the sales force.

Brochures and Radio and billboard advertising can be useful sales adjuncts to demonstration, provided their message is based on the specific package for the zone.

Subsidy may be a necessary sales element. The first adopters in a community may merit special compensation for their risks in the form of a subsidy on the

inputs. Too often, however, subsidies tend to become permanent, outliving their usefulness and inhibiting the spread of innovation. Funds available for subsidy are usually insufficient to serve the needs of more than a few farmers. Those who do not receive the subsidy feel cheated if they have to pay the full price. The temporary nature of the subsidy should be clearly presented.

In a few cases a permanent subsidy is justified to equalize transportation costs of inputs or to increase production of badly needed export crops. When subsidies are used to encourage innovation, however, they should be cut off once substantial profit results from the innovation.

Subsequent Year demonstration can be sharply reduced once a nucleus of farmers in a village is regularly applying the innovation package.

Training

It is important to realize that ideas are more effective if they come from the farmers themselves. The field agent must guide the farmers until they discover the essential points. He must ask questions that lead them to define the essential needs and problems, and then demonstrate solutions and ask questions that lead them to state the solution.

Within each phase of training there should first be a *presentation* of the training points—the skills and understandings of that phase—and then a *followup*. The agent can generally make the presentation to a group of farmers. If skills are involved in the phase, each farmer must get a chance to use the tools and equipment during the presentation session. The group must be small, with a site prepared for the training.

Farmers only partially acquire skills and understandings in the presentation session. They sometimes use the equipment in the wrong manner, do not perform simple practices, or are late in their timing. If the package is simple, local volunteers may be able to handle some of the followup.

The agent, however, may have to spend time with each farmer. It is often useful to work with a group in a followup, to show a farmer a neighboring field which has been well prepared, for example.

Followup requirements are hard to predict. Training points which appear simple to professionals can prove difficult for farmers to acquire. Professionals must stay close to the followup during the point phase of a project (p. 32) to learn how much and what kind of followup is necessary.

Marketing

An important function of an innovation package as a catalyst of development institutions is to get farmers to market their crops through a local cooperative. While in the long run a multipurpose cooperative can be a highly efficient marketing channel, it often has a great deal of trouble getting a share of the farmers' marketing business because local merchants often give better prices and service.

Fledgling cooperatives find themselves unable to compete because of lack of *volume*, lack of *pricing flexibility*, and lack of *competent management*. A certain minimum volume—a full truckload at the collection point—is needed for efficient marketing, to give the farmers a competitive price. If a cooperative starts with only a handful of members, a full truckload may not be forthcoming from the participating growers.

Some countries have attempted to solve this problem by giving cooperatives a marketing monopoly on certain crops. This can work if the crop is primarily for export, and if the central institution handling the marketing operates efficiently.

If the crop is largely for local consumption, however, such a monopoly is almost impossible to enforce. Monopoly, moreover, may encourage inefficiency, giving the farmer generally poorer prices than he would get from competing merchants. Good service and good management are better assurances of adequate volume.

The problem of pricing flexibility is more complex. Local cooperatives are often required to buy and sell at prices fixed by central institutions. These prices are often set only once a year, and central institutions are rarely able to respond to the week-to-week changes in market conditions. Yet managers of fledgling cooperatives are often themselves too inexperienced to buy and sell at the right price.

The whole problem of cooperative marketing raises difficult policy issues. Given resources and organizational competence, the government can help in the point and line phases by arranging for direct marketing and eliminating middlemen. It can cause government institutions to procure directly from new cooperatives, giving them more margin for error. It can provide essential marketing information. It can furnish loans for storage facilities so that associations can hold crops off the market to obtain better prices. It can provide equipment and equipment loans so that associations can do a better job of milling.

A variety of measures are necessary to enable new cooperatives to capture an adequate share of the market.

DISCIPLINE

Economically sound projects may fail because:

Local farmer leadership may limit participation to a small closed circle.

Local farmer leadership may select a well-connected, incompetent manager who neglects or abuses his responsibilities.

Field staff and primary society leadership may be unwilling to ask delinquent borrowers for repayment.

Farmers may not apply the appropriate practices.

Farmers may misuse loans.

Principles of Agricultural Development Discipline

Explicit Rules. The rules regarding the selection and removal of managers, eligibility for participation, minimum participation, and action against delinquent borrowers must be clearly written and carefully explained from the start.

Independent Spot-Checking. Someone from outside the community must spot-check the performance of the farmers who receive government assistance or loans. Field agents can then make honest reports while maintaining rapport with the community.

Group Sanction. Community pressure is the most effective source of discipline. If everyone suffers a modest penalty because one has misperformed, each will apply pressure to a potential delinquent to get him to perform.

Performance Incentive. Communities which perform well should get a small bonus in the way of additional loan funds. Communities which perform below standard should similarly get a small penalty. The prospect of more development for more people in the community can be a powerful incentive.

Individual Farmer Discipline

The key discipline problem with individual farmers is repayment of loans. The best means of discipline is group or community pressure. It is sometimes useful to have a group of 10 to 25 farmers cosign each other's loans. If one farmer defaults, the rest are denied further credit. Such a small borrower-group can serve as a good point of contact in a village for field agents. It can also work as a mutual aid group: if one farmer is in danger of delinquency because of an accident or

illness, his cosigners will be inclined to help him.

Broader community penalties may not be satisfactory. A bank or agency may threaten to cut off credit if every loan is not repaid on time, but such a threat is not credible. Should a government cease development activities in a whole farming community, thus losing the resulting increased revenue, because a few farmers are in default? Small sanctions are more credible.

Other performance aspects are related to repayment. If a farmer clearly cannot repay a loan because of weather conditions, after having followed the recommended practices, his loan should be extended. If it is clear that he did not follow the recommended program and thus did not generate enough income, the loan should not be extended.

Management Discipline

Certain governmental standards of manager performance must be set as a condition for community assistance. The communities into which the zone project is first introduced should be those which have the better managers. If farmers see that good primary society management can lead to more governmental assistance, they will tend to select their managers with more businesslike criteria. A good manager might be rewarded with a bonus based on the profit or gross margin of the society.

Participation Discipline

The leadership of a farming community is generally composed of farmers who have substantially more land under cultivation than the average farmer. They are still part of the peasant community, but they generally work much or most of their land with hired labor. If asked what local farmers need most, they are likely to refer to credit to hire labor or buy more land, although the average farmer has no such need. Most government agents and institutions deal with these farmers almost exclusively in stage 1.

Where credit resources are scarce, community leaders are the first to receive assistance. Even as resources expand, the leadership is often unwilling to allow large numbers of farmers to participate in development activities. They may exclude smaller farmers from coop membership or from loans, arguing that they are too small to be financially responsible. Or, they may allow only members of their village factions to participate.

The government must, therefore, enforce rules that will lead to mass participation. In the point and line stages it must require that some of the participants be average-size farmers. In the point stage, community leaders may want to participate to the exclusion of others. But the average-size farmer is the relevant example for most of the members of the community.

Motivation, Discipline, and Social Structure

In dealing with problems of motivation and discipline, it is essential to consider traditional patterns of authority and communication. Some LDC societies are highly centralized. Nothing happens in the village except by order handed down through the province, district, township, and village chiefs, even where the incentive is obvious.

In other societies, communities have a high degree of internal autonomy. The district chief knows that he can get nothing done in a village until a consensus is reached.

Whatever the traditional structure, communication should follow the principle of saturation (see page 31). The project leadership must convince the local leadership and individual farmers, no matter what the pattern of authority and communication. At the same time, project leadership must carefully observe the traditional protocol of local communication.

8
Project Outputs

The next step in the planning process is to determine how fast the project can get results. How many farmers can be persuaded and supported to adopt the standard package of innovations each year? How fast can all suitable farms in the zone be improved, and what will be the yearly increase in production and income?

The usual first assumption is that the quantity of outputs depends on the quantity of inputs—that results achieved depend on resources made available. In basic agriculture, however, the binding constraint on the speed of results is more likely to be a complex set of behavioral and administrative factors. Therefore, it is more efficient to set the pace of the project initially on the basis of these constraints rather than on resources available. (The reader may wish to refer to Table 3.1 [p. 35] for an overview of this procedure.)

PACE OF ADOPTION

Behavioral Assumptions

If a sound improvement package is properly presented, supported with all the necessary services and resources, how many farmers will want to adopt it each year?

To answer this question consider why farmers might resist innovation, why farmers might be motivated to adopt innovation, and how the interplay of resistance and motivation might work to set the pace of adoption.

Resistance. Subsistence and subsistence-mixed farmers often exhibit resistance to seemingly attractive innovations. Sources of this resistance include:

1. **Mistrust.** Farmers are highly skeptical about suggestions from government agents until those agents have proven themselves. Government extension agents, or agents of parastatal bodies or private agribusinesses, are outsiders. The degree of mistrust varies from country to country and from culture to culture. In some cultures farmers will try whatever an educated person suggests, provided the suggestions are presented logically. Past experience with innovation is a major factor. Successful development gradually builds up confidence, rapport, and receptivity.

2. **Lack of Self-Confidence.** A farmer who has not been involved in innovation often lacks confidence in his ability to participate.

3. **Fear of Disturbing the Present Farming System.** Most farmers find that at certain times of the year their physical ability to do the necessary work is exhausted. New methods usually appear to require extra work, even if on the whole they save labor. Subsistence farmers fear that this may interfere with work on basic crops.

4. **Fear of Losing Leisure.** During many months of the year the average farmer devotes less than half his time to principal crops. He often uses this time for semi-leisure activities, such as hunting, fishing, and foraging. These activities are often enjoyable and comprise an important part of his social life. An improvement program is likely to cut heavily into the time available for such activity.

5. **Contentment.** Poverty does not automatically mean mass discontent. A farmer whose income is normal for his community is usually content and he feels that his present performance as a farmer is respectable.

Motivation. If a community is not severely isolated from the outside world, some farmers will not be content with their present income. Generally, these farmers have had some reason to expect that they might be making more money. Such farmers have the self-confidence and discontent to take risks that the community generally fears. They can form the nucleus of innovators—the first 10-50 farmers in a community who, seeing a demonstration of the package, will ask for assistance.

Pattern of Adoption. The success of this nucleus will have three effects on the community. First, it will remove much of the skepticism and fear. Second, it will give others confidence. Third, it will upset the social equilibrium of the community enough to cause some useful discontent. This should cause a multiplier effect: for every previous innovator, some friends and neighbors will want to try the innovation.

If the government provides the community with adequate resources and services to extend the innovation package on a multiplier basis, the effect will continue. By the third or fourth year the innovation package will become acceptable. It will set a new pattern of living standards and work habits in the community.

Computation

In order to compute the number of farmers in the average community who are likely to adopt the package each year, information about three facts is needed:

1. **Nucleus:** the number of adopters in the first year
2. **Multiplier:** the number of new adopters recruited each year *per* adopter to date (taken as a constant)
3. **Maximum:** the total number of suitable farms

To illustrate, assume a nucleus of 25, a multiplier of 3, and a maximum of 400:

	New Adopters	Total to Date
First year	25	+ 0 = 25
Second year	25 x 3 = 75	+ 25 = 100
Third year	100 x 3 = 300	+ 100 = 400

In order to get the number of "new" adopters in the second and third year, multiply the "total-to-date" adopters of the previous year by the multiplier. The number of new adopters to date can, of course, never exceed the maximum, i.e., the total number of farmers in a community to whom the package is suited.

If the value of the nucleus is dropped to 10, the following occurs:

	New Adopters	Total to Date
First year	nucleus = 10	+ 0 = 10
Second year	10 x 3 = 30	+ 10 = 40
Third year	40 x 3 = 120	+ 40 = 160
Fourth year	160 x 3 = ~~480~~	+ 160 = ~~640~~
	400 - 160 = 240	Maximum = 400

With a smaller nucleus or multiplier, the rate of adoption gets off to a slow start, but it takes only a year or two longer to cover the whole community. If an innovation is sound for a community, it will spread within three or four years.

Sources of Estimates

How can the nucleus, the multiplier, and the maximum adoption be estimated for the average farming community of a zone?

The *maximum* is based on the most solid data. Begin with the number of farms and the number of farming communities in the zone (p. 46 and 110). For zone Y, assume that there are about 32,000 farms within about 80 farming communities, each served or potentially served by a primary society.

Some sample statistics have been gathered on the distribution of these farms by size and other characteristics (p. 45 and p. 48). Eliminate those farms for which the package is of doubtful application—those which are too small or purely subsistence. Even in a subsistence-mixed or mixed community, some farms cannot be developed further because they are farmed by young men still clearing ground for subsistence crops or by elderly people growing only their minimum food requirement. An alternative way of estimating the maximum is to take farms within one standard deviation of the mean of the key characteristic (p. 45). For zone Y, a maximum of 300 remains out of 400 farms in the average community.

The *nucleus* and the *multiplier* must initially be based on guesswork. Perhaps some previous campaigns in the country or region will give some indication of what might be expected. As the point and line phases of the pilot project in the region are completed, planners may obtain some solid indications of these values. Meanwhile, a multiplier value of 3 and a nucleus value of 5-10% of the maximum are safe figures for planning purposes. The more simple the innovation package, the higher will be the nucleus relative to the maximum. The size of the multiplier will likewise depend on the simplicity and the relative profitability of the innovation package. For a package like zone Y, a nucleus of 20 and a multiplier of 3 is a reasonably safe assumption.

EXERCISE

Compute the pace of adoption for the following sets of factors:

	Nucleus	Multiplier	Maximum
1)	15	5	1,200
2)	20	3	400
3)	30	2	600
4)	30	4	700
5)	40	3	400

PACE OF EXPANSION

The Basic Problem

In the early stages of a project, the best available talent must be on hand to cope with unforeseen problems. Gradually this talent learns how to improve the plan and to set policies which will reduce the unexpected and permit lower level technical staff and monitors to cope adequately.

This is the major feature of *limited administrative capacity:* the limited amount of talent and institutions in a developing country to administer large-scale projects reaching thousands of farmers. Time is needed to work into the job gradually, to make mistakes on a small scale and to rectify them quickly, to document experience, and to learn how to give adequate guidance to the field staffs.

Another aspect of limited administrative capacity is the inability of supervisory, technical, and subordinate staff to handle a variety of activities simultaneously. Initially a professional at the district level should be expected to supervise a comprehensive project in only one township. A professional at the township level should only be expected to supervise in one community. Although a monitor can handle 100-300 farmers when he gains some experience, initially he should only be expected to service a nucleus of farmers. The number of subordinates and subunits can be increased gradually.

Finally, there is the problem of inadequate numbers of field staff. Many developing countries have training institutions which are only gradually turning out enough professionals to fill the vacancies in all the districts and townships.

The Pace of Expansion for Zone Y

Use zone Y to illustrate how to plan within these limitations. This zone has 32,000 farms in 160 villages, 80 farming communities, and 16 townships, spread over four districts. Applying the point-line-network approach, start the project in one district, one township, one primary society, with a nucleus of 20 farmers.

Expand to the line phase during the second year by launching the project into four districts. Every district-level officer will now be responsible for one new township having one new primary society in the project.

	Year 1	Year 2
Districts covered	1	4
Townships covered	1	4
Primary Societies in Phase A	1	4
Primary Societies in Phase B		1
	1	5

To avoid confusion with the project year, consider the phases to which the farming communities (in this case the primary societies) are advancing. The pace of adoption for zone Y is based on a nucleus of 20 and a multiplier of 3. Thus, the first primary society has 20 participating farmers (i.e., 20 improved growers) in phase A in year 1 of the project. In year 2 of the project, this group advances to phase B, with 20 x 30 = 60 new participating farmers, bringing its total improved growers to 80. The four new primary societies which have been launched into the project are still in phase A, with 20 improved growers in each. The officer in charge of the first district is now supervising two primary societies, while the officers in the other districts are supervising one primary society each.

The line phase of the project is now completed. How is the project expanded further? In year 3 add 16 new primary societies, one for every township in the zone. Every agricultural assistant in charge of a township will be involved in the project. Those who started in year 2 will be supervising two primary societies each; the one who started in year 1 will be supervising three primary societies.

		Year 1	Year 2	Year 3
Districts covered		1	4	4
Townships covered		1	4	16
Primary	in phase A	1	4	16
Societies	in phase B		1	4
covered	in phase C			1
		1	5	21

The primary society that was lauched in year 1 into phase A has reached phase C. How many participating improved growers does it have? Review the pace of adoption for zone Y:

			Phase A				Phase B				Phase C	
Nucleus	=	20										
Multiplier	=	3	New	Total			New	Total			New	Total
Maximum	=	300	20	20	x 3	=	60	80	x 3	=	~~240~~	~~320~~
											220	300

How many improved growers have been reached by year 3 of the project?

			Year 1	Year 2	Year 3
	Phase A	20 x	1 = 20	4 = 80	16 = 320
	Phase B	60 x		1 = 60	4 = 240
	Phase C	220 x			1 = 220
Total primary societies			1	5	21
Improved growers in year			20	140	780
Plus previous year total			+ 0	+ 20	+160
Total improved growers to date			20	160	940

This computation provides the first output figure the coverage of clients (pp. 5-8). By multiplying the pace-of-adoption coefficients (the number of new improved growers in each phase in one average community) for each stage by the number of communities in each stage, the total number of new improved growers brought into the project each year is projected.

In year 4, 32 new primary societies, two for each township, can be launched. By this time all district- and township-level officers have had enough experience to handle the new load. By the end of year 4, 1 + 4 + 16 + 32 = 53 out of 80 communities of the zone are involved in the project. The remaining 80 - 53 = 27 communities can be launched in the fifth year.

		Year 1	Year 2	Year 3	Year 4	Year 5
Districts covered		1	4	4	4	4
Townships covered		1	4	16	16	16
Primary	Phase A	1	4	16	32	27
Societies	Phase B		1	4	16	32
covered	Phase C			1	4	16
	Phase C+				1	5
		1	5	21	53	80

Phase C+ simply indicates that the project has reached its objective and has been completed for those primary societies. They continue to have the same number of *total* improved growers as in phase C, but they have zero *new* improved growers. To illustrate, compute the number of new and total improved growers in year 5.

Standard Pace of Adoption			Year 5:	Primary	Improved Growers	
Phase	New	Total		Societies	New	Total
A	20	20		x 27 =	540	540
B	60	80		x 32 =	1920	2560
C	220	300		x 16 =	3520	4800
C+	0	300		x 5 =		1500
				80	5980	9400

The last years of the project can now be plotted.

Primary Societies							
Phase	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
A	1	4	16	32	27		
B		1	4	16	32	27	
C			1	4	16	32	27
C+				1	5	21	53
	1	5	21	53	80	80	80

In year 8 there is no further project activity: all communities are in phase C+. By the end of year 7 the project has reached its stated objective of getting all suitable growers in the zone to adopt the improvement package.

The line for phase A defines the pace of expansion for any project. The pace of expansion for the zone Y project may be defined as 1–4–16–32–27, the number of primary societies or communities launched into phase A of the project in each year.

Role and Variations

Two key decisions of the project plan are the pace of adoption and the pace of expansion. From these two factors the number of improved growers to be reached by the project in any year and the *pace of the project* can be determined.

By the same token, if there is a need to change the level or pace of inputs or outputs, it *must* be done by changing one or both of these pacing factors. If the project plan is to have logic and coherence, the inputs and outputs have to be derived from the pacing factors.

Consider some variations on the pace of the project set:

1. Suppose that instead of package C (p. 115), packages A or B were promoted. If the need was urgent, the project's pace of expansion could be 4–32–44, telescoping point and line (with some risk), going in year 2 into two primary societies in each township, and launching almost three primary societies in each township in year 3.

		Year 1	Year 2	Year 3	Year 4	Year 5
Primary	Phase A	4	32	44		
Societies	Phase B		4	32	44	
covered	Phase C			4	32	44

2. The 1–4–16–32–27 pace of expansion has a relatively high peak of activity the fourth year. For budgetary and administrative reasons it might be better to continue moving more gradually, putting off the peak to the last year, with a pace of expansion 1–4–16–24–35.

In the fourth year, instead of expanding to two societies in each township, the project will expand to two societies in half the townships and one society in the other half.

3. The Ministry of Finance might request a cutback in the project, requiring more years to achieve completion. The pace of expansion might then be 1–4–16–24–24–11, taking an extra year to launch all the primary societies and an extra year to complete them.

Phase	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Phase A	1	4	16	24	24	11		
Phase B		1	4	16	24	24	11	
Phase C			1	4	16	24	24	11

The number of years it takes to complete a project is always equal to the number of years required to launch all communities, plus the number of phases per community, minus one.[1] In the above case: 6 years to launch communities + 3 phases - 1 = 8.

4. If more years are needed, the pace of adoption can also be slowed.

1. The minus 1 adjusts for the last phase where the stipulated maximum of farms served by the project is less than the logic of the pace of adoption would support.

By adapting the pace of expansion and pace of adoption, the length of the project can vary from five to nine years. Even if a zone is much larger, the duration of the project will be within the same range.

Suppose, for example, the zone was three times the size of zone Y with 12 districts, 48 townships, and 240 communities. All the districts could not be covered in the line phase, but otherwise the logic would proceed the same as in the initial example, taking only one year longer: 2–6–12–48–96–76. In the third year it covers all districts, in the fourth year all townships, in the fifth year two per township, and in the sixth year the balance.

In every example of a pace of expansion, the expansion of the number of communities launched each year is defined in terms of some simple formula related to the number of administrative units. The formula might be one per district, or one per township, or one and one-half or two per township, or even three per township. In the last year, an odd number is reached representing the balance.

Regional Program Pacing

A zone project should be part of a regionwide or nationwide basic agricultural program. Suppose that zone Y is a part of a region consisting of ten zones. These zones may differ in cropping calendar, average acreages, fertility, present and potential yields, and recommended improvements; but assume that they all have the same principal cash and food crops and the same general type of recommended package. Assume also that each has a pace of adoption of three phases and a pace of expansion of five years—a seven-year duration of project.

It is probably best to begin with only one pilot project in the region the first year, the point phase for the region. In the second year, the line phase, expand to three additional zones. In the third year, expand the program to the remaining six zones. The regional program would then cover a span of nine years.

Year:	1	2	3	4	5	6	7	8	9
1 point zone	[––	––	––	––	––	––	–]		
3 line zones		[––	––	––	––	––	––	–]	
6 network zones			[–	––	––	––	––	––	–]

COMPUTING THE OUTPUTS

A Simple Example

All project output estimates are determined by the project pace. Take an example where the pace of adoption is based on a nucleus of 10, a multiplier of 4,

and a maximum of 250: 10 new/10 total in phase A, 40 new/50 total in phase B, and 200 new/250 total in phase C. The pace of expansion is 1–4–20. The number of communities and improved growers may be calculated as follows:

Phase	PoA*	Year 1	Year 2	Year 3	Year 4	Year 5
A	10	x 1 = 10	x 4 = 40	x 20 = 200		
B	40		x 1 = 40	x 4 = 160	x 20 = 800	
C	200			x 1 = 200	x 4 = 800	x 20 = 4000
New improved growers		10	80	560	1600	4000
(+ previous total)		(+ 0)	(+10)	(+ 90)	(+ 650)	(+2250)
Total improved growers		10	90	650	2250	6250

*Pace of Adoption

Multiply the number of new improved growers per community for each phase by the number of communities in that phase in each year. Then add the totals for each year and cumulate them. Now take the various figures on the above table, multiply them by various per-community coefficients and per-grower coefficients, and obtain projection of all of the outputs and nearly all of the inputs of the project.

Suppose that the innovation package for the zone in the above example enables the average farmer to increase production of cereal by 200 kilos, of legume by 400 kilos, and of fiber by 800 kilos, thus earning an additional $100 in cash income.[2] What will be the total increases in production, year by year, as a result of the project?

The increases in production and income can be derived by multiplying these per-farmer coefficients by the number of total improved growers for each year.

	Year 1	Year 2	Year 3	Year 4	Year 5
Total improved growers	10	90	650	2250	6250
Increased production					
cereal x .2 tons =	2	18	130	430	1250
legume x .4 tons =	4	36	260	860	2500
fiber x .8 tons =	8	72	540	1720	5000
Increased income x $100 =	1	9	65	225	625 (in $000s)

By multiplying the coefficients by the number of total improved growers for each year, the essential outputs of the project are determined. Note that the outputs do not end in the fifth year: the production and income engendered by an agricultural project continue for decades after the years of actual project investment activity.

2. The effects of these increases upon market prices must, of course, be assessed in overall planning.

The Standard Project Outputs

The above example addresses all three basic types of project outputs:

1. **Coverage of Clients.** The number of communities and total improved growers reached indicates how much of the client system has been covered by the project.

2. **Volume.** The coverage of clients generates increased production of various crops. These are the physical volume measures of a project.

3. **Objective.** The increase in coverage and volume then causes the change in the *client state of system* which is the real objective of the project: an increase in income.

The volume is within the client system on the farm. The *efficiency* of a project would be its coverage per agent or coverage per $1,000 of expense. The *effectiveness* of a project would be its increased income per $1,000 of total investment.

There is a standard causal chain in basic agriculture:

Pace-of-Expansion x Pace-of-Adoption = Coverage-of-Growers

Coverage x Package = ΔVolume $\rightarrow$ ΔIncome

EXERCISES

Compute the number of total improved growers for each year of project activity for projects with the following paces of adoption and paces of expansion:

1. Pace of Adoption: 25–75–300*

   Pace of Expansion: 1–5–20–40–34

2. Pace of Adoption: 30–60–180–330*

   Pace of Expansion: 1–5–15–29

3. Pace of Adoption: 20–60–220

   Pace of Expansion: 4–32–44 . . . *the zone Y fast pace*

4. Pace of Adoption: 20–60–220

   Pace of Expansion: 1–4–16–32–27 . . . *the zone Y basic pace*

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*New improved growers by phase.

5. Pace of Adoption: 20–6–220

   Pace of Expansion: 1–4–16–24–24–11

Compute increased production and increased income based on:

6. Exercise #1 above

   Per-grower coefficients: cereal + .3 tons, fiber + .4 tons, income + $150

7. Exercise #3 above

   Package B coefficients (Table 7.2, p. 116)

   NOTE: use cotton yield of +200 kg/ha., peanut yield of +700 kg/ha.

8. Exercise #4 above

   coefficients from Table 9.1, p. 141

   NOTE: for increased production use the increase in kilograms of the improved system over the present system. Round figures off to the nearest ten kilograms or $5.

9. Exercise #5 above, with coefficients the same as exercise #8

9
Project Inputs

The inputs needed as part of the Project Operations Plan are relatively easy to compute. In most cases a coefficient is multiplied by the number of growers (new or total), the number of primary societies (in one or all stages), or the number of townships or districts. Credit is computed in a similar manner, but the nuances of repayment and other financial problems can best be treated under project financing. One input, storage capacity, is somewhat complicated to compute, and a special section at the end of this chapter will discuss it.

PROJECT PLAN PRESENTATION

There are three documents in the Project Plan:

1. Standard Improvement Package (Table 9.1)
2. Project Operations Plan (Table 9.2)
3. Project Financial Plan (Table 10.1)

The emphasis in all of these documents is upon brief tabular presentation. The planning approach embedded in this volume stresses concreteness and simplicity. It is not intended to be unrealistically rigid. Its projections are admittedly hypotheses—not immutable specifications of the future. But they are to be informed by technical and situational knowledge. They cannot be vague and

fuzzy if they are to be sound and proper guides to decisions and action. Hence the substance of the operational plan is reduced to a set of basic tables.

The elements of the Present Farm System (Tables 4.1 and 9.1) and the results of the analyses of improved and long-range improved systems (Tables 6.5 and 9.1) are combined into the Standard Improvement Package. After the project is approved, certain implementation plan documents are needed (see part IV).

The format of the Project Operations Plan has three key features:

1. **Systems Overview**
2. **Selectivity**
3. **Compactness**

Systems Overview

The plan provides a succinct overview of the elements of the entire project. The left-hand column of Table 9.2 shows project content. *Pacing factors* are on lines 1-6, indicating coverage of communities, townships and districts, and showing the coverage of the *operations task* of the project (p. 5-8). Lines 7-8 are *coverage* measures indicating the number of clients reached by the project. *Outputs* follow: line 9 is the *objective*, the desired change in the state of the system of the client; the increased production on lines 10-13 may be considered as either objective measures, part of the desired change in the client state of the system, or as *volume* measures.

Inputs needed to sustain the pace of the project are indicated on lines 14-31. Line 14 is the staffing attribute of the operations task; lines 15-19 are the input attributes of the supervision and control tasks; lines 21-26 are attributes of other tasks; lines 28-30 are the main attributes of the supply tasks; line 31 is the equipment task.

Each data column indicates the state of the system of the project for each successive year and the values of its key attributes. The coefficients or project interrelationships are indicated in the right-hand column.

Selectivity

The plan focuses only upon key attributes of the project. Their values are shown on Table 9.2.

At each decision step, the documentation procedures should require the minimum data and management time and talent necessary to reach a sound decision. Later, full detail can be displayed in the documents of the annual task plans (see part IV). It is sometimes necessary to supplement the Project Operations Plan with partial or complete task plans to answer specific problems of

TABLE 9.1 STANDARD IMPROVEMENT PACKAGE FOR ZONE Y

	¢/Kg	Kg/Ha	Ares	Kg. Produced	Kg. Consumed*	Marketed	Gross Income	Inputs	Net Income
PRESENT SYSTEM									
1. Cotton-1	17	500	75	375		375			$ 64
2. Cotton-2	17	300	20	60		60			10
3. Millet	6	900	50	450	400	50			3
4. Peanuts	10	700	30	210	180	30			3
5. Maize-1	5	1200	12	140	100	40			2
6. Maize-2	6	1000	8	80	50	30			2
7. Totals			195						$ 84
IMPROVED SYSTEM									
1. Cotton-1	17	700	138	965		965	$164	$23	$141
2. Cotton-2	17	330	20	66		66	11	1	10
3. Millet	6	1300	50	650		250	15	7	8
4. Peanuts	10	1400	74	1035		855	86	16	70
5. Maize-1	5	2000	12	240		140	7	2	5
6. Maize-2	6	1220	26	310		260	16	2	14
7. Totals			320						$248
LONG-RUN IMPROVED SYSTEM									
1. Cotton-1	17	700	142	995		995	$169	$25	$144
2. Cotton-2									
3. Millet	6	1300	40	520		120	7	5	2
4. Peanuts	8	1400	104	1455		1275	102	22	80
5. Maize-1	5	2000	12	240		140	7	2	5
6. Maize-2	5½	1220	22	270		220	12	1	11
7. Totals			320						$242

*Remains constant in the improved and long-run systems.

TABLE 9.2 BASIC AGRICULTURAL PROJECT OPERATIONS PLAN FOR ZONE Y

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Total	Sources of Data
Coverage									
1 Primary Societies Covered									
a A	1	4	16	32	27				Rate of Adoption: Phase A = 20 growers per PS
b B		1	4	16	32	27			Phase B = 60
c C			1	4	16	32	27		Phase C = 220
d C+				1	5	21	53		(Phase C+ indicates project completed in those societies)
									Total 80 PSs in zone
2 Townships Covered	1	4	16	16	16	16	16		
3 Districts Covered	1	4	4	4	4	4	4		
4 Improved Growers									
a New	20	140	780	2480	5980	8660	5940		Based on lines 1a-1d
b Total	20	160	940	3420	9400	18060	24000		
Outputs									
5 Increased Cash Income (in $000)	3	20	118	428	1128	2167	2880		Line 4b x $125 in years 1-4; x $120 in years 5-7
6 Increased Production (in tons)									
a Cotton	12	96	564	2050	5830	11200	14880		Line 4b x .6 in years 1-4; x .62 in years 5-7
b Millet	4	32	188	684	658	1264	1680		Line 4b x .2 in years 1-4; x .07 in years 5-7
c Peanuts	16	131	770	2805	11280	21672	28800		Line 4b x .82 in years 1-4; x 1.2 in years 5-7
d Maize	7	53	310	1129	2820	5418	7200		Line 4b x .33 in years 1-4; x .3 in years 5-7

Staff Numbers and Costs (in $000)	N	C	N	C	N	C	N	C	N	C	N	C	N	C		
7 Monitors	1	1	5	4	22	15	56	39	91	64	91	64	54	38	225	1 per PS in A and B: 2 per PS in C, @$700
8 Township Agricultural Assistant	1	3	4	9*	16	35	16	29	16	29	16	29	16	29	163	1 per Township @$1800 + $500 for vehicle
9 Coop Assistant	1	3	4	9*	8	17	8	14	8	14	8	14	8	14	85	1 per 2 Townships @$1800 + $500 for vehicle
10 District Agricultural Officer	1	3	4	9**	4		4		4		4		4		12	1 per District @$3000 for vehicle
11 District Coop Officer	1	3	4	9	4		4		4		4		4		12	1 per District @$3000 for vehicle
12 Program Coordinator	1	6	1	3	1	3	1	3	1	3	1	3	1	3	24	Assistant Province Agricultural Officer @ $3000 + $500 for vehicle
13 Total Staff Cost		19		43		70		85		110		110		84	521	
Other Budget Items																
14 Demonstrations		3		10		19									32	@$600 per PS in Phase A- (3 years only)
15 Subsidy to New Growers		3		12		48									63	
16 PS Manager Salary Subsidy		1		2		6		13		20		5			47	@$3000 per PS in A @$300 in A ($500 in year 5): $200 in B
17 Monitor Training		1		1		3		7		7					19	@$200 per new monitor (line 7)
18 Publicity and Brochures (fixed)		5		5		2		2		2		2		2	20	
19 Miscellaneous (fixed)		5		10		10		10		10		5		5	55	
20 Total Project Budget		37		83		158		117		149		122		91	757	Includes staff training Includes staff cost (line 13 + lines 14-19)
Production Inputs (in tons)																
21 Peanut Seed		3		19		105		335		807		1170		800		.135 x line 4a (local replacement after 4 years)
22 Sulphate of Ammonium		4		32		188		684		1880		3612		4800		.2 x line 4b
23 Single Superphosphate		2		12		71		257		978		1880		2500		.075 x line 4b; .104 after year 4
24 Ox Equipment Sets		20		140		780		2480		5980		8660		5940		1 x line 4a

*Salaries are annual requirements; vehicles are a single expense. There are 4 assistants ($1800), but only 3 new vehicles ($1500). Cf. line 15, years 3 and 4-7; line 19, years 1 and 2-7.

**The District Agricultural Officer's salary is not charged to the project only his vehicle. Cf. line 18.

feasibility. But the information on Table 9.2 displays the feasibility of the project as well as can be done on paper.

Selectivity requires that small-cost items be combined and that numbers be rounded off liberally. Note that on lines 10-13 and 28-30, figures over 1,000 are rounded to the nearest five tons. Costs are rounded to the nearest $1,000.

Compactness

Project plan documents should be compact, a feature that follows naturally from selectivity. In this case all inputs and outputs are on one page. If a project were planned to promote packages A or B as shown on Table 7.2 (p. 116), the Operations Plan, the Financial Plan, and all relevant farm-level data could be displayed on one page.

If a plan is ready to go beyond the originating agency, it will be useful to supplement the tables with an introduction and explanation. A short introductory sheet can give the highlights of the project plan. Each table can be supported by backup information giving the significance and derivation of the data line by line. Note, however, that the traditional approach to writing project plans has been to supplement a narrative explanation with tables. Here, it is suggested that it is more efficient to supplement tables with narrative explanation.

Some Comments on the Outputs

The ultimate objective of the zone Y plan is expressed on line 9 (increased cash income of $2,880,000). Note that in year 7 the outputs of the project will be seven to eight times the outputs of year 4. This is typical of effective agricultural development projects. The pace of adoption and the pace of expansion advance at an accelerating rate. Combined, they result in a double acceleration. The first three or four years of a basic agricultural project produce outputs too small to affect the overall statistics of the zone. Only in the last few years of the project is there a mass transformation.

Explanation of Data Sources

The project objective, stated on line 9, is obtained by multiplying the number of total growers (line 8) by $125 for years 1-4 and by $120 for years 5-7. Table 9.1 indicates that the improved system for zone Y will yield a net income of $248 per farmer. Repayment of loans to obtain equipment (see chapter 10) is $38 per year. The net income of the improved system ($248) minus the loan payments ($38) and the present net income ($84) projects the increased cash income per farmer in years 1-4 ($125 is used rather than the exact figure of $126

for easier calculation). The decrease in net income for the long-range system, due to the drop in prices of key crops, is expected to result in the smaller increased cash income ($120) for years 5-7.

To obtain the increased production figures (lines 10-13), refer again to the Standard Improvement Package (Table 9.1). The improved system yields a projected increase of 590 kilograms of cotton-1, equivalent to .6 metric tons. (One thousand kilograms equal one metric ton.) The long-range system yields a 620 kilogram increase in cotton production, again rounded to .6. Projections for the other crops are obtained in the same way.

PERSONNEL INPUTS

In many LDCs, the availability of trained or professional people has been a greater constraint on projects than the availability of financing. Effective use of subprofessionals can enable a developing country to avoid many manpower bottlenecks.

Monitors

The effective use of large numbers of subprofessionals[1] is the primary corollary of the policy essential of saturation (pp. 31-32). When calculating a preliminary *adopter-monitor ratio* on Table 7.2, package C requires one monitor per 120 new adopters per year. Three further factors must be considered:

1. **Dispersion.** It is impractical for one monitor to service new adopters in several different communities. Travel among several communities is too expensive and time-consuming; and the monitor must be part of the community to maintain rapport. There should be at least one monitor per community, even though a community may have very few new adopters.

2. **Learning.** A monitor needs extra time per adopter while he is learning his job, and the effective adopter-monitor ratio is quite low at this stage.

3. **Dropouts.** In spite of adequate planning, recruiting, and supervision, many monitors are likely to prove unsuitable. The percentage of attrition depends on the type of monitors and the scope of the program.

The procedure for computing the number of monitors needed is to:

1. Set the preliminary adopter-monitor ratio as indicated on Table 7.2.
2. Reduce the adopter-monitor ratio to allow for dropouts.

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1. Used here, a professional is anyone with at least 10 years of education plus at least a full year of specialized training.

3. Start phase A with one monitor per community to allow for training.

4. Add enough monitors in each phase to maintain the minimum ratio.

To illustrate, if the pace of adoptions is 20–60–220 (new adopters in phases A, B, and C) and the adopter-monitor ratio is 100:1, then one monitor per community is needed in phase A, one in phase B, and three in phase C. If the ratio is 200:1 and the pace of adoption is 30–120–480–560 (total adopters 1,200), one is needed in phases A and B, three in phase C, and three in phase D.

Usually, monitors are needed to work with new adopters only during the first year of adoption. They should be dropped from the project when the number of new adopters is reduced.

Professionals with Governmental Agencies

The budgeting of the project staff has two related problems.

First, many of the project staff of various ministries are likely to be civil servants on regular ministry budgets. In computing the budget and other project costs, the new investments necessary to achieve the objective of the project must be identified. Is the salary of a civil servant a new investment?

Second, many of the essential staff may be devoting part of their time to other projects. Should salaries and other individual expenses be allocated to different projects?

The solution is to keep things simple. On Table 9.2 (lines 15-18), township-level staff salaries are charged to the project. District-level staff salaries are not. Charging their salaries and other expenses to the project might add some $60,000 to $120,000 to the total cost of the project. (Note, however, that the cost of the vehicles assigned to these staff members is charged to the project.) This amount of money should not change any basic project decisions. The government of country X would not abolish these positions if the project were not launched. So the salaries can be left as part of general overhead.

On the other hand, it is often worthwhile to charge to projects the extra expenses which will not be forthcoming from the regular ministry budgets. Assume that the field staff of country X suffers from a shortage of transportation. Vehicles are necessary to the success of the project, even if used partly for other projects. In some countries it might be necessary to budget extra travel money to supplement the regular budget, if district and province officials are to give the project adequate guidance and supervision.

How many professionals are needed? First, the full staffing pattern for the zone must be completed for the project to be a success. For this reason it is important to show numbers of people on the Operations Plan even when they are not charged to the project. In addition, some extra professionals may be needed. On Table 9.2 a project coordinator (line 19) is needed, which means an extra province deputy agricultural officer.

In some projects a variety of subprofessionals is needed. They should probably be combined in one line item marked "Others" for planning at the multiyear stage rather than be itemized. Later, at the annual task planning stage, they can be itemized in detail.

Nongovernmental Staff

In some projects private or parastatal institutions play a major role in the field. Agribusinesses, an agricultural development bank, or an agricultural supply corporation may have branches in the zone. Should their field personnel be charged to the project?

If they are paid out of gross margin earned from the project, their cost has in effect already been deducted from the benefits (line 1). The net-income-per-farmer coefficient is based on the income he receives before the gross margin on marketing his crops and after the gross margin on distributing supplies to him. On zone-level projects the secondary benefits and the secondary costs of marketing and supply distribution are excluded. For certain purposes it may be necessary to include benefits and costs in evaluating a total regional program (see chapter 10).

At times, however, the project must initially subsidize salaries of such people until the volume of business generated provides enough gross margin to cover all their salaries and expenses. There is a subsidy for the salaries of the managers in phases A and B (line 22) while volume is still low. In year 5 the project is launched into communities with new primary societies, so the phase A subsidy must be raised to $500. Assume that in phase C the volume will be adequate to pay all primary society salaries and expenses out of gross margin earned.

Standard Cost Factors

Table 9.2 displays a radical departure from the way the costs are presented in traditional budgeting practice. Separate line items for salaries, travel, per diem, and other personal expense items are absent. Instead, all these items have been combined in the explanations in the right-hand column (lines 13-19) into *standard cost factors* covering the expenses of an average man in the various categories.

For purposes of actual budget allotments or releases of funds, accountants need figures broken down by type and object of expenditure, to control expenditures and prevent misuse of public funds. But the detail and type of breakdown needed for *control* purposes are not necessary for *planning* purposes.[2]

First, the presentation of costs for traditional control purposes gives too much detail for the multiyear planning stage of decision making. The detail violates the principles of selectivity and compactness.

Second, the breakdown of costs for control purposes does not provide the information actually needed for planning decisions. For planning, the *total* cost of adding or subtracting one position from a project must be known to the nearest thousand.

To enable timely and intelligent decision making, plan documents must be easy to draft and easy to revise. If inputs, outputs, and costs are based on simple factors, rough estimates of alternatives can be made quickly.

A table places outputs and performance targets together with inputs. Long-range project planning and annual budgeting are carefully distinguished, producing a cost presentation that is quite different from traditional budgets. This sets the groundwork for considering alternatives, as a rational way of allocating scarce resources. The exercises found in this chapter demonstrate this important point.

The standard costs on lines 14-20 are taken from Table 2.1 (p. 18). The same standard cost factors can generally be used for an entire region or country. In some cases a particular zone may require substantial extra travel resources, or a special salary supplement may be authorized for difficult conditions. In that case, different standard costs must be calculated for the zone.

Standard cost factors on personnel and other cost elements should be prepared and approved, at least within the agency, before zone Operations Plans are drafted to insure comparability between plans.

In some countries, costs such as housing, health insurance, and retirement might be included depending on whether or not they are charged to a ministry's annual budget. If housing comes from a government pool that is not allocated to different ministry budgets, it should not be charged as part of the project cost. If, in principle, housing is *supposed* to be provided from a pool which, in actuality, is grossly inadequate, it might be advisable to provide for it in the project budget.

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2. Earl Kulp, *Rural Development Planning*, pp. 223-26 on Budgeting for Decision.

OTHER BUDGET ITEMS

Promotion

Lines 21-27 of Table 9.2 show that most of the items are part of the promotion effort.

Demonstration (line 21). There is a tendency to think of demonstration as an activity that continues in a community year after year. In terms of promotion, however, it is an essential investment only to the point where a nucleus of farmers have adopted the package. From that point on, they are the demonstration.

For the zone Y package, a comprehensive farm demonstration (not a small-plot demonstration) is needed in the year before the project is launched in the community. On Table 9.2, $600 is provided to cover the cost of supplies and equipment for the package, plus the cost of field days on which farmers will see the results and the practices.

By the fourth year of the project a total of 53 primary societies will be exposed to the project, a large enough nucleus to provide demonstrations for the remaining 27 communities. To obtain the figures on line 21, multiply the number of societies in phase A- (that is, the communities to be introduced into the program the *next* year) by $600 and round to the nearest thousand.

Subsidy (line 22). This promotion cost is essential only to the point where a nucleus of farmers in every township has adopted the package. One hundred and fifty dollars is provided to cover half the supply and equipment costs (see Table 9.1) for the nucleus adopters for the first three years.

Training (lines 24 and 26). All staff must be saturated with training (see chapter 13). The cost, however, is small. Since this package requires that the monitors must be skilled in handling oxen and ox equipment, the project provides six weeks of pre-service training. The $200 covers the cost of training and allows for a 30-50% dropout rate during training.

Subsequent in-service training for all staff is covered by "miscellaneous." Most of the costs are already covered by the various travel expenses built into the personnel standard cost factors; additional expenses would amount to only a few hundred dollars a year.

Fixed Costs (lines 25-26). The main fixed cost of such a project is for writing and printing the Operations Manual for the staff and brochures explaining the package to the farmers. The miscellaneous line item also includes about 5% for contingencies.

Consolidation

When the project plan is reviewed for initial approval, it is advisable to be able to make immediate revisions. It is therefore useful to consolidate the input and output coefficients into per-community, per-township, and per-district factors. The consolidated factors for zone Y would be:

Per Primary Society	In A-	In A	In B	In C
Monitors		$ 700	$ 700	$1400
Monitor training		200		200
Demonstrations	$ 600[a]			
Subsidies		3000[a]		
Manager subsidies		300b	200	
Total	$ 600	$4200[c]	$ 900	$1600

Per Township	1st Year	After 1st Year
Agricultural assistants	$2300	$1800
Coop Assistants	1150	900
Total	$3450	$2700
Per District	$6000	

[a] Years 1-3 only.
[b] $500 in year 5.
[c] $1200 in year 4; $1400 in year 5.

In addition, fixed costs are as follows: year 1: $10,000; year 2: $15,000; years 3-5: $12,000/year; years 6, 7: $7,000/year. Standard output factors for production and income can be computed on the basis of so much per community in phases A, B, and C in a similar manner.

When computing the budget on the basis of the consolidated cost factors, the resulting total will differ from the more detailed computation (as on Table 9.2) by a few thousand dollars due to different rounding and different ways of calculating minor items. Such differences are not enough to affect decisions at this stage of planning.

EXERCISE

Using the above consolidated cost factors, recompute the budget for the zone Y plan. Assume that during a review meeting the deputy commissioner suggests that the pace of expansion be changed to 1–4–12–32–31. Recompute the budget on the basis of the revised pace.

NON-BUDGET INPUTS

Lines 28-31 of Table 9.2 show the quantities of main production inputs needed but do not show the costs of these inputs. Their cost is mainly covered by production credit (see Table 10.1). Subsidies in the above budget also cover a small part of the cost. The Operations Plan must show production input not covered by the project budget, just as it must show certain essential personnel (e.g., district officers) to insure that these resources will be available in the quantities needed.

The computations are not difficult. Coefficients are taken from data on Table 9.1 and the following information: sulphate of ammonium (N1) and single superphosphate (P1) are applied at the rate of 0.1 ton per hectare; cotton, millet and maize-1 require N1; peanuts, P1. Determine the number of hectares of crops requiring each fertilizer and multiply by 0.1: in the improved system 200 acres of cotton-1, millet, and maize-1 are programmed; multiplication by 0.1 reveals that 0.2 tons of N1 are required by each farmer in each of the four years of the improved system. Multiply the total number of growers (line 8, Table 9.2) to obtain the amount of chemical required for each year of the project. (The number of tons of N1 required in the long-range system is approximately the same as in the improved; note, however, that the requirements of P1 change, due to the increased acreage of peanuts in the long-range system.) Equipment and peanut seeds are needed only the first year, so their coefficients are multiplied by the number of new growers (line 7). One hundred and thirty-five kilos of peanut seed are required for 104 ares, based on the long-range plans.

The various production inputs are generally produced by other projects or are imported under programs subject to close governmental control. It is important for those responsible for other agribusiness projects and special import programs to consolidate the projections of requirements of all the zone plans as a basis of forecasting future year requirements. For example, demand for ox equipment (line 31) rises to 8,660 sets in year 6. If there are ten such zones in the region, the zone projects will probably be somewhat staggered, but nevertheless demand may rise as high as 50,000-70,000 sets a year. Only by planning and acting several years in advance can the equipment requirements for the last three years of the project be assured. Similarly, large quantities of oxen will be required, and a breeding program must be started in advance.

Sometimes the production of physical inputs should be included in the zone project. If seed production or ox breeding were to be done locally, they would be part of the project. One or two line items would show, for example, the hectares of seed that must be planted each year and the investments necessary from the

government budget. A coefficient or a standard investment cost per hectare would be necessary. Certified seed production would then be one of the support tasks of the project, viewed as a system.

Irrigation is another type of support task which needs to have its key attributes outlined (e.g., physical output targets). If a package includes irrigation, it is essential to determine, year by year, the number of hectares to be irrigated, the number of dams to be built (assuming it is community-scale irrigation), and possibly the meters of canals and channels needed. Again, the principle of selectivity applies. If the irrigation is on an individual scale, the detail will be included in the Standard Farm Improvement Plan and reflected in the increased crop production. Only supplies and equipment need to be shown on the Operations Plan.

EXERCISES

1. Prepare a Project Operations Plan for rapid promotion of package B (p. 115). Use the following coefficients:

   – Pace of Adoption: 30–90–230 (maximum 350)

   – Pace of Expansion: 4–32–44 (townships: 4–16: districts 4–4)

   – Monitors: 1 per 2 primary societies @ $700

   - Agricultural Assistants: 1 per township @ $1,800 + $500 for vehicle

   – District Agricultural Officers: 1 per district @ $2,500 + $3,000 for vehicle

   – District Coop Officer: same as district agricultural officers

   – Demonstrations: 1 per PS in A- @ $100

   – Subsidies: $12 per adopter in phase A ($360 per PS)

   – Publicity: $3,000 per year

   – Miscellaneous: $5,000 per year

   – Increased Cash Income: $25 per improved grower

   – Increased Production: Cotton .2 tons and Peanuts .2 tons per grower

2. Prepare a Project Operations Plan for rapid promotion of package C. Use the pace of expansion in exercise 1 above and take all other coefficients and fixed elements from Table 9.1.

STORAGE

The main marketing input of a zone plan is storage. In many countries storage has been a serious bottleneck to development and a cause of income loss to farmers.

The problem of allocating resources for storage is potentially complicated. A wide range of trade-offs must be considered, not just in a community or zone but in a national context. These trade-offs include community versus regional or central storage, expansion of storage or expansion of processing facilities, more storage against more transport equipment, and alternative types of storage facility construction. Setting an optimum comprehensive nationwide storage investment plan taking all these trade-offs and alternatives properly into account can be based upon simulation based on Queuing Theory.[3] Fortunately, by making a few assumptions and generalizations the problem of planning the storage requirements of a zone plan can be addressed without a computer.

Basic Considerations

Primary vs. Secondary Storage. In planning the complete delivery system from farm to consumer, there is a choice between more storage at the *primary* or community level or more storage at the *secondary* (provincial, regional, or national) level.

Primary storage is generally more economical. Experience in a number of countries indicates that it is less expensive to provide storage for a ton of most crops in small structures made largely with local materials than in large modern warehouses. This type of primary storage might be called *improved traditional*, with mud-and-wattle, adobe, or country brick walls with, perhaps, corrugated sheet metal roofs and plastered inside walls. No imported structural steel is required, cheaper construction labor and management is available, and members of the farming community can contribute labor as an investment in the facility.

In any marketing system, the maximum portion of the total storage should be at the primary level—the investment is smaller and farmers can benefit from better prices through better timing of the community's crop sales.

Duration in Storage. Ideally, crops should be held in primary storage as long as possible. The best prices of food crops, for example, are generally right before harvest.

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3. See Kulp, *Rural Development Planning.*

Constraints include:

1. Long-term storage (more than a few weeks) requires careful, well-disciplined stores management.
2. Certain crops require careful disinfecting and regular spraying to prevent deterioration.
3. Improved traditional construction is not adequate for more than a few weeks storage of certain crops.

Outflow. Planning storage for an average primary society or community amounts to planning the flow of crops onto the market from an entire zone or region. An even flow reduces the secondary-level storage and processing capacity required. It is particularly important for crops requiring expensive investments in processing capacity. The longer the processing facilities can work at a stable pace, the less capacity is needed to handle the annual volume. Crops for domestic consumption are generally consumed in even quantities over the year and therefore require an even outflow.

During the post-harvest season, every truck in the region will haul crops from the countryside. Sharp peaks in outflow requirements probably cannot be met by available trucking capacity. It is not economical for transport companies to provide trucks which will only be busy a few weeks of he year. More trucks can be available only if crop hauling requirements are spread over several months.

Inflow. By and large, planners or managers can do little to control the inflow of crops to the primary societies. Farmers lack on-farm storage, and they urgently need the cash. They must be able to sell when crops are ready.

But storage for sharp inflow peaks can be uneconomical. It does not pay to maintain most of a society's storage capacity to meet a peak need that lasts only a month. It may make it unprofitable for a primary society to market a crop which would otherwise be profitable for the farmers. Sometimes storage responsibility must be backed onto the farms themselves for short periods.

Multipurpose Storage. Storage built for a single crop will sit idle much of the year. Diversification is the key to profit. A second-season crop gets its storage by using fixed assets that are already available.

As the primary society develops from a part-time depot into a year-round diversified business, its management requires more careful training and supervision. The warehouse must be properly cleaned and disinfected before the second crop goes in, and the second crop often requires better handling than the traditional first cash crop.

General Procedure

To compute the storage requirements of an improvement package for a community, move from the certain to the uncertain. Start with those crops and factors which are easy to determine and make the computations which will help decide which are less easy to determine (see Table 9.3).

Sequence of Crops. Suppose a package involves the expansion of production on two or more crops. Begin with the crop which has the highest *qualitative* storage requirements--the crop which must be moved in and out of primary storage without deterioration. Then compute the storage requirements of crops which have successively lower qualitative storage requirements.

For example, zone Y cotton has the highest qualitative storage requirement. It cannot be held in an improved traditional store for more than six weeks without deteriorating. Unshelled peanuts have the lowest qualitative storage requirement. If there is no rain, they can be stored in open yards. Even if zone Y has ample rain after the peanut harvest, peanuts can be adequately protected in temporary storage for up to a month.

Sequence of Operations. Computations can be made by half-month periods and can be easily fitted onto a standard accounting and planning worksheet. Starting with the most certain element:

1. **Compute inflow.** Estimate the percentage of the total crop which the farmers are likely to deliver in each half-month period by checking the harvesting-finishing operations and by estimating the probable time lag between the finishing operations (threshing, sorting, etc.) and the actual deliveries to the buying point. Then estimate[4] the total *increased* production by the community in the last phase of the project (phase C in zone Y). Assume that there is already adequate storage for existing production. In some cases, if storage is grossly lacking, it may be necessary to compute storage for the entire cash crop production. Where the short-term and long-term packages differ in production volumes, use the long-term projection. Then multiply the percentages for each half-month by the total crop to get the inflow in tons.

2. **Test outflow rates.** Test a relatively low number of truckloads hauled away per period to see if the resulting inventories present any problems. Will all

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4. There is no neat methodological formula to guide the planner in scheduling crop delivery to storage location after finishing operations are complete. An element of judgment must be exercised in estimating the time lag.

the crops be removed before deterioration sets in? Will storage facilities be largely empty after the peak month? If so, try a higher rate of outflow. As the outflow rate is tested, the end-of-period balance of tons in storage is computed using the following formula:

ending balance = previous balance + inflow - outflow

3. **Compute storage and working capital needs.** After computing the ending balance in tonnage, multiply the balance by square-meters-per-ton and value-per-ton for that crop to get the actual storage and working capital required. There are a few anomalies in this computation: Table 9.3 shows zero requirements for the first and last periods of activity on each crop. This oversimplification should not effect any decision making.

4. **Compute total requirements.** When the above computations are complete for all cash crops in the package,[5] add the number of square meters and truckloads and the amount of working capital required for the package. If the total storage space and truckloads show uneconomical peaks, readjust the outflow of the last crop or back some of its storage onto the farmers to even out the requirements.

Application to Zone Y

The procedure on Table 9.3, crop by crop, is as follows:

Cotton. After computing the inflow from November through January of three hundred tons of increased production, try a low outflow rate of 25 tons, five truckloads, per period.

	November		December		January		February		March		April
Inflow	30	45	75	75	45	30					
Outflow	-25	-25	-25	-25	-25	-25	-25	-25	-25	-25	-25
Balance	5	25	75	125	145	125	100	75	50	25	0

The last 30 tons delivered in late January will not be cleared out until April, well beyond the six-week limit for cotton in primary storage. On a subsequent trial, an outflow rate of 35 tons per period manages to clear out all the cotton before the six-week limit. The peak tonnage in storage is 100 tons in early January. At one square meter per ton, this requires 100 square meters for storage.

5. Millet is not a cash crop in this package.

TABLE 9.3 STORAGE REQUIREMENTS COMPUTATION FOR ZONE Y (PER AVERAGE PRIMARY SOCIETY)

Month:		January		February		March		April		May		June		July		August		September		October		November		December	
Half:		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Cotton																									
Inflow:	share	15%	10%																			10%	15%	25%	25%
	tonnage	45	30																			30	45	75	75
Outflow:	tonnage	-35	-35	-35	-35	-25																-30	-35	-35	-35
Balance:	tonnage	100	95	60	25	0																0	10	50	90
	sq. mtrs.	100	95	60	25	0																0	10	50	90
	$000s	17	16	10	4	0																0	2	9	15
Maize																									
Inflow:	share											5%		10%	10%	10%	5%			5%	10%	15%	15%	20%	
	tonnage											5		10	10	10	5			5	10	15	15	20	
outflow:	tonnage	-5	-5	-5	-5	-5	-5	-5	-5			-5		-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5
balance:	tonnage	35	30	25	20	15	10	5	0			0		5	10	15	15	10	5	5	10	20	30	45	40
	sq. mtrs.	25	20	20	15	10	5	5	0			0		5	5	10	10	5	5	5	5	15	20	30	30
	$000s	2	2	2	1	1	1	1	0			0		1	1	1	1	1	1	1	1	2	3	5	4
Peanuts																									
Inflow:	share											10%		15%	20%	25%	20%	10%							
	tonnage											39		58	78	98	78	39							
Outflow:	tonnage	-12	-7									-39		-40	-40	-40	-40	-40	-40	-20	-20	-16	-12	-12	-12
Balance:	tonnage	7	0									0		18	56	114	152	151	111	91	71	55	43	31	19
	sq. mtrs.	15	0									0		40	115	230	300	300	220	180	140	110	90	60	40
	$000s	1												2	6	11	15	15	11	9	7	6	4	3	2
Total																									
Sq. meters req'd		140	115	80	40	10	5	5	0	0	0	0	0	45	120	240	310	305	225	185	145	125	120	140	160
Truckloads		11	10	8	8	6	1	1					11	11	11	11	11	11	11	6	6	11	11	11	11
Working capital ($000s)		20	18	12	5	1	1	1					0	3	7	12	16	16	12	10	8	8	9	17	21

NOTE: Square meters rounded to nearest 5; working capital rounded upward to nearest $1,000.

Planning Factors (based on 300 improved growers per average PS in phase C)

Cotton: 1.0 ton per farmer x 300 = 300 tons per PS; price $170 per ton; requires 1 square meter per ton.

Maize: .33 ton per farmer x 300 = 100 tons per PS; price $50 per ton; requires .7 square meter per ton.

Peanuts: 1.3 ton per farmer x 300 = 390 tons per PS; price $100 per ton; requires 2 square meters per ton.

Truckloads: 5 tons each for cotton and maize, 4 tons for peanuts.

Maize. About 40% of this crop will be produced in the first season and 60% during the second. At the minimum outflow rate, one truckload of five tons per period, only 25 square meters is added to the peak storage capacity requirement, since the second maize inflow peaks before the cotton inflow. If only these two crops were considered, the maize could be cleared out sooner to even out the number of truckloads over the year. This minimum outflow rate has the advantage of moving maize evenly onto the market over nine months of the year. With a construction cost of $20 per square meter for primary storage, an even flow of maize is maintained with an additional investment of only 25 x $20 = $500 per primary society or per 100 tons marketed. On a ten-year loan at 12%, this comes to only $53 a year, or $.53 per ton.

Peanuts. A total peanut crop of 390 tons and a storage requirement of two square meters per ton potentially presents the largest storage problem. With an outflow rate of eight truckloads a period for 32 tons:

	July	August		September		October		November	
Inflow	39	58	78	98	78	39			
Outflow	-32	-32	-32	-32	-32	-32	-32	-32	-32
Balance	7	33	79	145	191	198	166	134	104
Square Meters	15	65	160	290	380	400	330	270	205

A peak storage requirement of 400 square meters for peanuts is 275 square meters over the peak required by the other crops. This means an investment of 275 x $20 = $5,500, an annual carrying charge of $880 to store a crop worth $39,000 (390 tons @ $100), which amounts to over 2% of the value of the crop and consumes most of the 2½% gross margin (see Table 7.2, line 33).

With an outflow rate of ten truckloads (40 tons) a period, the peak is reduced to 300 square meters. This would require an investment of 175 x $20 = $3,500, an annual carrying charge of $560, 1.4% of the $39,000 value of the crop. This is still too much to carry a one-month peak. On Table 9.3, there is a one-month peak of about 40 tons in late August and early September. If backed onto the farmers, it would amount to only about 133 kilos per farm.

The zone Y package will require 225 square meters of storage per primary society—an investment of $4,500 at an annual carrying charge of $720 principle and interest. The average primary society can anticipate $2,850 in gross margin from the package (Table 7.2, line 35), amounting to a reasonable 25% of the total gross margin.

There is one further problem on the peanut outflow: should the rate of 40 tons be continued after the peak is passed? Holding crops in storage as long as possible is particularly important with peanuts, which require expensive investments in edible oil processing facilities. Table 9.3 resolves this by setting the after-peak outflow at a rate that will even out the total truckloads to 11 per period over a total of six months, insuring availability of adequate trucking at reasonable rates.

EXERCISES

1. From Table 6.2 (p. 87) assume that a community is growing 100 tons of cereal and 100 tons of legume. Cereal requires .7 square meters per ton and legume requires one square meter per ton. The outflow for each is ten tons per half-month. The inflow is as follows:

	October		November		December		
Cereal			20	30	30	20	(By half-months in tons)
Legume	10	30	30	20	10		

Compute the peak storage requirement.

2. Now assume that a fiber crop is introduced with a production of 100 tons per community and the following inflow, in tons, is:

	January		February		March
Fiber	10	20	30	30	10

Fiber requires one square meter of storage per ton. Can the outflow be kept to a minimum of five tons a period without additional storage space, over that required for cereal and legume?

3. On Table 9.3 assume that a farmer can temporarily store up to 500 kilograms of peanuts on his farm, a maximum of 150 tons for the community. If forced to temporarily store more, there would be losses. How low can storage capacity be reduced and still avoid losses? Can it be reduced to 200 square meters? Can it be reduced to 180 square meters?

ROAD CONSTRUCTION

Transportation is one of the five essential factors of agricultural development (p. 14). It is particularly important to marketing; for example, there is a problem of making sure there is enough steady business to insure the availability of trucks. Similarly, it is often maintained that more or better roads are the key factor missing in the agricultural development of certain regions.

The road requirements of a region for agricultural development depend on the crops being promoted in the packages for the various zones. Some crops must be brought to market in the rainy season and roads must be all-weather. Other crops can be held in the communities until roads are passable. Sometimes more community storage can substitute for all-weather roads. Some crops are bulky and must be carried by large trucks, while others can be delivered easily by ox-cart.

Planners should make an inventory of access conditions of every community and district center of a region.[6] They should find out which communities do and do not have all-weather access, which have truck access, and which have only cart access. Perhaps only part of the zone is ready to adopt a particular package requiring all-weather or truck access.

Investments in road construction should generally not be included in the zone plan. Major roads rarely are oriented to particular zones. Management of road construction does not need to be coordinated with month-to-month project operation and does not lend itself to inclusion in agricultural plans. But zone plans can give the best indication of the benefits of major road construction.

Minor feeder roads are often built by the farming communities, and a basic agricultural zone plan can be a powerful incentive to such construction. There are generally a number of communities in any zone with adequate access where the project can begin. As other farmers see neighboring communities making more money, there will be an incentive to build access roads to make their communities eligible for the project.

In communities where better access roads cannot be built completely with self-help, funds should be part of the project; and construction targets should be part of the Operations Plan.

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6. Kulp, *Rural Development Planning*, pp.374-78 and 394-96.

10
Project Financing

Project planners and managers need to know how to determine a project's requirements and its economic soundness. They must be able to determine credit requirements, cost-benefit relationships, foreign exchange needs, and employment effects. And they must know how to address the practical problems of negotiating the financing of a project. These are the subjects of this chapter.[1]

CREDIT COMPUTATION

Two types of credit computation help determine credit needs: (1) seasonal credit and (2) multiyear production credit.

Seasonal Credit

Table 9.1 (p. 141) indicates that farmers in zone Y need $51 in cash inputs each year after adopting the improved package. Do all of these cash inputs call for credit? The simplest and safest assumption is that farmers need credit for all specified production inputs.

The seasonal production credit requirements of a project can be computed

1. For further information on economic analysis, see Price Gittinger, *Economic Analysis of Agricultural Projects* (Baltimore: John Hopkins, 1972).

by multiplying cash inputs required per farmer by the number of new improved growers added to the project each year. If 20 new growers each adopt a package requiring $50, the project will require $1,000 of seasonal production credit (see line 1, Table 10.1).

Multiyear Production Credit

As with seasonal credit, new loans for animals and equipment can be calculated by multiplying the standard loan of the package by the number of new adopters each year. But as the loans are repaid the result is to reduce the need for additional inputs of credit. The net expansion of credit in any year, or the net annual investment, is the new loans minus the repayments.

Suppose that a project makes $100 in new loans each year for three years with loans repayable in three annual installments.

	Year 1		Year 2		Year 3		Year 4		Year 5		Year 6	
Loans of	loan	repay	loan	repay	loan	repay	loan	repay	loan	repay	loan	repay
1st year	100			34		33		33				
2nd year			100			34		33		33		
3rd year					100			34		33		33
	100	- 0	100	- 34	100	- 67		- 100		- 66		- 33
Expansion	100		66		33			-100		-66		-33
Outstanding	100		166		199			99		33		0

Although the project makes $300 in new loans, the maximum credit expansion resulting from the loans is only $199.

Here is a typical pattern of credit expansion. Assume that a primary society has a rate of expansion of 20–60–240 participants in a project whose package requires a three-year loan of $300 per farm (all figures in $000s).

	Year 1		Year 2		Year 3		Year 4		Year 5		Year 6	
Loans in	loan	repay	loan	repay	loan	repay	loan	repay	loan	repay	loan	repay
Phase A	6			-2		-2		-2				
Phase B			18			-6		-6		-6		
Phase C					72			-24		-24		-24
	6	- 0	18	- 2	72	-8		-32		-30		-24
Expansion		= 6		= 16		= 64		= -32		= -30		= -24
Outstanding		6		22		86		-54		-24		0

Rapid expansion of participants is typical of basic agricultural projects. By the end of the third year, in this illustration, loans have been made totaling $96,000. But $10,000 has been repaid, so that cumulative credit expansion has only been $86,000. For zone Y credit expansion see lines 2-4, Table 10.1.

Storage and Marketing Loans

Seasonal and three-year production loans are short-term loans to the farmers. Let us assume there is also a need for long-term loans to each primary society for the construction of storage facilities in phase B. Determining total project storage credit requirements (line 3) is similar to the computation of medium-term credit. If terms are ten years, and repayments are in ten equal installments, the loans equal $4,500 times the number of communities in phase B each year.

Phase B	Year 2 loan	Year 2 repay	Year 3 loan	Year 3 repay	Year 4 loan	Year 4 repay	Year 5 loan	Year 5 repay
Year 2: 1 PS	$4,500			-450		-450		-450
Year 3: 4 PS			$18,000			-1,800		-1,800
Year 4: 16 PS					$72,000			-7,200
Year 5: 32 PS							$144,000	
	4,500	-0	18,000	-450	72,000	-2,250	144,000	-950
Expansion:	4,500		17,550		69,750		134,550	

The final credit item on Table 10.1 is *marketing working capital* loans (line 4). These loans to primary societies enable them to carry their peak inventories of crops purchased. The peak requirement is the amount needed when all suitable farms in the community have adopted the package. The project requires a peak inventory of about $21,000, or $70 for each of the 300 growers in the zone. The peak need at the primary society level lasts for only a couple of months. As the crops move to market, however, that peak may be transferred forward, increasing working capital requirements at regional and central levels. If so, increased capital requirement continues until the increased inventories in the economy are liquidated by export or sale. Unlike storage capacity, working capital can be added in increments. Working capital requirements are determined by multiplying the number of new improved growers in each year of the project by the working capital requirement per grower.

EXERCISES

1. Compute the net credit expansion on medium-term production loans for zone Y with five-year and two-year repayment. Take the new-loan values from line 2 of Table 10.1. In each case, what is the difference in net expansion from the values shown on Table 10.1?
2. Take the results of exercise 1, page 159. Compute the total credit expansion based on:
   - seasonal production loans = $25 per new improved grower
   - three-year production loans = $100 per new improved grower
   - warehouse construction loans = $5,000 per PS in phase B
   - working capital loans = $50 per new improved grower

TABLE 10.1 PROJECT FINANCIAL PLAN FOR ZONE Y (ALL FIGURES IN $000S)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Totals	Data Sources
Credit Expansion Required									
1 Seasonal Production Loans	1	7	39	124	299	433	297	1,200	line 4a x $50, (Table 9.2)
2 3-Year Productions Loans									
a. New Loans	5	34	187	595	1,435	2,078	1,426		line 4a x $240, (Table 9.2)
b. Repayments		-2	-13	-75	-277	-739	-1,370		
c. Expansion	5	32	174	520	1,158	1,339	56	3,284	
3 Storage Construction Loans (10 Yr.)									
a. New Loans		5	18	72	144	122			line 1b x $4,500, (Table 9.2)
b. Repayments			-1	-2	-9	-24	-36		
c. Expansion		5	17	70	133	98	-36	287	
4 Working Capital Loans	2	10	55	174	419	606	416	1,682	line 7 x $70, (Table 9.2)
Total Project Costs									
5 Total Credit Expansion	8	54	285	888	2,009	2,476	733	6,453	lines 1 + 2c + 3c + 4
6 Total Government Budget	37	83	158	117	149	122	91	757	line 20 (Table 9.2)
7 Total Project Cost	45	137	443	1,005	2,158	2,598	824	7,210	
Project Benefits									
8 Annual Gross Benefits	3	20	118	428	1,128	2,167	2,880		line 5 (Table 9.2)
9 Annual Net Benefits	-42	-117	-325	-577	-1,030	-431	+2,056		line 8 - line 7
10 Cumulative Net Benefits	-42	-159	-484	-1,061	-2,091	-2,522	-466		
11 Primary Societies Covered									
a. Phase A	1	4	16	32	27				
b. Phase B		1	4	16	32	27			
c. Phase C			1	4	16	32	27		
12 New Improved Growers		140	780	2,480	5,980	8,660	5,940		

Subsequent Years	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17
8 Gross Benefits	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880
2 3-Year Loan Repayment	1,646	1,168	475							
3 10-Year Loan Repayment	36	36	36	36	36	36	34	27	12	
9 Annual Net Benefits	4,562	4,084	3,391	2,916	2,916	2,916	2,914	2,907	2,892	2,880
					last payment for PS-1	PS-4	PS-16	PS-32		

COST-BENEFIT ANALYSIS

At this point, primary costs and benefits have been computed. These data must now be combined to determine whether the project represents a worthwhile investment.

Total Project Cost. The total amount of credit expansion is the sum of the credit expansion required for seasonal production loans (line 1), three-year production loans (line 2c), storage construction loans (line 3c), and working capital loans (line 4). Combining credit expansion (line 5) and project budget (line 6) gives the total project primary cost.

Many economists would argue that some labor costs should be included in the total project primary cost. The assumptions in the farm programming exercise should eliminate this need. It was assumed that each farm has a fixed amount of labor available, a fixed labor constraint month-by-month. Any amount of labor used to that point is available to the farmer at no marginal cost; it is like a fixed asset which he owns. Any amount of labor above that constraint point cannot be obtained, under this assumption, at any price.

Such is the situation of small peasant farms in much of the Third World. Farmers may "trade days," or they may work for each other, but they do not hire labor from outside the community for peak needs. Family labor availability is both a fixed asset and a binding constraint, not an input bought off the market.

In other projects, cash inputs by farmers or local merchants should be included if they are necessary to the objectives of the projects and if they can be reasonably and consistently expected. The simplest way to reflect cash inputs by farmers is to deduct them from the net income to farmers.

Net Benefits. The net benefits calculation is on lines 8 and 9 (Table 10.1). The annual gross benefits are taken from line 9 of Table 9.2. From this subtract the total project cost (line 7) to obtain the annual net benefits.

Internal Rate of Return

Is this a good investment? Should the Ministry of Finance or the Ministry of Planning approve the investment necessary for this project? Will it be attractive to a development bank? Suppose that some 200 projects have been proposed for financing over, say, a five-year period, requiring a total investment of $1,300 million, while prospective investment resources are only $850 million. Some projects will have to be cut out of the national program. Will this project be

included? In other words, how does this project compare with others with which it is competing for scarce financial resources?

One might argue that the financial attractiveness of this project insures its financing. It requires a total of $7,210,000 investment, which produces a stream of income which builds up to a total of $2,880,000 a year and then goes on year after year. Moreover, it starts producing some income fairly early, so that the economy is never out of pocket by the full amount of the investment. In fact, the most that the economy is out of pocket is $2,535,000 in year 6, less than the net income of year 7 alone.

Nevertheless, the investment comes first and the benefits follow. Another project might have a smaller ratio of annual benefits to total investment, but might have a faster pay-back. It may be preferable to get only $130 back on a $100 investment, but to get it back in three years, than to get $200 back on a $100 investment in 15 years. Money earned in the future is worth something less than its face value today.

So we must compare projects financially not only in terms of the ratio of earnings to investment, but in terms of the *timing* relationship of investments and benefits. To compare both the timing and the value of investments and benefits, we must choose an interest rate which indicates the premium that is placed on money this year in preference to money in future years.

One way to compare projects financially is to compare their *discounted* present value, the present value of their streams of future net benefits at a given interest rate. The formula is as follows:

$$\text{Discounted Present Value} = \sum_t \frac{N_t}{(1+i)^t}$$

where:

N = annual net benefits

t = year

i = interest rate

Discounted present value has many limitations as a measure of the relative financial attractiveness of projects, and thus as a criterion for project selection. The main limitation is that it requires what is often an arbitrary or highly debatable choice of an appropriate interest rate. As the following table illustrates, the choice of interest rate can make a big difference in the discounted present value.

Discounted Value of $1:

After	At:	5%	10%	15%	20%	25%	30%	40%	50%
2 years		$.907	$.826	$.756	$.694	$.640	$.592	$.510	$.444
5 years		.784	.621	.497	.402	.328	.269	.186	.132
10 years		.614	.386	.247	.162	.107	.073	.035	.017
15 years		.481	.239	.123	.065	.035	.020	.006	.002
20 years		.377	.149	.061	.026	.012	.005	.001	.000
25 years		.295	.092	.030	.010	.004	.001	.000	.000

So a related measure, the *internal rate of return*, is generally preferred as a financial criterion. It avoids the problem of choosing an appropriate interest rate. The internal rate of return is the interest rate at which the project's discounted net present value equals zero.[2] It is the i at which the discounted stream of future benefits or income of a project equals the discounted stream of future investments and costs. It shows, roughly speaking, what money invested in the project can earn.

There is no easy formula for computing the internal rate of return. One must arrive at it by trial and error, trying out various interest rates and using them to compute the discounted present value of zero. A calculator is particularly useful for this computation.

The internal rate of return on the zone Y project is about 57%—very good indeed. Even adding a cost figure for the additional on-farm mandays required by the improved farming system (to satisfy some economists), the internal rate of return is over 40%, well above that of typical industrial projects.

Why is the rate of return so high? First, an innovation package cannot be recommended to a farmer unless it has a high return for him, high enough to cover his many risks (see pp. 64-65). Second, land and labor are figured as fixed assets, as investments of the past. Unlike an entrepreneur starting a new manufacturing business, a peasant farmer does not have to borrow money to buy land and pay labor. So the leverage and return on capital invested in peasant agriculture can and should be greater than that invested in industry.

The agency responsible for allocating scarce investment resources can use the internal rate of return as a prime decision criterion. It can list projects and their

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2. Using the formula on page 166, internal rate of return = the value of i at which

$$\sum_t \frac{N_t}{(1+i)^t} = 0$$

See Gittinger, *Economic Analysis.*

investment requirements in order of decreasing rate of return and thus get a useful project priority listing. It can then go down the list in allocating available financial resources, approving projects until available resources are exhausted—and it will have made a sound allocation from a purely financial point of view.

But there are other important criteria to be considered. A developing nation has more objectives than maximizing potential financial return. It also has other constraints. It should consider, for example, who will benefit from a project, and favor a project benefiting 100,000 people over a project with a slightly higher internal rate of return which will benefit only 10,000 people. It should also consider the demands of projects on scarce management talents, and avoid projects which will spread these scarce management resources too thin. Thus, it may be better to invest $1 million in one project with a 25% internal rate of return than in ten projects averaging 35% internal rate of return—if the ten projects present a far greater management burden than one project.

Secondary Costs and Benefits

The last column of lines 10-13 on Table 9.2 (pp. 142-43) shows that the project earns money because it produces substantial increased tonnages of crops, particularly cotton and maize. The project has these tonnages produced on the farms and delivered to community warehouses. Are the crops worth anything if they are not processed and moved to market?

Some additional investments will probably be necessary to process the increased production of a zone project and move it to market. These investments are outside the zone and thus beyond the scope of a zone project. The increased peanut and cotton tonnage of the zone Y project, for example, will have to be processed by ginneries and an oil extraction plant. These facilities may draw their raw materials from parts of several zones, depending on transportation patterns. Their management and problems are radically different from those found in zone projects.

With these additional investments come some additional benefits. As crops are processed and moved to market, they acquire added value. Thus, every zone project will have some secondary costs and benefits which are outside its scope.

The full computation of costs and benefits must, then, be done on a couple of projects, perhaps on a regional basic agricultural program. Such a program would consist of several zone projects plus some agribusiness projects. The tonnages to be processed and stored, year by year, would be given by the zone projects—in effect, their aggregate physical outputs. In addition, the regional program may include some facilities for manufacturing and storing inputs, such as fertilizer, improved seed, and small equipment.

Secondary costs tend to range from 40% to 80% of primary costs; secondary benefits tend to add another 25% to 50% to the primary benefits. Basic agricultural programs which include agribusiness projects should have consolidated internal rates of return over 20%. Seventy-five percent could be added to the costs and 30% to the benefits of the zone Y project, and it would still have an internal rate of return of 50%.

Foreign Exchange

Foreign exchange and the balance-of-payments may be a more critical problem in many developing countries than the general availability of investment funds. It is often important to know the balance-of-payments costs and benefits of a project. How much foreign exchange does it require? How much foreign exchange will it generate? What imports are needed, and what are its exports worth?

The zone project plan has much of the data necessary to compute the foreign exchange costs and benefits. On the cost side, it has the quantities of the main physical inputs needed year by year (Table 9.2, lines 28-31). Given the tonnage of agricultural chemicals needed for a project, one can easily determine the foreign exchange component, or cost per ton, for these imports. On the benefit side, the project plan gives the tonnages of increased crops to be produced, year by year. Given these tonnages, one must then convert those which are to be exported into tons of processed materials, e.g., ginned cotton and peanut oil. The value of these processed exported tonnages is the foreign exchange earnings of exports generated by the project.

The zone Y project, with its heavy tonnages of cotton and peanuts, obviously has a favorable balance of trade. A project which produces crops largely for domestic consumption and requires heavy tonnages of imported agricultural chemicals, however, might have to be re-examined for its foreign exchange drain.

EMPLOYMENT GENERATION

Many developing countries are beginning to realize that employment may be a more important goal than raising overall GNP. In justifying a basic agricultural project as an investment, it is important to show how many jobs it will generate.

Problem and Task Definition

Until recently, the calculation of employment generation in subsistence agriculture has largely been ignored by economists and statisticians. Project plans

for subsistence agriculture have rarely indicated the employment effect. Statistics rarely specify jobs held in the rural non-modernized sector.

The critical question is whether young people stay on the farm or in the farming community or whether they go to the city to look for work. Employment generation can constitute a change in the economic conditions of the community which provide work prospects that are more attractive than those found in the city.

Income Targets. What must an on-farm job offer to compete with the city? Consider both the long-term and the short-term prospects that attract a young person with a few years of school to the city.

In country X, a casual city laborer can hope for about six months work a year, averaging $25 a month or $150 a year—the equivalent of $100 a year in the village. A primary school graduate can earn about $360 a year in the city—the equivalent of $260 a year in the village. The short-run minimum income for a job in farming should be $100; the long-range minimum $260.

Jobs Needed. Suppose that the demographic pattern in country X is such that the labor force of adult males is increasing by 2½% a year. This means that in zone Y, with 32,000 farms (Table 2.1, p. 18), about 800 more young men must find jobs each year. Therefore, in the short run there must be land and capital for 800 jobs which can earn over $100 a year. In the long run, there must be land and capital for 800 new farms a year, each of which can earn over $260 a year.

Alternatives. Regarding land availability, there are three possibilities:

1. Adequate land is available in the community for all new farms needed.
2. Adequate land is available in other zones but not in the community.
3. No additional land is available, so jobs can be created only by making farming more productive.

Short-Run Possibilities

If the labor force on an average zone Y farm with the improved package were increased from 2¼ MEs (adult male equivalents), there would be a 40% increase in labor available and, presumably, a 40% increase in production and income. The improved farm is earning $204 in cash (p. 141) in addition to $117 in subsistence production for home consumption (Table 4.1, p. 48)—a total of $321. A 40% increase would add $128 to the farm income. An additional man would thus produce more than the $100 equivalent he might earn as a casual laborer in the city.

Assume that the average farm with the improved package is operating four hectares, including fallow. Another 40% adds 1.6 hectares. The 800 new workers per year in the zone are scattered over 80 villages, amounting to ten per farming community. Each farming community, then, must be able to provide 16 additional hectares for its growing work force in the short run.

Capital Requirements. No budget outlays are specifically needed to raise new workers to the required level of productivity. The original project budget is sufficient to teach the new technology to the entire community. Nor are additional sets of oxen and improved equipment needed. The one set per farm is sufficient for a work force of 3½ MEs.[3]

All other capital inputs per farm must be increased by 40% to handle increased production. Seasonal credit, storage, and working capital amount to $3,170,000 ÷ 24,000 farms = about $130 x 800 new workers, or about $104,000 per year.

Long-Run Possibilities

Feasibility. Can the package provide at least $260 gross income per farm, including subsistence? The improvement package for the zone Y project can provide a total income of $320 for a mature family. However, each new farm requires four hectares, including fallow. For ten such farms a year in a community, 40 hectares a year need to be staked out for eventual cultivation. If the land is available, the project can provide new farmers with a prospect of living that meets their expectations.

Capital Requirements. The total credit outlay of the project as it stands is $6,453,000 (line 5, Table 10.1); divided by 24,000 farms it comes to about $270 per farm. This credit would be needed for each additional farm, less the $50 initial outlay in credit expansion for each additional new worker.

Project Increment. Starting in year 8, assume that 800 young workers who began in year 4 of the project are now married and ready to run full-size farms. They will then need another $220 of credit for various purposes ($270 - $50). From that point on, the project will have additional annual costs of approximately $220 x 800 = $176,000 a year. This will produce an additional stream of income of $360 - $130 = $230 x 800 farms = $184,000. The income stream from the new farms in the zone will increase by $184,000 a year as long as land is available.

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3. Peak ox-work is in April, 43 days ÷ three-man team = 14 ox days.

Resettlement Possibilities

If insufficient land is available to accommodate the growth of the labor force, resettlement in another sparsely populated zone with immediate growth potential can be considered.

Perhaps the key to organized, economically sound job creation through resettlement is to provide young workers with the minimum needed to start a farm in a wilderness area. To facilitate later provision of services, they should be moved in groups and settled in relatively compact communities. They should also be given the opportunity to obtain clear title to all the land a large mature family could possibly handle. They need transportation and supplies until the first food crops are harvested. This initial assistance should come to $50-100 per person.

It should take them six or seven years to build a mature farm and absorb the complete package of investments and improvements for farms in that region. They would thus need all types of credit plus the extension and coop-building effort for the zone. This might cost $300-600, depending on the technical possibilities and requirements of the zone. The package should be scaled to provide them with an income comparable in real terms to prospective urban incomes for primary school-leavers.

Intensification Possibilities

If no extra land is available, then the agricultural development strategy should focus on innovation packages which raise productivity and labor requirements per hectare. Agriculture, in other words, must be made more labor-intensive.[4]

Such intensification requires yield-raisers that are more potent than those illustrated on Table 5.1 (p. 64). Applied without bottleneck-breakers to present areas in zone Y, these would only raise income by about $36 per average farm, about a third of what is needed to provide for an additional laborer. Further research is necessary to enable such a zone to support more laborers without putting more land into cultivation.

It might be possible to provide for the short-term expectations of young workers in zone Y by introducing better yield-raisers on present crops. But to provide an additional $260 a year on existing acreages would require some new high-return enterprises and, very probably, irrigation. It would require institutions and investments appropriate to stage 3 and perhaps investments of $600-1,200 per farm. This would still be less expensive than providing a job in industry.

4. Edgar Owens and Robert Shaw, *Development Reconsidered* (Lexington, Mass.: D.C. Heath, 1972), pp. 58, 60.

It should be possible for the program manager to attach to the project plan an analysis and rudimentary strategy for meeting the employment problem of the zone, indicating what additional research is necessary.

BUDGET NEGOTIATION

Total Program Requirements

The government budget and the credit requirements of basic agricultural development are likely to be negotiated as part of regional or even national programs.

Assume that zone Y represents the exact average of ten zones in region R. The pilot zones will be launched over three years, one zone the first year, three zones the second year, and six zones the third year (p. 134). Requirements for the program are as follows (all figures in $000s):

Year	1	2	3	4	5	6	7	8	9	Total
Project Budget	38	194	623	1065	1440	1290	1350	990	540	7550
Seasonal Loans	1	10	60	283	905	2074	1038	4788	1782	12000
3-Year Prod. Loans	5	33	260	1174	3764	7950	11070	8240	280	33100
Storage Const. Loans		5	32	151	546	810	1035	497	210	2900
Working Capital Loans	1	13	91	400	1275	2915	4750	4875	2490	16800

The budget requirements for the first and second years are not worth negotiating as separate programs. The program manager need only acquire funds from different programs allocated to the specific communities that form the point phase of the project. When the budget exceeds $500,000, a formal project and program appropriation will be necessary within the development budget.

Note that the budget requirements of the program have an unusual feature: they rise and then they fall. The component projects have explicit beginnings, middles, and ends. It may be possible to fit the rise up to $1,440,000 a year into the normal trend of rising operating budgets for the Ministry of Agriculture.

Padding the Budget

Experienced administrators, in anticipation of a common budget office habit of trimming all requests by 10-20%, would probably inflate figures in Table 9.2 by at least 10% so the project can survive.

Actually, there is some padding in this budget, derived from the simplicity of its assumptions and interrelationships. For example, it assumes that none of the

staff have vehicles, while many probably do. All figures are rounded to the nearest $1,000. The budget also assumes that all project personnel begin work on the first day of the fiscal year.

There should be some care taken when padding budgets, however. If the person responsible for the budget is transferred, someone must know how to shift funds to meet unexpected problems and opportunities.

The Cost-Benefit Approach to Budget Defense

If the agency or project manager is asked to reduce the budget, perhaps the most honest, realistic, and defensively successful approach is to cut outputs. If the budget office asks for a revised budget showing a 10% cut, indicate clearly how many communities will have to be eliminated from the program and how much output will be reduced.

Consider year 3 on Table 9.2 (p. 142). How could it sustain a 10% cut of $16,000? Because of the large amount of money for subsidies that year, by cutting the subsidy to $100 per new grower in phase A ($2,000 per PS in A), $16,000 could be saved. For any cut beyond that, new communities would have to be eliminated, disappointing farmers and district officials and lowering the overall economy of the project.

When the budget office demands a percentage cut in the project budget, the project manager should respond with a revised project operations plan that has a revised pace of expansion while preserving the same unit cost factors. The project is still successful, even though it is slowed down. Cutting any of the unit cost factors (except a soft one such as subsidy after the second year) can threaten the success of the project.

Budget offices tend to see agricultural extension as a welfare service, like clinics and schools, which the government gives to poor farming communities. It is important to use the basic planning tables to show the budget office that today's basic agricultural development will pay for tomorrow's schools and clinics.

CREDIT NEGOTIATION

General Considerations

Each type of credit has different requirements and should probably be negotiated from a different source or combination of sources. Funds available from development banks are limited. Basic agricultural development usually requires more credit than has previously been considered. If possible, credit

should be obtained from commercial banking or other private and semi-private sources. Credit for inputs requiring substantial foreign exchange is more appropriately obtained from foreign development or international commercial banks. Inputs which do not require foreign exchange are appropriately financed from domestic savings and investment sources. It is important for the long-run development of an economy to start domestic savings and investment moving into basic agriculture.

Working Capital for Marketing

The requirements for working capital for the primary societies can most properly come from domestic commercial banks through cooperative provincial or district unions. This credit can be secured by goods in the warehouse with a ready market. The goods are bought at harvest and then held while the market price rises. For convenience of administration, it may be easier for commercial banks to lend the money to unions or marketing boards, which in turn retail them to the primary societies.

Financing working capital for marketing is almost never inflationary, since the money put into the economy is for goods already produced. A central bank, therefore, should be able to put enough increased credit into the economy to move the crop to market.

Holding crops in storage in anticipation of a better market may present some problems. It may be necessary for primary societies to operate as bonded warehouses, giving a lien on the crops they are holding as security for loans.

Seasonal Production Loans

There are a number of ways to make lending to peasant farmers attractive to commercial banks.

Well-Tested Standard Loan Packages. Before a bank makes a production loan, it has to be satisfied that the purpose of the investment is sound. A commercial bank lacks the background, experience, and staff to investigate the soundness of farm production loans and must rely on the agricultural services to provide the necessary information.

Proven Project Support. A bank needs assurance that the loan recipient will receive the support of other core agricultural services to make the loan profitable—support by extension training, supply distribution, and crop marketing. For this reason, it may not be possible to obtain commercial bank support until the line or network phase of a project.

Group Loan Administration. To keep administrative costs low and for accounting and administrative purposes, it is desirable for the banks to handle loans to one borrower-group as if it were a single loan. This means that the $20-40 administrative cost can be spread over some $500-1,000 worth of loans.

Community Credit Discipline. As noted earlier, the most effective repayment incentive can come from a cosigner group (see page 122-23).

Premium Interest Rate. Even with the above features, seasonal loans still entail more risk and expense than loans to established businessmen. On a group of borrowers with $300-500 in loans, a bank still needs a spread of 5-6% between what it pays to depositors for its money and what it charges to farmers. It must, therefore, be able to charge peasant farmers a higher interest rate than it charges regular commercial customers. If such a rate meets with social, political, or religious resistance, the extra interest can be treated as a special handling charge for a small loan.

Bankers unfamiliar with agricultural credit are often concerned with the possibility of crop failure. Actually, this is a minor risk for the banker—the loan can simply be extended until the next harvest. Bankers in the winter wheat country of North America have prospered while seeing farmers through two or three crop failures in a row. Even if the interest rate is as high as 20%, the farmer should be able to pay 18 months' interest and still make money if the innovation package is sound.

For administrative convenience, the bank may prefer to wholesale loans to a primary society, which in turn can retail the loans to farmers. The margin that primary societies make on loans can be a significant part of their total gross margin. But there are some advantages to having loans made directly from banks to borrower-groups. Farmers may take credit discipline more seriously if it comes from a commercial bank. There is also a psychological benefit: like any commercial merchant, farmers take pride in doing business directly with a bank. Finally, farmers may eventually become good savings clients of banks.

Medium-Term Production Loans

Medium-term credit presents some special problems for commercial banks. In many countries commercial banks are forbidden to make medium-term loans to anyone. Therefore, in many countries, particularly in Latin America, affiliated institutions (*financeras*) are often established to make medium- and long-term

loans. These financeras are funded by commercial banks, government funds, and development banks.

In the table on page 000, the medium-term credit for region R is over 50% of the total investment of the program. In years 3-6 medium-term credit requirements are over $13 million; in years 7-9 they are almost $20 million. A combination of development bank and commercial bank financing might be most appropriate. In the first years, while the repayment experience is just beginning, development bank funds might predominate. In the last years of the program, once the farmers have proven that they can and do repay on time, commercial bank financing might take over most of the financial burden.

Storage Construction Loans

On storage and other construction loans and on irrigation and land-clearing loans, it is important to get the interest rate and the annual repayment as low as possible. In the zone Y project, the repayment was calculated at ten years at an interest rate of 10%. Principal and interest took up 25% of the expected annual gross margin of the average primary society. Such a fixed cost burden for a primary society is a bit risky. It would be better to have 15-year terms and a 7% interest rate. On a $4,500 loan the annual carrying cost would be $300 principal and $170 interest, a total of $470. This would be only 16% of the expected annual gross margin, a sounder fixed cost burden. Long-term financing for basic agriculture can thus come most appropriately from a development bank.

Program Presentation

It has been suggested that the basic project plan should consist of three tables: the Standard Improvement Package, the Project Operations Plan, and the Project Financial Plan. Requests to various sources for financing will generally require additional tables to show a consolidated regional program, the financing being requested from the specific source (budget office, commercial bank, or development bank), and the intended program of disbursement and repayment. Finally, for development banks, there must be a narrative of the project.

Financing institutions have special requirements for the narrative and tabular format of a loan request. They require a description of the region, its physical characteristics, its transportation facilities, and its farming systems. They also require a detailed description of how the program is to be organized and operated[5] and a special analysis of some of the financial aspects.

The tables contained in this volume provide the basis for internal decision making within an agency. They also provide most of the data necessary to prepare a financing request without any further decision making.

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5. See Kulp, *Rural Development Planning* (New York: Praeger, 1970), pp. 428-32, 598-602.

In effect, the tabular exercises in part III have *formulated* a project. Together with supporting agribusiness projects, such zone projects constitute a formulated program for the development of basic agriculture.

The project planning procedures in this section produce a composite set of sound decisions. They are nominally multi-year decisions. But in the early stages of a project they are only valid for one year until the next round of feedback is available.

Some of the assumptions in the chain of decision, notably the pacing assumptions, are highly conjectural. Each year of operation improves the empirical basis for these assumptions, particularly those concerning the farmers' pace of adoption. Feedback will probably necessitate a substantial revision of the optimum farm program each year, indicating substantial changes in project inputs, credit, storage, and subsidies.

Therefore, planners will have to revise these tables each year to maintain a set of sound decisions. Because of constant revision, this book has stressed the limiting of project documents to a few tables. This eliminates paperwork and unnecessary project documents.

Part IV
Implementation Planning & Control

11
Management of Field Agents

Implementation is management after the formulation and approval of a project, when coping begins, while planning and policymaking continue.

GENERAL PRINCIPLES

The Mass Production Approach to Implementation

Some 60 years ago, auto manufacturers were concentrating on the product, on designing automobiles with better styling, comfort, and performance on the road. Henry Ford turned his attention to the production aspects. He designed a product for high volume, low unit cost production. He broke the production process down into short-cycle operations. He then analyzed the timing and method of each job, designed special fixtures and equipment to facilitate and speed up each job, and controlled the timing with a moving assembly line.

This principle of mass production made possible the use of unskilled labor in jobs formerly held only by skilled labor. As a result, Ford tripled labor productivity and was able to pay unskilled labor $5 a day at a time when skilled labor was earning $15 a week or less.

Lack of skilled labor is presently a bottleneck to development in most developing countries. Not only are developing countries in need of productivity in their agricultural development staffs but they are urgently in need of overcoming

skilled manpower bottlenecks. This chapter presents a set of principles and practical techniques for organizing and guiding the implementation of a project which makes use of project field monitors with limited skill and training. It uses the principles of mass production.

Emphasis on Routine

A US county extension agent is expected to work out his own annual program. He has been thoroughly trained during years of professional education. Field project monitors in developing countries, by contrast, are often unskilled or semi-skilled workers promoting a standard package. The monitor's routine should be specified and clearly outlined. As he gains experience, the monitor will modify and adapt this routine to the individual needs of his clients.

Short-Cycle Planning. The annual cycle of the field agent's work is made up of *phases*. Each begins with a *presentation* to a group of farmers followed by *visits* to individual farms. What should the monitor say and do first? How long should it take? How much can he do in a day or a week? What are the earliest and the latest dates for each set of presentations and visits? Monitors must be instructed carefully in these matters.

Paperwork. On every visit to the field, the monitor should fill in a form, compiling certain highly specific data about each farm. Such forms:

—give structure to the routine of each visit (they organize the work)

—provide a check on the monitor's work

—help educate the monitor

Training

The training of project field monitors is radically different from the training of extension, coop, or credit agents in developed countries in two ways.

First, training should be *confined to the package*. It should cover only those crops included in the package and those innovative inputs and practices being promoted by the project.

Second, the training should be conducted in *short and frequent sessions*. Monitors should be given an initial training of one to two weeks more (if special skills like ox-handling are needed) followed by a few days of training for each new phase of the first annual cycle.

Training in each phase should feature:

1. **Exhaustive Explanation** of themes, skills, practices, and problems; the reasons for the inputs, practices, and routines; the questions and objections farmers are likely to raise; and the special difficulties that may be encountered.

2. **Rehearsal** of skills and explanations before the class.

3. **Class Visits** to actual farms and adopter groups, to watch the trainer give a presentation and handle the tasks of the visit.

4. **Supervised Visits** by individual monitors accompanied by their immediate superior.

5. **Review Sessions** held every fortnight or so with the district monitors, to discuss the problems enountered to date.

FIELD AGENT WORK SCHEDULE

Table 11.1 illustrates the Field Agent Work Schedule, one of the two basic implementation planning documents. It is a simplified schedule of one monitor's work during the annual cycle.

Format and Computation

The steps for completing the form are as follows:

1. **List the Activities** of the field agent over the year in the left-hand column, in rough chronological sequence.

2. **Estimate the Two Factors Which Determine the Time Required.** The first factor is the number of groups the agent must meet, visit, or service for each activity. The agent works with three levels of groups: the *community* (PS), the primary society committee or general meeting; the *village* (V), all those who are active or interested; and the *borrower group* (B), 10 to 20 farmers of the same village (preferably neighbors) who have made the same package loan and who are grouped for convenience of servicing. Assume that in the zone Y project the monitor, with a full load of 100 adopters, will work with four village groups and ten borrower groups. The schedule must reflect a maximum rather than an average workload.

The second factor is the time required for each meeting or visit and the number per day. In the "per day" column the number ranges from 1 to 20. These figures are estimates based on the time it actually takes to service one group and to commute from one group to another. Some activities can be accomplished

TABLE 11.1 FIELD AGENT WORK SCHEDULE FOR ZONE Y MONITORS

WORK ACTIVITY	Meeting With	Per Day	Do With	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June
1 Monitor Training at Province Office				5			2		2				2		
2 Present package to PS committee	1 PS	1		(1)											
3 Present package to Village Groups—preparations	4 Vg	2		(2)											
4 Present package to Village Groups—meetings	4 Vg	1		(4)											
5 Survey farms of loan applicants	160 frm	4			(14	18	8)								
6 Clear applications with PS committee	160 frm	20				(3	5)								
7 Complete farmer signoff on loans	100 frm	20					(5)								
8 Distribute oxen to borrower groups	10 Bg	1						(10)							
9 Punch oxen (insert nose rings)	10 Bg		8												
10 Distribute ox plows	4 Vg	1						(4)							
11 Distribute seeder-weeder attachments	4 Vg	1							(4)						
12 Train oxen—presentation	10 Bg	1						(8	2)						
13 Train oxen—followup No. 1	100 frm	5							(14	6)					
14 Train oxen—followup No. 2	10 Bg	2								(5)					
15 Prepare 1st season farmer workplans	100 frm		13												
16 Distribute 1st season seeds and fertilizer	4 Vg	1								(4)					
17 Train use of seeder—presentation	10 Bg	1								(4	6)				
18 Train use of seeder—followup	100 frm	6									(13	4)			
19 Guide 1st season cultural practices	100 frm		18												
20 Train use of weeder—presentation	10 Bg	1										(10)			
21 Train use of weeder—followup	100 frm	6										(5	12)		
22 Recheck 1st season practices	100 frm	5											(5	15)	
23 Prepare 2nd season workplans	100 frm		22												
24 Get 1st season yield samples	10 frm	2													(5)
25 Distribute 2nd season seeds	4 Vg													(4)	
26 Check Cotton spraying	100 frm	6		9)											(6
TOTAL DAYS				17	18	21	20	22	22	19	19	19	19	19	11

NOTE: "Meeting With"code: PS = Primary Society, Vg = Village Gp, Bg = Borrower Gp, Frm = Farm; "Per Day" = number of meetings or visits possible per average day; "Do With" = activity can be done simultaneously with indicated activity number; ( ) = period during which the activity can be done.

while conducting visits for other activities. These are indicated in the "do with" column. The *punching of the oxen* (line 9), for example, can be done on the same day that the oxen are distributed to a borrower-group (line 8).

3. **Indicate time limits for each activity.** The form provides about six spaces per month, enough to indicate whether activities take place in the first, middle, or last part of the month. Closer scheduling is not necessary for an annual plan. Some activities, such as distribution of second-season seeds (line 25), must take place during a specific 2-week period. Others, such as surveying loan applicants, can be spread over three months (line 5). The training that launches each phase should take place on consecutive days, not over a range of time, so it is not bracketed.

4. **Allot activity days to each month.** The total time required by each activity is the "meeting with" factor divided by the "per day" factor. First fill in those activities which must be done within one month. Then, proceeding chronologically, distribute the days of the multi-month activities so that no month is overloaded. The feasible monthly workload, even on a 5½- or 6-day work week, is 22 days; 19 days is better.

Features of the Zone Y Schedule

Phase 1: Loan Preparation (lines 1-7). The presentation includes demonstration of equipment and an explanation of the package, its benefits, and its conditions. This may have been preceded in May by a yield-results and practices demonstration (pp. 118-19). At the first presentation (line 2), the committee of the primary society must, presumably, pass a resolution formally requesting assistance and authorizing the activities and the schedule. At the meetings with the village groups (mass meetings) the applicants are signed up. Some will be dropped by the committee as not credit-worthy, subject to some limitations (discussed on page 123). After the survey of the forms of credit applicants, the committee and the staff (monitor, agricultural assistant, and primary society manager) should reduce the list to the number of loans available.

Phase 2: Ox and Plowing Training (lines 8-15). In our example this part of the schedule takes every available day in November and December. The distribution time requirements are determined by the number of farmers that can be supplied by one truckload. Equipment for a village group can be delivered by one truckload, but a truckload of oxen is only sufficient for one borrower-group. When distributing the material, the monitor can also present the extension themes for the phase.

Ox and plow training must wait until the oxen have recovered from the nose-punching. The training presentation can be done with a large group, with the first followup occurring on individual farms. Because of the substantial new skill involved, a second followup is necessary. The group can learn from each others' performance by participating in a *walk-through*, a visit to each farm.

Other Phases. There are three other phases:

Phase 3: 1st Season Planting (16-19)

Phase 4: 1st Season Weeding (20-23)

Phase 5: 2nd Season Startup (24-26)

Planting and weeding require some skills training, but far less than in phase 2. The December farmer training session can also cover the phase 3 and 4 routines. There is some overlap between phases 4 and 5. The cotton field preparation begins while the first season crops are being weeded. So the cotton work plans can be discussed with the farmers while the first-season practices are rechecked.

Professional Staff Work Schedule

The schedule of the township-level professional is essentially derived from the monitor's schedule. In the zone Y plan, each agricultural assistant will have one or two new monitors each year, up to year 6. He should spend a good deal of time making the rounds with them. In addition, he must participate in activities which are too technical for the monitors or which cannot be fitted into their schedules, including:

1. Taking and analyzing soil samples to confirm or modify fertilizer recommendations.
2. Taking second-season yield samples (November) which cannot be fitted into monitor schedules.
3. Setting up demonstrations in new communities of the township where the project has not yet been launched.
4. Arranging major demonstrations and field days.

Most important, however, he should supervise, guide, and assist monitors, devoting about 60% of his time to these tasks. He should spend five to six days a month with each new monitor.

Similarly, a coop assistant covering two townships will be working with one primary society in phase A in years 1 and 2 and up to four primary societies in phase A in year 4. He should devote about 50% of his time training the managers of these phase A societies, or three to eight days a month.

TABLE 11.2 INITIAL SURVEY FORM (FRONT)

COMPREHENSIVE CREDIT INITIAL FARM SURVEY ZONE	farmer: primary society:	no.

village: township: district:

monitor: agr. asst:

members of the household			labor value
names	ages	other occupation	

miscellaneous assets

oxen: cattle: plough: spraypump:

PRELIMINARY PROGRAM

crops	hectares present	hectares planned	credit needed	present yield	present earned	cash income improved yield	cash income improved earned	cash income incr'se

APPROVALS

farmer: PS manager:

monitor: PS chairman:

agr. asst: AA/Credit:

TABLE 11.2 INITIAL SURVEY FORM (BACK)

LAND UTILIZATION
INITIAL SURVEY farmer: no.

plot no.	in crop	past year's crops grown first season	second season	dimensions	hectares	analysis

NOTE: At the bottom, make a sketch of plot locations.

THE MONITOR-FARMER RELATIONSHIP

Package Adaptation

The standard package for zone Y was based on a family workforce of 2½ MEs (p. 60). Nearly all farms will have more or less this number. How should a bottleneck-breaker package be adapted to the resources of a particular farm?

Specific production targets are needed for each new adopter. Targets for the project were set by linear programming, by far the most difficult planning technique applied in this book. How can monitors or agricultural assistants be expected to do linear programming for dozens of farms? Can they communicate the results to farmers in any comprehensible and credible fashion? Farm-level target setting has to be done with a simplified and flexible technique.

First, the monitor needs to determine the farmer's resources and current activities by filling out part of the Initial Survey Form (Table 11.2). After filling in the heading, he fills in the block for the household members. Their labor value is taken from a look-up table (see page 61). Then with the help of the farmer, he paces off the fields to determine the number of ares and takes a rough estimate of the smaller plots. At this point he must determine the sizes of the larger plots from the dimensions, to the nearest five ares. He should then summarize the hectares presently grown (or grown during the past season) in the "preliminary program" block.

His next task is to get a commitment to expand acreage, and to list these acreages for the coming season under the "hectares planned" column. The monitor should suggest a recommended number of ares for each of the main crops of the package and also an acceptable range, based on the amount of labor in the family. A possible look-up table might be:

	Cotton Ares		Peanut Ares	
Labor (MEs)	Recommended	Maximum/ Minimum	Recommended	Maximum/ Minimum
1.0	60	50- 70	30	25- 35
///				
1.6	95	80-110	50	40- 55
1.8	105	90-125	55	45- 65
2.0	120	100-140	60	50- 70
2.2	130	110-155	65	55- 75
2.4	140	120-170	75	60- 85
2.6	155	130-180	80	65- 90
2.8	170	140-195	85	70-100
3.0	180	150-205	90	75-105
3.2	190	160-200	100	80-110
3.4	200	180-240	105	85-120

TABLE 11.3 PRODUCTION INPUTS FORM

PRODUCTION INPUT REQUIREMENTS form no. 2	farmer:						no.:
	crops:						
Hectares Planned	Initial						
	Revised						
	Final						
Fertilizer Recommendation	Cost per Ha.						
Initial Plan	Kgs.						
	Cost						
Revised Plan	Kgs.						
	Cost						
Pesticide Recommendation	Cost per Ha.						
Initial Plan	Kgs.						
	Cost						
Revised Plan	Kgs.						
	Cost						
Seed Recommendation	Cost per Ha.						
Initial Plan	Kgs.						
	Cost						
Revised Plan	Kgs.						
	Cost						
Total Loan	Initial						
	Revised						
	Date						
	Due						
	Interest						

MEDIUM TERM LOANS Items	Cost	Loan	Date Needed	Date Received	Total Interest	Installments No.	Installments Amount

Monitor	Society

TABLE 11.4 FARM SCHEDULE CONTROL FORM (FRONT)

FARM WORK PLAN							
Farmer Monitor Agricultural Assistant		Name of First Crop			Name of Second Crop		
		First Plan	Final Plan	Actual	First Plan	Final Plan	Actual
1 HECTARES				Fill in With Dates			
2 Preparation	Slashing						
3	Plowing						
4	Harrowing						
5 Seed	Kilos						
6	Delivered						
7	Planted						
8 Weedings	First						
9	Second						
10	Third						
11 Spraying	Delivered						
12	First						
13	Second						
14	Third						
15 Fertilizer	Delivered						
16	First						
17	Second						
18 Harvest	Started						
19	Finished						
20	Delivered						
21	Yield						
22	Price						
23	Gross Value						
24	Net Value						

TABLE 11.4 FARM SCHEDULE CONTROL FORM (BACK)

OXEN

			Plan	Actual
Purchase		Date		
		Price		
Train				
	Plowing	1st		
		2nd		
	Seeding	1st		
	Weeding	2nd		

EQUIPMENT PURCHASE

		Plan	Actual
Toolbar-Plow	Fill in dates		
Weeder-Seeder			
Spray Pump			

RECORD OF VISITS Use two lines per visit

Date	Operation	Crop	Problems Encountered

This table is taken from the standard package (Table 9.1) which called for a farm of 2.5 MEs to handle 142 ares of cotton—about 60 ares per ME to the nearest five ares. This figure is used to compute ares recommended for other MEs. The minimum-maximum figures are simply the recommended ares per ME, plus or minus five or ten ares. At this point, the recommendation can be made to the farmer.

The cash income columns should be filled out from similar look-up tables. One table should give standard yields, by the hundredweight, for various ares of each crop. Another table should give earnings for various hundredweights. The project manager might have the monitor complete the form when he does the survey, or he might do it at the society office with the help of the secretary-manager. The farmer should get a copy of this and other forms. Income targets are more important as a source of motivation to farmers than production targets.

Later the targets may have to be changed. If the rains come late, more food-crop acreage will have to be planted to compensate for lower expected food-crop yields. Revised acreages and consequently revised input requirements are reflected on the Production Inputs Form (Table 11.3). For each type of input there is an initial and a revised plan block. Again, costs and kilos required should be computed by referring to a look-up table. The figures should be rounded: if seed or fertilizer comes in 20-kilo bags, then the requirements should be to the nearest 20 kilos.

Fertilizer recommendations may also be adapted. Modifying zonal recommendations on fertilizer requires some kind of local soil testing or fertility trial demonstrations. This may be feasible as the project progresses at least on a village basis, although not on a farm-by-farm basis. Fertilizer recommendations may also be adapted to the number of years a plot has been under cultivation. The form has a "years in crop" column on the Land Utilization Survey block.

Follow-Through

A farmer will get results only if he follows the recommended practices *on time*. He will have to make changes from his traditional work schedule as he applies bottleneck-breakers (p. 91). The monitor should make up a work schedule for each farm (see Table 11.4). The planned dates should be taken from a look-up table, prepared perhaps by the district agricultural officer in consultation with the township-level agricultural assistant. On the reverse side of the form the monitor should fill in the dates he visited farms and, very briefly, what he saw, what operations were in progress, and any problems he noted.

The Borrower-Borrower-Group Relationship

The organization of farmers into small groups is very important. it speeds up teaching and distribution of material and can help assure credit discipline (p. 122). There is an additional broad psychological benefit. Each member considers himself a member of a new peer group, whose standard of performance is at a new high. He strives to meet the norms of that group and takes pride in being part of it. Groups should preferably be composed of reasonably close neighbors, but they should also be balanced. If only larger farmers form the first groups, the subsequent groups may be too weak for overall credit.

EXERCISES

1. After reviewing Table 11.1, the province agricultural officer asks you to revise the schedule so that, except during two peak months, the maximum number of days will be reduced to 17. What activities would you shift, modify, or combine to respond to this request? Prepare a revised Field Agent Work Schedule.
2. Refer to exercise (p. 152), Table 7.1 (p. 114) and Table 9.1 (p. 141). Prepare a Field Agent Work Schedule and a Farm Survey Form relevant to the needs of a project promoting package B. Assume that the present system farm work calendar will continue to be followed.

STAFF GUIDANCE AND CONTROL

The Operations Manual

A lot of technical and administrative information must be communicated to the project staff. This information must be taught in training sessions and *retained* in writing. Often bulletins need to be sent out revising various items.

The best way for staff to maintain this information is in a looseleaf Operations Manual. It should be systematically codified by section and chapter. Table 11.5 gives a suggested list of sections.

Much of the material will be common to the nation or the region; other manual orders will be specific to the zone or district. Some of the manual orders will concern primarily the coop managers and supervisory officers, although the information should also be communicated to the extension staff. Each order should be identified by number and date in the upper left-hand corner. The recipient should file it in the proper place, discarding the the previous issuance.

TABLE 11.5 REGION R OPERATIONS MANUAL

Table of Contents

100: General

- 110 Overall Policy statements by the minister etc.
- 120 Zone Plans
- 130 Organization & Responsibilities
- 140 General Project Procedures
- 150 Project Schedules
- 160 Field Staff Work Schedules
- 170 Primary Society Management Schedule

200: Credit & Supply Procedures

300: Farm Programming

- 310 Standard Packages
- 320 Initial Farm Program Procedures
  - 321 Use of the Survey Form
  - 322 Initial Programming Procedure
  - 323 Revised Programming Procedure
- 330 Programming Standard Factor Tables
  - 331 Standard Man-Equivalents
  - 332 Standard Yield Estimates
  - 333 Standard Earning Estimates
  - 334 Standard Input Requirements
- 340 Use of the Production Inputs Table
- 350 Farm Work Schedules
  - 331 Use of the Form
  - 332 Standard Work Calendars

400: Equipment & Oxen

- 410 Oxen
  - 411 General Handling
  - 412 Procurement
  - 413 Illnesses
- 420 Ox Plows
  - 421 Features of the Improved Plow
  - 422 Handling of the Improved Plow
  - 423 Procurement & Inventories
  - 424 Spare Parts
  - 425 Maintenance & Repairs
- 430 Seeders
- 440 Weeding Attachments
- 450 Spray Pumps

500: Crop Husbandry—chapters for each crop

600: Soil Fertility—bulletins with recommendations by crop and zone

700: Marketing & Storage

800: Supervision

900: Miscellaneous

Staff Work Schedule Control

All staff should have personal work schedules similar to the farmer's schedule. The monitors' schedules should show, by village and borrower-group, the planned and actual dates of each activity:

MONITOR WORK SCHEDULE

PHASE 2

Village Borrower Group	Distribute Oxen			Distribute Plows			etc
	Plan 1	Plan 2	Actual	Plan 1	Plan 2	Actual	
Village A				12/5			
Group 1	11/6	11/8	11/9				
Group 2	11/8	11/10					
Village B				12/7			

Similarly, the agricultural assistant should have a schedule broken down by villages, the district officer a schedule broken down by townships, etc.

Thus the theme, *first plan/revised plan/actual*, should run through the scheduling of everyone involved in the project. The first plan enables all staff members to block out their work properly. The revised plan gives them a base against which to check their actual performance.

It is also useful to have summaries of the farmers' work schedules. The monitor might have a sheet for each borrower-group with a rough tally of how many have completed certain operations and received certain assistance. This can be reviewed by the professional staff to see what kinds of delays and problems are being encountered. The staff can also discuss these summaries with the primary society committee to inform them of the progress and performance of the project.

Spot-Checking and Disciplinary Action

It is important that a senior officer periodically visit in the field to examine up-to-date records of planned-vs-actual operations. The planned-vs-actual format immediately focuses attention on divergences from plan. It provides a basis for *management by exception*, for getting down to the real problems.

The senior officer should then spot-check a few actual farmer records to see if they are properly recorded. He need not examine any representative or significant sample to make his point; the fact that records are liable to be checked by a senior official is a deterrent to misrecording. If a deliberate misrecording is found and if immediate disciplinary action is taken, the word will get around that the government insists on performance. Even without such a discovery and followup action, frequent spot-checking will motivate the field staff to be aware and efficient.

12
Scheduling

This chapter provides the basic management tools for one of the most critical aspects of project success: seeing to it that, week by week, things get done on time.

THE NATURE OF THE PROBLEM

In chapter 1 we noted that projects involve three kinds of tasks: (1) operations, (2) support, and (3) *preparations.* All preparation tasks (the study, planning, and negotiating which must precede operations and support) have one critical attribute: *time.*

The time dimensions of all the necessary tasks are linked together to form a network. From a starting point, various tasks fan out and move in sequence and in parallel—first the planning and negotiating and then the recruiting, equipping, supplying, building, and training. Finally, they converge to support the operations task.

This process repeats itself in annual campaigns. The first years, the point, line, and network phases of a project require a great deal of push to get tasks done on time. The earliest tasks and the earliest events in the tasks require a special effort to get them done on time. A basic agricultural project, then, requires a *sense of urgency.*

There are six common reasons why tasks are not completed on time:

1. **Insufficient Lead Times.** Too often, work begins too late. Certain support tasks (e.g., procurement) require long *lead times.* Ordering and other initial steps must occur months before the day when the support is needed. Project designers and managers are often unrealistic about the lead times required. Support tasks are too often started during the same season as the operations tasks, when realistically they should have been started the previous year.

2. **Omissions and Oversights.** Managers often fail to take into account all the tasks and steps that are necessary to launch a project. For example, support tasks, such as recruiting, training, procurement of supplies and equipment, and credit arrangements, usually involve a multiplicity of time-consuming bureaucratic clearances and approvals.[1]

3. **Uncoordinated Schedules.** Basic agricultural projects invariably involve more than one agency (p. 233). A general agreement to cooperate is easy enough to obtain; but if such an agreement is not followed by effective joint scheduling, people from an agency may not be available when they are needed. For example, training for agricultural field workers is to take place at specific times. Personnel from the Department of Cooperatives should attend some of these sessions. If the Department of Cooperatives' schedule is not coordinated properly with the Department of Agriculture's schedule, the proper personnel may not be available.

4. **Ignored Deadlines.** Certain deadlines are critical to the success of basic agricultural projects, e.g., the deadlines of the cropping season. In many other types of projects, material which arrives a few weeks late can still be used. In agriculture, missing a cropping season deadline usually means waiting until the next year. The rigidity of agricultural deadlines is often not appreciated by officials who must give authorizations and clearances.

Other types of deadlines may be critical, e.g., for annual submissions of budget requests, for quarterly releases of funds, or for periodic meetings of high-level committees. If such deadlines are missed, it may take an extraordinary top-level action to get a project back on schedule.

5. **Indecision.** A common cause of project delay is indecision. A plan, a procurement order, or a building design may be submitted to an official for approval. If he is uncertain about some aspect of the request, he may let the file sit on his desk while he considers the problem. By the time he gets around to making a decision, it may be too late to launch the project in the current year.

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1. For a vivid and detailed illustration, see Jeffry L. Pressman and Aaron B. Wildavsky, *Implementation* (Berkeley: University of California Press, 1973).

Difficult decisions are often delayed because officials avoid them by passing them to superiors. If tenders on bids are sought for the provision of supplies, all the tenders may be higher than the original budgeted estimate. Should the lowest tender be accepted or should a new call be issued? The nominally responsible official is often reluctant to make such a decision, so he gives it to his superior who in turn passes it to his superior, and so on.

Committees cause many delayed decisions. When disagreement is voiced at a committee meeting, a decision may be put off until the next meeting. By that time, it may be too late for action.

6. **Lack of Trouble-shooting.** *Coping* is as essential to effective management as policy and planning. A successful project must have a trouble-shooter, someone who can go immediately to the field when things go wrong. He must have the authority to make decisions or the ability to contact the official with such authority.

To avoid fatal delays a project must have three features:

1. A **thorough schedule** which can alert the project management when work is falling behind, even if the deadline for completion is months away.

2. A **trouble-shooter,** the project manager or a deputy, who can visit in the field looking for deviations from the plan and getting prompt decisions to rectify them.

3. A **sense of urgency** by all involved.

We shall now look at the basic techniques of project scheduling.

SCHEDULING TECHNIQUE–BAR CHARTING

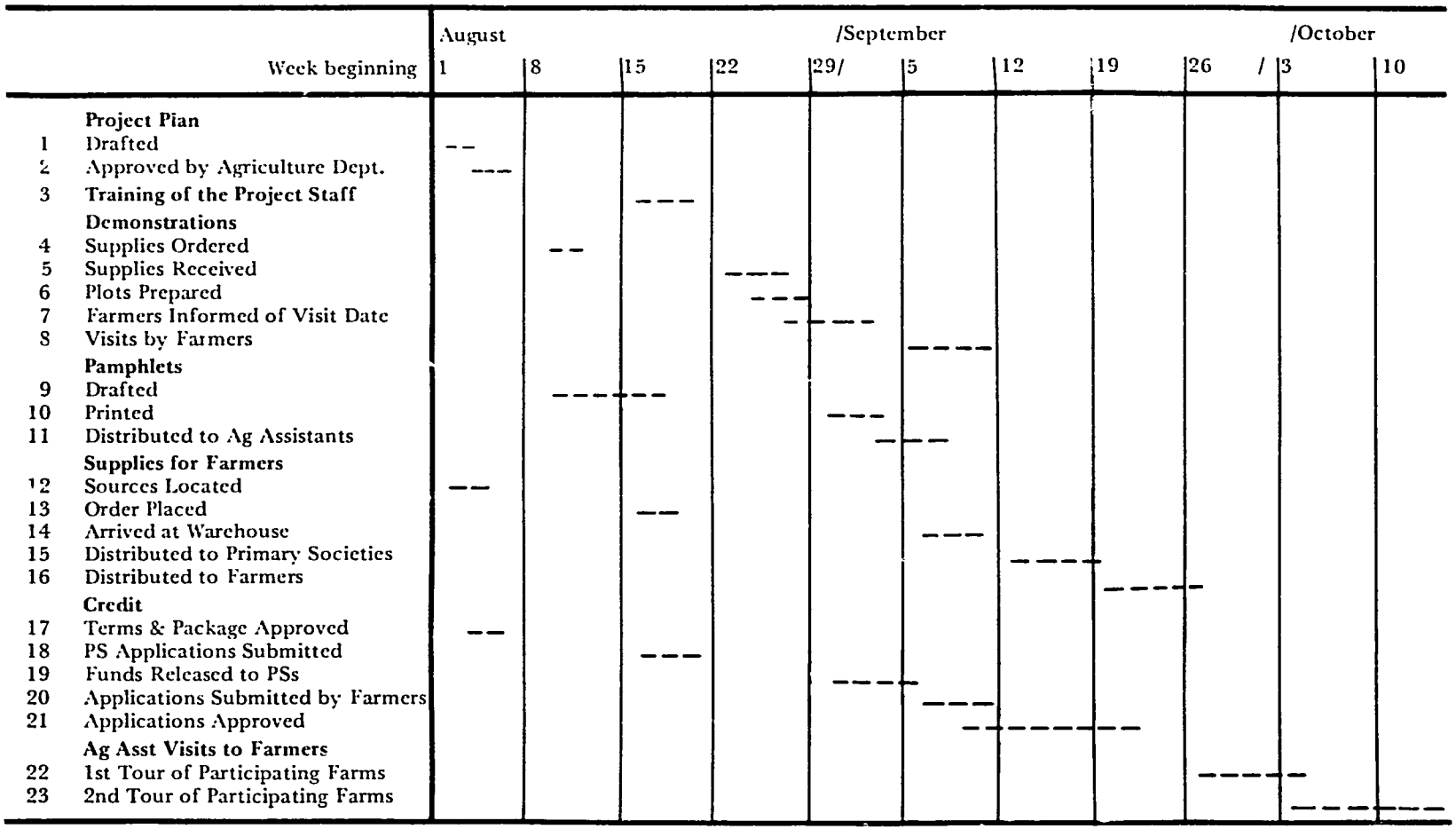
The most common technique used for project scheduling is the Bar Graph or Gantt Chart (see Table 12.1). The tasks and steps within tasks are listed vertically. The time scale and calendar are listed horizontally at the top. Bars to the right of each step show when each element of the work is to be completed.

The bar chart is easy to read and understand. It can also be used to show *planned vs. actual events.* Drawing a vertical line down from today's date indicates where the project is behind schedule. It is a good tool for management by exception, and it indicates where trouble-shooting is needed.

But this technique has two serious limitations:

1. It does not show which tasks and steps are dependent on others. On line 8, for example, visits to demonstrations are scheduled for the week of September

TABLE 12.1 AN EXAMPLE OF BAR-CHART SCHEDULING



NOTE: The above schedule is the Line phase of a project whose standard package includes a) elimination of weeding by application of herbicide to 60 ares of coffee and bananas and b) growing an additional 25 ares of peanuts, using improved seed.

5. Can this activity begin if certain other activities have not been completed? On which activities is it dependent? The chart does not tell us.

2. It does not indicate which activities can survive delays and which cannot. Does the project schedule really collapse if the pamphlets are not written by August 20? Does the project schedule collapse if funds are not released on time (line 19)? Management effort must be selective: it can never focus on everything at once. Management has to know which tasks are critical to the final deadline. The bar charting technique does not provide this information.

CRITICAL PATH METHOD COMPUTATION

Basic Concepts

Projects have succeeded for decades with bar chart scheduling, but there is a better way—the *Critical Path Method* (CPM). CPM views a project as a network of *events* connected by *activities.* Some events can only occur after others are accomplished. The events have a more flexible relationship to the overall task. But, by definition, as well as in sound practice, *all* the stated events must occur to complete the overall task. The *critical* path technique identifies that *sequence* (or path) of *events* which sets the total amount of time required for the overall task. This is the critical path. The other, more flexible arrangements of events are linked to this path to make up the complete task schedule. This network can be drawn as a map showing:

1. The related events which are necessary to some task, such as establishment of the poultry feed scheme.

2. The relationships among those events:

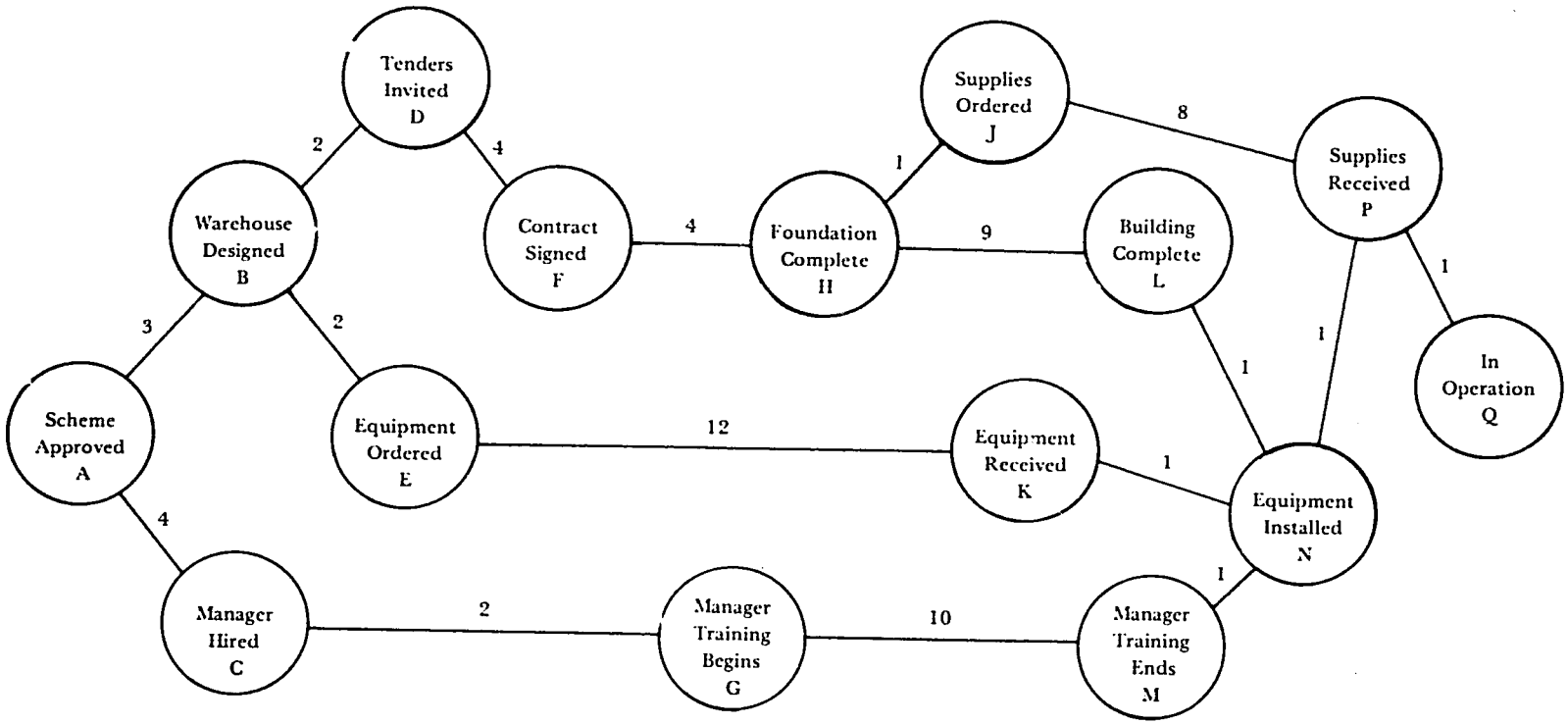
a. in terms of their *sequence*, when they must follow in some order, and

b. in terms of the *time intervals* between related events. Minimum time intervals are set by the time it takes to perform the activity which produces an event.

Diagram 12.1 shows such a network for a rather simple project to launch an enterprise to buy and store maize, mix it with poultry feed additives, and pelletize a high-quality feed for poultry growers in a maize-growing area. This project requires that recruiting and training, equipment procurement, supply procurement (the additives), and construction be carried on at the same time.

The *events,* as their labels indicate, are points in time at which some work is started or completed (events are sometimes referred to as *milestones*). The lines

DIAGRAM 12.1 THE POULTRY FEED SCHEME–CPM NETWORK



Numbers indicate activity times in weeks

connecting them indicate the *activities*, whose content can be inferred from the events preceding and following them. The numbers on the activity lines indicate the necessary amounts of *time*, in weeks, required for each of these activities.

Sometimes the activities consist of solid effort. In other cases an "activity" is a small amount of action which requires a rather long time to be performed because of "waiting time" or delays. Activity AB, from Scheme Approved to Warehouse Designed, requires three weeks of solid work designing the warehouse. But activity BE, from Warehouse Designed to Equipment Ordered, indicates that it usually takes about two weeks to get all the necessary approvals for the issuance of a Government Purchase Order. The actual work may take only a few hours.

The basic set of events necessary to a task is fixed by the nature of that task and by what is required to accomplish it in a particular setting. *Some* of the time-sequence of relationships among those events are also fixed; i.e., before accomplishing D (Tenders to Build Warehouse Invited), it is necessary to complete B (Warehouse Designed). Other relationships are more flexible.

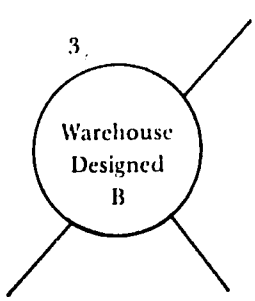
Thus, in Diagram 12.1, C (Manager Hired) cannot occur until after A (Scheme Approved); but C can take place before, after, or at the same time as B. Note, however, that C must take place soon enough to permit M to occur *not later than* events N (Equipment Installed) and P (Supplies Received). Otherwise completion of the overall task will be delayed.

We now turn to the technique of constructing a map or network of events-relationships and to determining the critical path of a project.

Mapping and Scheduling a Network

The first set of computations proceeds from the first to the final event of a network. The object is to determine the *earliest time* by which each event, or milestone, can be reached. Time is indicated in weeks from the starting event, A, which is zero. Since event B follows an activity taking three weeks from event A, the earliest date for event B is 0 + 3 = 3. Event D follows an activity which takes two weeks following event B, so the earliest date for D is 3 + 2 = 5.

The simplest way to keep track of these computations is to write them on the network itself, over or under the events. For example:



Earliest time can also be noted in a table:

Event	Path	Earliest
A		0
B	AB = 0 + 3 =	3
C	AC = 0 + 4 =	4
D	BD = 3 + 2 =	5
E	BE = 3 + 2 =	5
F	DF = 5 + 4 =	9

and so on.

In each case, the earliest time of an event is computed by adding the activity time of its path to the earliest time of the prior event. This continues until reaching a *merge point*, an event where two or more paths must merge (N in Diagram 12.1). All activity leading into a merge-point event must be completed before this event can take place. In Diagram 12.1 equipment can be installed a week after it has been received, but it cannot be installed before the building is complete, the manager is trained, and he is on the site. Similarly, supplies should be received only after the equipment is installed, although it would be physically possible to complete the supply task sooner.

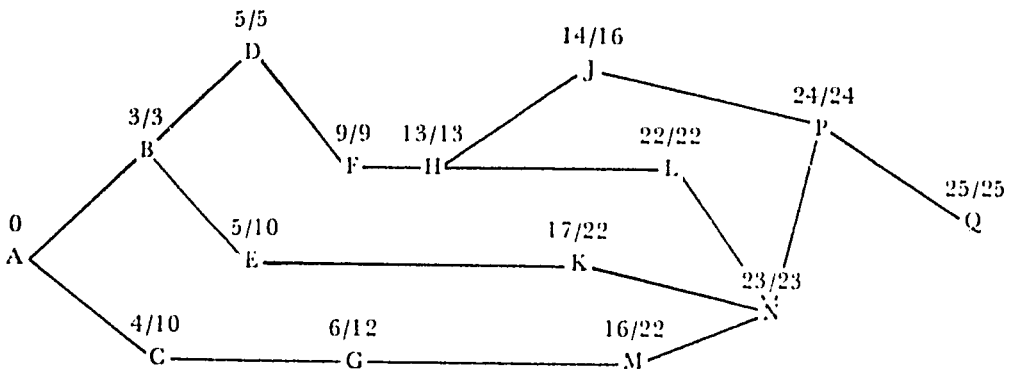
Finally, event Q (Scheme in Operation) can occur one week after P (Supplies Received). So the earliest time for completing the network and getting into operation is 25 weeks after event A, the launching of the effort.

Setting Deadlines Within the Network

What is the *latest time* for each event which will not delay the schedule of the project as a whole? This computation is the opposite of the forward scheduling of task completion which was examined in previous paragraphs. Below are some examples from Diagram 12.1.

Event	Path	Latest Time for the Event	Event	Path	Latest Time for the Event
Q	=	Week 25	G	MG = 22 - 10 =	Week 12
P	QP = 25 - 1 =	Week 24	F	HF = 13 - 4 =	Week 9
N	PN = 24 - 1 =	Week 23	E	KE = 22 - 12 =	Week 10
M	NM = 23 - 1 =	Week 22	D	FD = 9 - 4 =	Week 5
L	NL = 23 - 1 =	Week 22	C	GC = 12 - 2 =	Week 10
K	NK = 23 - 1 =	Week 22	B	EB = 10 - 2 =	Week ~~8~~
J	PJ = 24 - 8 =	Week 16		DB = 5 - 2 =	Week 3
H	LH = 22 - 9 =	Week 13	A	CA = 10 - 4 =	Week ~~6~~
	JH = 16 - 1 =	Week ~~15~~		BA = 3 - 3 =	Week 0

In each case, the "latest time" for an event is determined by (1) noting the scheduled time of the terminal event, and (2) subtracting the amount of time between the terminal event and the event whose deadline we wish to know. For example, event G (Manager Training Begins) must occur 13 weeks before event Q, or *not later than* week 12 of the 25 weeks scheduled for the task. According to our estimates, the *earliest time* of event G is week 6. The following table shows how deadlines are calculated.



When two or more paths lead backwards to an event, a decision must be made: which latest time value should be taken? Obviously, the latest times for events at division points should be the lowest time values. For event H of Diagram 12.1, the higher value for the latest time is JH = week 25 - 9 = week 16 - 1 = week 15. But if the foundation is not finished until week 15, then event L cannot be reached until week 15 + 9 = 24. Since a minimum of three weeks is necessary to get from L to Q, finishing the foundation in week 15 results in a two-week delay in the task. So the *deadline* for event H is week 13. It can be established by this computation:

Path Q–P–J–H = 10 weeks

Path Q–P–N–L–H = 12 weeks

Therefore, H must occur 12 weeks before Q to avoid delay, and week 25 - 12 weeks = 13 weeks.

The computations for the network give us this combination of earliest time and latest time for each of the necessary events. Now we can establish the Critical Path—the sequence of events which determines the minimum time required for the overall task.

The Critical Path is the route leading through the set of events whose earliest time is the same as the latest time. It is the path along which any delay will set back the final completion of the effort. In this network the critical path is:

A–B–D–F–H–L–N–P–Q

Each event of this path must be reached by its earliest time.

On other paths there is *slack*, a difference between earliest and latest time. This permits delay without invariably slowing the completion of the overall task.

Path A–C–G–M–N has a slack of six weeks. Path B–E–K–N has a slack of five weeks. Path H–J–P has a slack of two weeks. These slacks are the maximum amounts of delay hich will not affect the final deadline.

Slack Allocation and Scheduling

Now we know the range of earliest and latest times for scheduling events. The range is zero for events on the critical path. For events on the slack paths, there is some range of choice. We might schedule event C for any week between four and ten. There is some choice as to where to *allocate slack* to the various activities that lie on the given slack path.

On path B–E–K–N, for example, there is a slack of five weeks. We can add five weeks to activity BE, EK, or KN. Or, part of the five weeks could be assigned to each activity, e.g., two weeks more to activity BE, two weeks more to activity EK, and one week more to activity KN. The way in which slack is allocated determines the schedule of the activities along the slack paths.

	Slack	Activity		Scheduling
	5 weeks +	BE (3 + 2)	=	E = week 10
		EK (10 + 12)	=	K = week 22
or	2 weeks +	BE (3 + 2)	=	E = week 7
	2 weeks +	EK (7 + 12)	=	K = week 21
	1 week +	KN (22 + 1)	=	N = week 23

How do you decide where to allocate slack? A project manager responsible for the poultry feed scheme has a choice of allocating more time to the issuance of the purchase order; to the production and shipment of equipment by a manufacturer in a nearby country; or to the time that equipment sits in the

warehouse prior to installation. The manager would probably like to allow more time for production and shipment so that a delay by the manufacturer or shipper will not upset the entire schedule. Adding all the slack to EK would make a delay of up to five weeks on the part of the manufacturer or shipper acceptable.

In general, *slack should be allocated to those activities which are least under our control*—activities which people outside the organization must perform.

Presentation and Use in Coping

Once the scheduled dates are decided, the network and schedule should be presented in as cogent a manner as possible. Diagram 12.2 gives the author's slack allocation and scheduling in a workable format, with one event added. In contrast to the bar chart, the interdependencies and flexibilities of activities and events are shown. As on the bar chart, planned vs. actual occurrences can be indicated.

The CPM schedule is an excellent guide to trouble-shooting. The manager should check the status of each activity a few days or weeks before the scheduled deadline of its terminal event. If an activity is moving at a pace that will not make the deadline, the manager must "crash" the activity: apply extra efforts, resources, or decisions to get it done in time.

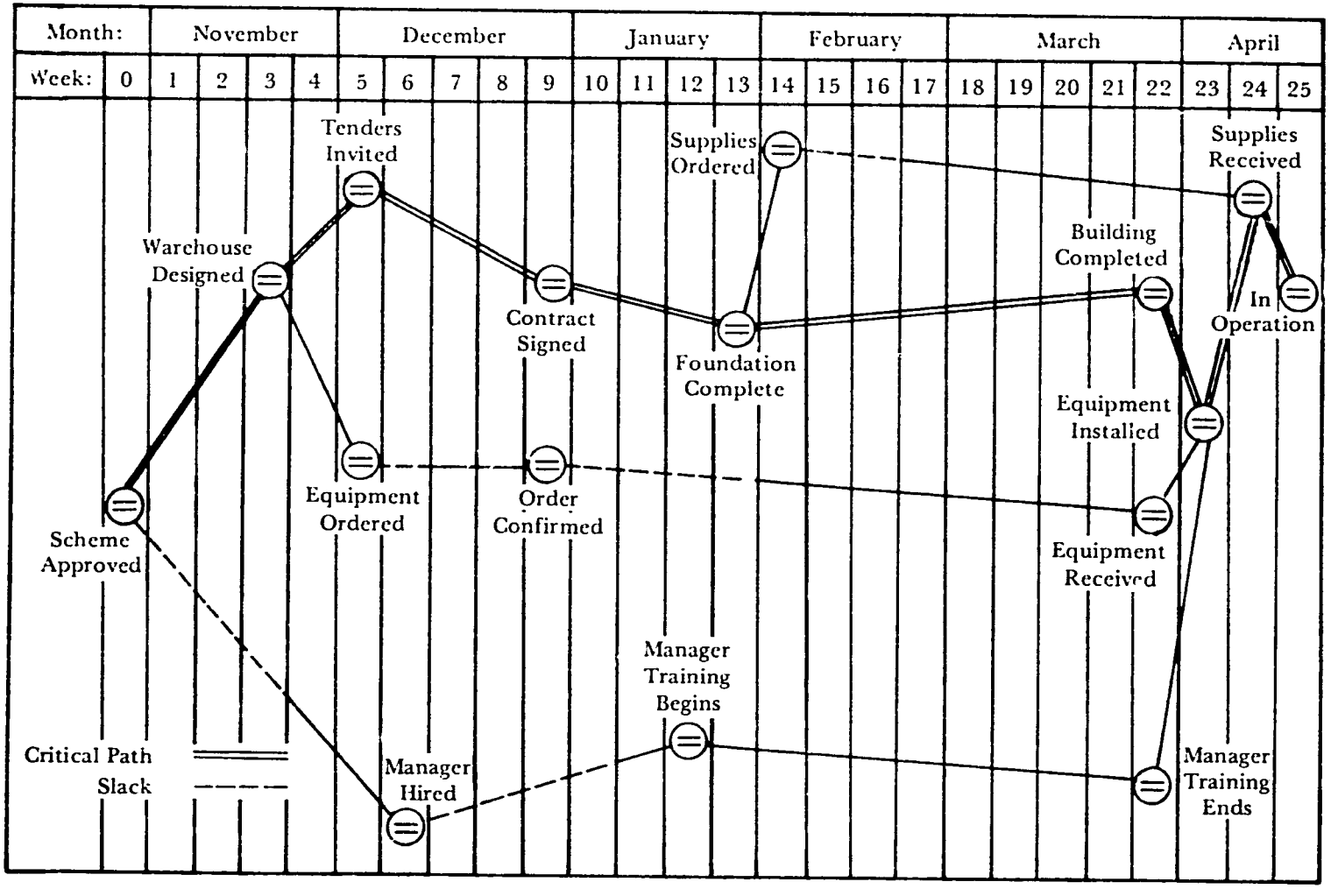
It is useful to examine each activity well ahead of time to consider how it might be crashed. If construction or design work falls behind, for example, more manpower or overtime work can be authorized to get caught up. If office activities, such as issuance of purchase orders or contracts, fall behind, the responsible senior official can call a special meeting to get the necessary signoffs. If a supplier is behind, express shipment can be authorized.

It is sometimes useful to break up a long activity with an intermediate milestone in order to be alerted to any need for crash action. So an additional event, Order Confirmed, is scheduled for week 9. If the order did not get to the supplier or into his production in time, one week before the scheduled date of Equipment Received is too late to take remedial action. Ten to sixteen weeks of work cannot be crashed in one week.

CPM is a planning tool. Like other planning tools, it is also a coping tool. It should be consulted often and compared with reality. As a planning tool, a CPM map is a set of predictions about two related things: (1) the events and activities necessary to fulfill some purpose, and (2) the time required for each event.

In a world of perfect knowledge, such a map would be completely reliable. In the real world we find a mixture of the certain, the probable, the possible, and

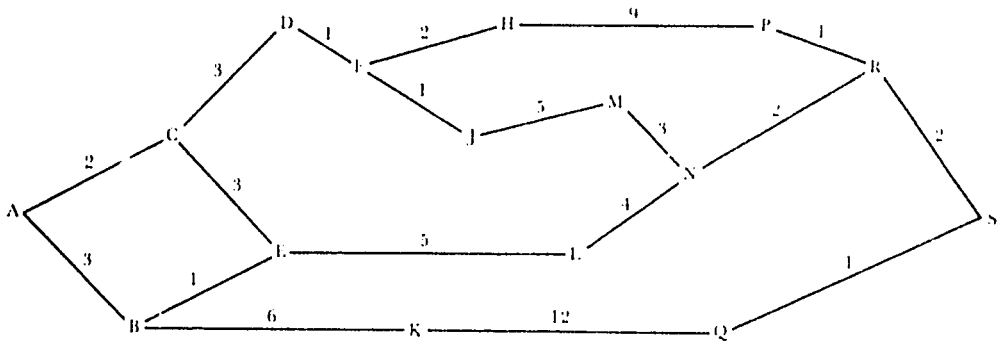
DIAGRAM 12.2 THE POULTRY FEED SCHEME - CPM SCHEDULE



the unknown. We also deal with two basic types of situations: the controllable and the uncontrollable. Yet when we commit ourselves to action, when our purpose is clear and our knowledge of the necessary means is reasonably sound, we commit ourselves to acting *as if* we know the essential network of activities and events, and acting *as if* we could control or influence the course of those events. CPM mapping cannot eliminate the unknown or the uncontrollable. It can, however, help us confront the issues, specify our assumptions, and then assist us in mapping the real against the intended. In this way it can facilitate both management and control of the types of activities which the method fits.

EXERCISE

Compute the earliest date and latest dates and find the critical path of the following network:



NETWORKING

Problems

There are three phases to the networking process, each of which has its stumbling blocks.

1. **Work Packaging.** Listing the tasks and events is called the work package. What are the relevant tasks and events of a project? On a construction or engineering job, the list of components and manufacturing or building operations indicates the relevant events. On an agricultural project, the physical work steps are only a small part of it. They must be proceded by a variety of bureaucratic steps, e.g., drafting, getting approvals, getting concurrences, negotiating, surveying, studying, computing, communicating, training, ordering, and arranging.

2. **Laying out a Network.** The events in the work package must be put together in a clear and coherent network. A measure of skill is necessary to avoid an incomprehensible mess of crisscrossing lines.

3. **Presentation.** A typical agricultural project may require a network of some 40 to 60 events. It is impossible to get the full names of many events on a network on the largest size stencil. So CPMers have resorted to:

a. **Wall-length schedules.** Managers often try to write all the labels on the schedule in plain English. They find that a six-month schedule then runs the length of an office wall. Copies cannot be stenciled and distributed, and the map is of limited value as a guide to organizational action.

b. **Numeric labeling.** Some CPMers put numbers on all events, with an explanation of the numbered events on another sheet or at the bottom of the sheet. Copies can now be made available, but it is necessary to look up each event. In addition, whenever the slightest change is made in the network, almost all the numbers must change with it.

c. **Bar-chart format.** In view of these problems, many CPMers convert their computed networks into bar charts with broken lines to indicate slack. This overcomes one weakness of the ordinary bar chart by showing the flexibilities. But it does not show the interdependencies.

Alphamemnomic Coding of Events

In the 1950s, as industrial engineers began to apply sophisticated and complex techniques of work measurement, they encountered similar problems of labeling and keeping track of hundreds of work elements. One industrial engineering firm, Serge Birn & Co., therefore, developed a technique of coding the elements by *alphamemnomics* (using letters as memory aids). When the code is built up systematically, a person can easily remember hundreds of three-letter codes.

The author has adapted this technique to CPM by developing a standard catalog of codes for tasks and events of rural development projects (see the Annex to this chapter). It is applicable not only to agricultural projects but also to other types of rural projects which operate over a large number of communities, e.g., school construction, clinic construction, feeder road construction, small irrigation, rural water supplies, adult literacy campaigns, family planning campaigns, and environmental sanitation campaigns.

The three-letter code works on the following system:

1. The first letter gives the general type or category of the task: B for Buying, C for Construction, F for Financing negotiation, M for Marketing preparation, P for Planning, etc. There are 16 standard first-letter codes.

2. The second letter works together with the first to pin down the task and positively identify it. Next to each of the first-letter codes in the catalog there is a list of *suggested* second-letter codes. After B = Buying, for example, the first suggested second-letter code is E = Equipment. So BE would be the code for Buy Equipment, a task with several steps. But if the equipment to be procured happens to be pumps, then we could better call the task BP = Buy Pumps. The suggested second-letter codes help the planner think of all the tasks in that category. He should then modify the code to express the task most literally.

3. The third letter indicates the step within the task. A series of third-letter codes is given after each first-letter code. The catalog, for example, provides 10 possible steps for buying. All 10 steps will rarely be required for a procurement task. The planner should examine the list of third-letter codes for each task and select those relevant to the particular operation.

The codes are so arranged, however, that the steps will almost invariably occur in the order listed in the catalog. Occasionally they may have to be modified, like the second-letter codes, to express the particular step more literally.

The code and catalog serve two purposes. *First*, the catalog serves as a guide to work packaging. For example, the planner may look at B and ask himself if he has any of those to buy. Then he looks at the third-letter codes and asks himself which steps are relevant.

The second purpose is for presentation. With three-letter codes it is possible to put a 60-event network of a six- to nine-month effort on an ordinary stencil with explanations of all the events at the bottom. When a reader has gone through the whole network once, he can generally remember what most of the codes mean.

Work Packaging for Zone Y

By seeing how the standard code applies to the line phase of the zone Y project, a network for the campaign can be developed while observing the thought process of work packaging. Proceed first-letter by first-letter:

A = Agreement. This letter covers negotiations that are not covered by Financing or Planning and can be set aside.

B = Buying. Equipment and oxen must be purchased. What about seed, fertilizer, and pesticide? If the first effort ends with the first season planting, fertilizer and pesticide do not have to be procured. Assume that certified peanut seed will have to be grown as part of the campaign in the zone. So, write on a scratch pad:

BE = Buy Equipment

BO = Buy Oxen

What steps are relevant to each task? Do we need an R = Requirements determined? Perhaps, but this step can better be covered by a planning task. Very often steps are covered by other tasks. Do we need an S = Specifications written? In this case there is little to the specifications writing; it can be combined with the ordering step. A step which takes less than two days or so can best be combined with another step; it produces no significant milestone. Do we need an O = Ordered? Yes. Do we need a C = Confirmed? Yes. Do we need a P = Produced? Yes, on the ox equipment that will be a very significant milestone. Do we need a W = Warehoused? No, but we do need an A = Arrival at the primary society. Finally, we need a D = Distributed, although we may find that event combined with an event on another task. As the networking is done, some steps may be eliminated.

The work packaging for the procurement tasks is as follows:

BE Buy Equipment O, C, P, A, D

BO Buy Oxen O, C, A

D = Demonstration. Special off-season millet plots must be planted in the target villages so that millet weeding can be demonstrated. We must secure cooperators (C), plant the plots (I), and have them visited (V). So we write:

DP Demonstrate Practices C, P, V

E = Evaluation. Must surveys be conducted as background to planning? Target villages must be picked. The zone project coordinator will have to begin his tour of possible target villages, submit his recommendations, and get them approved.

F = Financing. Fund releases must be secured from the budget and the bank (B cannot be used again) for loans. After formulating the project plan, we must determine precise needs, discuss them with the bank and get a commitment, prepare the necessary documentation, and finally get the funds released. So we write:

FB Finance from Budget D, R

FL Finance Loans N, C, D, R

G = Grow. The growing of the certified peanut seed will have some critical timing: it must be planted by a certain deadline. We will have to prepare land, plant on time, harvest on time, ship on time from storage, and distribute the seed on time. So we write:

GP Grow Peanut seed L, P, H, S, D

I = Implementation. The final operation is generally a series of steps labeled Implementation (in the villages). Ordinarily, volume or numbers of clients, targets, or material do not enter into CPM. But the number of village groups to be served by one agent will have a major effect on timing and scheduling. So for scheduling purposes, there should be two separate tasks: IB = Implementation in Beginning village, and IE = Implementation in Ending village. Sometimes the final operation task can be completed in a pilot village in advance. The reader should examine the list of third-letter codes for I = Implementation and consider, in the light of the Field Agent Work Schedule, which steps are relevant.

Diagram 12.3 shows the completed work package and schedule with the activity times. At the bottom of the network, four externally determined dates are noted: XBL, the latest date for submitting certain types of budget requests; XBE, the earliest date for releases of funds; XCL, the latest date for harvesting peanuts; and XCL, the latest date for planting first-season crops. Under each of these events is the designated earliest or latest date. They are connected to the event whose timing they govern.

The school solution for finding the critical path in the network in Diagram 12.3 is found on Diagram 12.4. Note that the network is completed about two weeks before the final XCL. The final deadline of a network in CPM is determined by the earliest dates along the critical path. It states the earliest the effort *can* be completed, not that it *must* or *will* be finished by then.

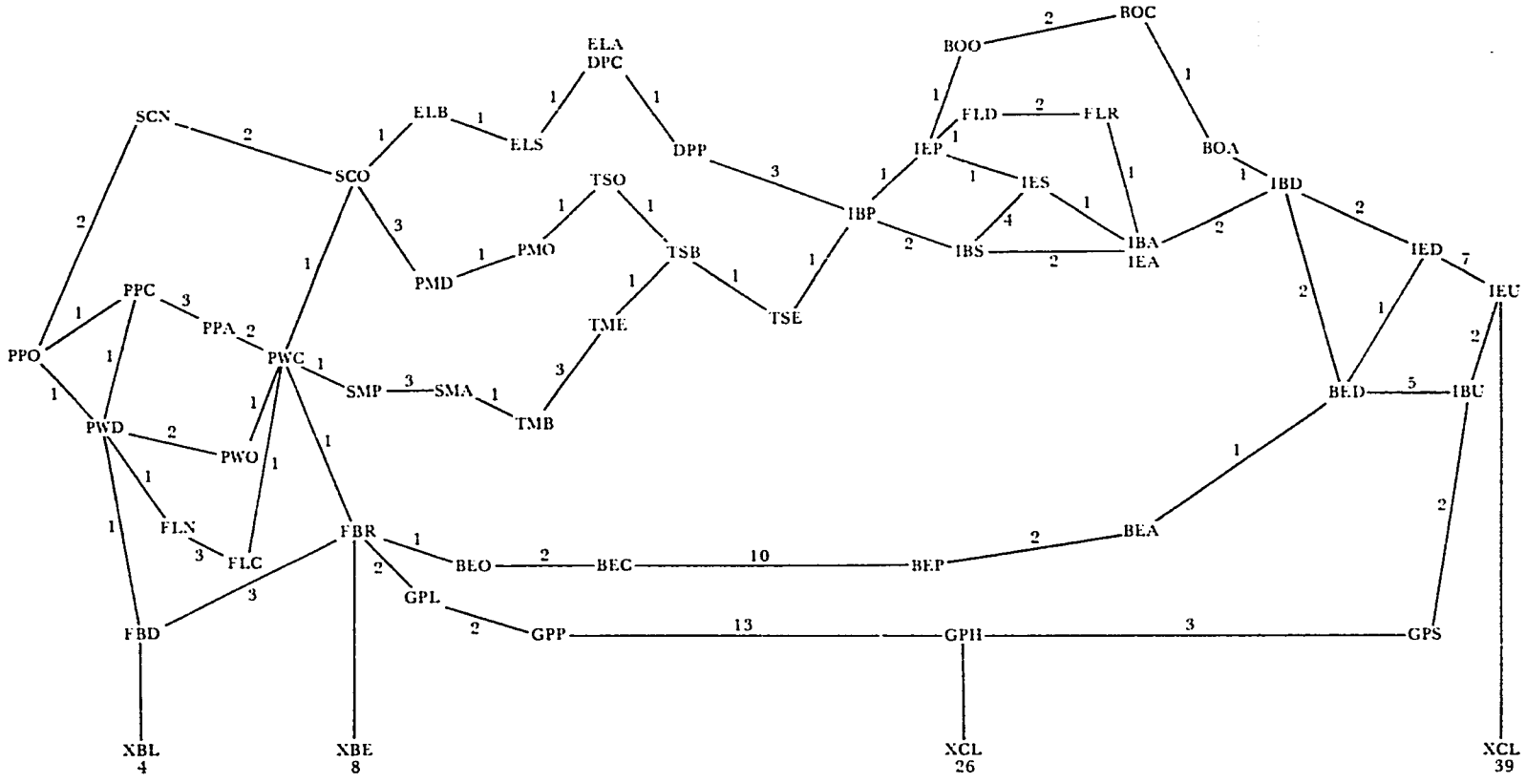
Layout and Presentation

Once the work package is assembled (as shown at the bottom of Diagram 12.3) the events should be arranged into a network. To avoid crisscrossing or running off the sheet, it is often necessary to zigzag a good deal. Zigzagging helps put events close together while maintaining visible lines.

Next, keep those tasks to the center which are most likely to have linkages with many other tasks—those most likely to have merge points. These include the initial planning activity, the recruitment and training in the middle, and the implementation in the end.

To avoid crisscrossing, the tasks near the outside should be those involving long lead times for procurement or production. The last tasks required should be located at the extreme outside.

DIAGRAM 12.3 ZONE Y CPM NETWORK



BE	Buy Equipment
BO	Buy Oxen
O	Ordered
C	Confirmed
P	Produced
A	Arrived
D	Distributed
DP	Demonstrate Practices
C	Cooperators secured
P	Planted
EL	Evaluate Locations
B	Begin survey
S	Submit proposal
A	Approval of sites

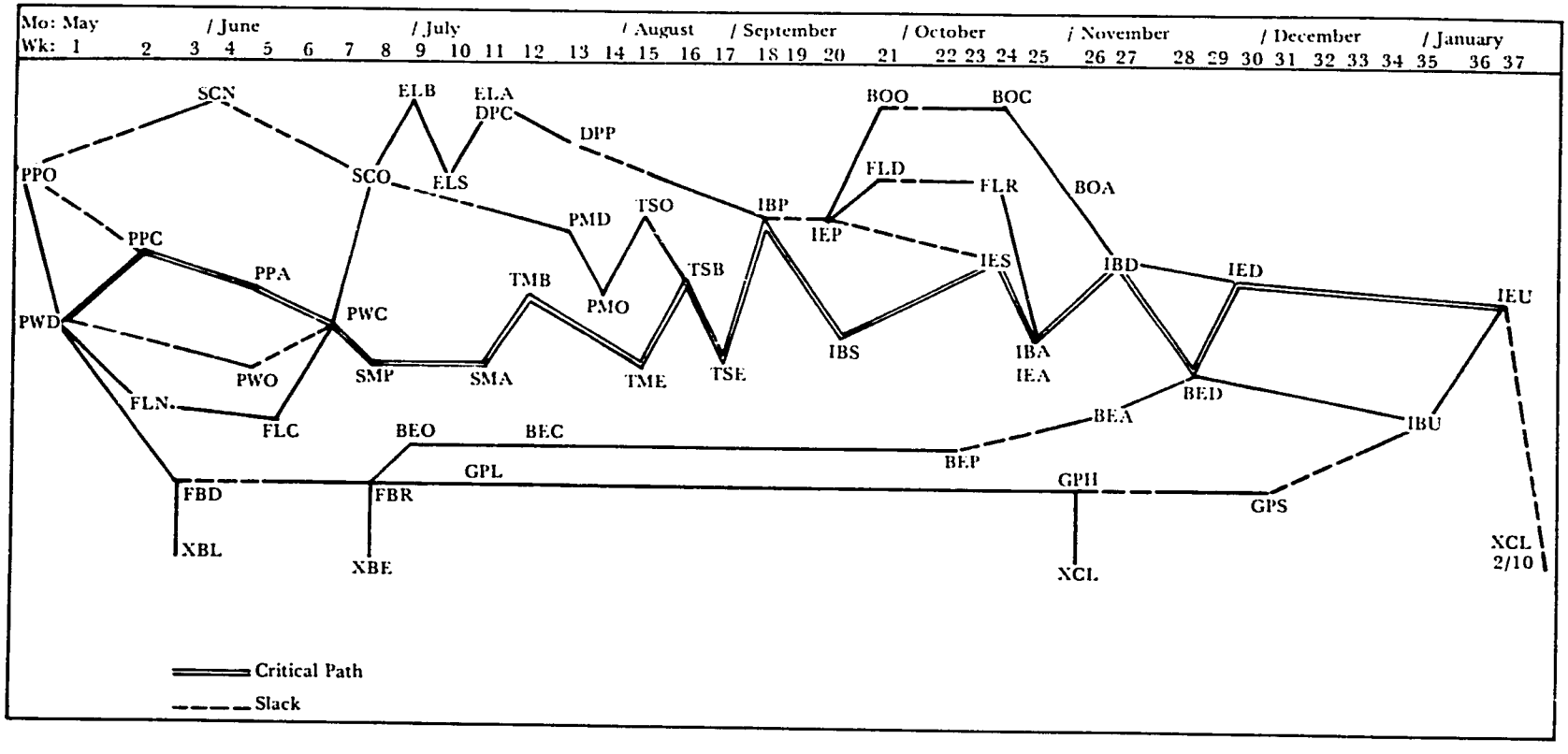
FB	Finance from Budget
FL	Finance Loans
N	Needs determined
C	Commitment received
D	Documentation complete
R	Release of funds
GP	Grow Peanut Seed
L	Land prepared
P	Planted
H	Harvested
S	Shipped

IB	Implement in Beginning Village
IE	Implement in Ending Village
P	Presentation of package
S	Survey of applicants
A	Approval of loans
D	Distribution of oxen
U	Usage of seed
PM	Plan Manual Orders
PP	Plan Project
PW	Plan Workplan
D	Drafted
O	Originating agency approval
C	Concurrences received
A	Authorization complete

SC	Staff Coordinator
SM	Staff Monitors
N	Nominate candidates
P	Publish openings
A	Approve candidates
O	On board
TM	Train Monitors
TS	Train Staff
O	Organize course
B	Begin course
E	End course

XB	Externally fixed by Budget	E	Earliest
XC	Externally fixed by Crop Season	L	Latest

DIAGRAM 12.4 ZONE Y CPM NETWORK



BE	Buy Equipment
BO	Buy Oxen
O	Ordered
C	Confirmed
P	Produced
A	Arrived
D	Distributed
DP	Demonstrate Practices
C	Cooperators secured
P	Planted
EL	Evaluate Locations
B	Begin survey
S	Submit proposal
A	Approval of sites

FB	Finance from Budget
FL	Finance Loans
N	Needs determined
C	Commitment received
D	Documentation complete
R	Release of funds
GP	Grow Peanut Seed
L	Land prepared
P	Planted
H	Harvested
S	Shipped

IB	Implement in Beginning Village
IE	Implement in Ending Village
P	Presentation of Package
S	Survey of applicants
A	Approval of loans
D	Distribution of oxen
U	Usage of seed
PM	Plan Manual Orders
PP	Plan Project
PW	Plan Workplan
D	Drafted
O	Originating agency approval
C	Concurrences received
A	Authorization complete

SC	Staff Coordinator
SM	Staff Monitors
N	Nominate candidates
P	Publish job openings
A	Approve candidates
O	On board
TM	Train Monitors (basic)
TS	Train project staff
O	Organize course
B	Begin course
E	End course

XB	Externally fixed by budget cycle	E	Earliest date
XC	Externally fixed by crop season	L	Latest date

EXERCISES

Draft work packages and networks based on the following project scenarios:

1. The Integrated Poultry Scheme

Following up on a small pilot scheme, this project aims to build a modern hatchery and poultry dressing-and-freezing plant, provide farmers with hybrid boiler chicks, and provide the credit and guidance for construction of improved traditional chicken houses on small farms. It will provide farmers in a number of villages with all the necessary support to operate small but profitable modern poultry enterprises.

Planning and Organization. The project manager drafts a life-of-project plan and gets the approval of his agency and an interagency committee. Before committee approval he must do a market survey and determine the probable pricing. He must also draft a first-year work plan which his agency approves after the committee approval of the plan. After committee approval of the plan, he draws up an organizational plan for the cooperative which will operate the hatchery and dressing plants and handle the extension. This and the workplan must be submitted to the minister for final approval. Once the workplan is approved by his agency, work can proceed on the design of the plants.

Financing. Once the minister has approved the plan, he can get a commitment from the Ministry of Finance for an initial capital grant from the Development Budget. The project manager then completes documentation for the release of funds. He can then complete negotiation with the Cooperative Bank for a long-term loan to construct the buildings. Once the commitment is received, the call for tenders can be issued. After completing documentation on the construction loan, he can negotiate a commitment of the necessary working capital. Once the officers of the new cooperative have been appointed, the commitment of credit for the farmers can be obtained.

Recruiting and Training. The first officers of the cooperative are transferred from other agencies after the minister approves the project. They then staff the project with Poultry Assistants (PAs) who are nominated from the present extension staff and approved by the secretary-general and the commissioner. The job openings for monitors are publicized in target townships. PAs and monitors will be working for the cooperative on a contract basis. One coop officer drafts and gets approval of guidebooks which will serve as the basis of training PAs and monitors. Additional material will be required for training the monitors. PAs are given a short course followed by a longer one for monitors with PAs assisting.

Construction. Tenders are called for construction of both plants. A contract is let and construction proceeds on the hatchery. Once the hatchery is completed, construction proceeds on the dressing plant.

Procurement. Layers and vaccines are ordered from abroad after working capital funds are released. Hatchery equipment is ordered after the initial capital grant since this procurement has a longer lead time. It will be stored in a warehouse until the building is completed. Dressing plant equipment is ordered after the dressing plant foundation is completed.

Implementation. The program is presented first in the beginning village and then in the other villages. Farmers are brought by trucks to the pilot scheme to see a demonstration. The farmers then organize village producer groups and, at the same time, submit requests for loans. By this time the credit has been released. Approvals for all loans are made at the same time. Roofing and barbed wire, locally procured, are distributed to participating farmers, village by village. Once the housing is built, the day-old chicks are distributed.

Breeding. The imported chicks are foundation stock. The hatchery uses it to hatch and raise parent stock. These must be ready to start laying when the farmers are ready to receive their day-old chicks. Vaccine must be received by the time the parent stock is hatched.

Marketing. After the parent stock starts laying, the coop must arrange transportation. Once the first chicks distributed to the farmers are grown, marketing begins. This is the terminal point.

2. The Rice Fertilizer Project

This project is for a region of rice growers in which there is no cooperative structure. There are, however, agricultural assistants in every district, and in some zones there are many local extension clubs built around fertilizer demonstrations. The ministry intends to start a project for distributing fertilizer through district-level coop federations in three districts, with four township-level groups of participants in each. In each township, borrower-groups are to be organized in three or four villages. No monitors will be necessary; teachers will help with the loan applications.

Planning. Before the project plan is drafted, data from fertilizer adaption trials must be collected and analyzed to provide a basis for fertilizer recommenda-

tions in the project, and to provide a basis for computing costs and benefits. Then the project plan is drafted and approved by the department and by an interdepartmental committee. The first-year workplan is drafted, to be approved by the department after the project plan is approved. At the same time, the project manager must make a survey of the target zone to choose target villages. These recommendations must be submitted before the workplan can be approved by the committee.

Financing. Once a project workplan is approved by the department, documentation is prepared for the project budget. Funds are released after the committee approves of the workplan. After committee approval of the workplan, a commitment is given by the cooperative bank on credit for the farmers. Documentation must be submitted and a release secured by the time the fertilizer goes into the district-level warehouses. A loan for warehouse construction is secured once the design is completed; the funds must be released before the signing of the contract for construction.

Recruiting. Once the workplan is approved by the department, the project manager draws up a list of nominees for the three-man project coordination staff from among the officers of the department. They are transferred to the project once the budget funds are released.

Organization of Federation. Once the three coordinators or deputy managers are on board, they visit the districts and townships and arrange for the organizatonal meetings of the new coop federations. The delegates of the township extension clubs elect officers, including the managers.

Training. After the committee has approved the workplan, the project manager begins work on the manual for the managers. This must be approved by the department. After the managers have been selected, he organizes the course. After the district federations have been organized, their committees secure volanteer teachers in each of the target villages. These teachers are brought in for a two-day course on project credit procedures.

Procurement. After the bank gives a commitment on credit, fertilizer is ordered. It will be stored in a warehouse in the port when it arrives, awaiting delivery to the districts upon completion of the warehouses.

Implementation. Once the teachers have been trained, the program is presented at meetings in each of the target villages. The forms are filled out and

the requests for loans are submitted. Upon approval, fertilizer is distributed from the district warehouses. The fertilizer must be distributed to the last village by the final deadline for applying fertilizer to rice.

CLOSING THE PROGRAM MANAGEMENT LOOP

The total program management process has earlier been described as a closed loop. The management system produces decisions for the program system, which in turn delivers services to the client system—the farmers. These in turn produce feedback to the management system.

The planning process requires the bulk of the necessary management skills. Feedback serves as a basis for coping and continuing updating of planning. Feedback is of two types: monitoring of the program and evaluation of the effect of the program on the client system.

Monitoring

The key to control of the field staff work is record-keeping on all work, showing *plan/revised plan/actual* (see chapter 11). This format also applies to the project plan as a whole. Any plan should have a format showing for each period, the plan, the revised plan, and the actual date and volume of accomplishment, together with a final column for a brief explanation of the divergences from plan.

Reports should be kept to a minimum: project officers should regularly consult with subordinates and look at their records. Once or twice a year, however, it is useful to have a tabular report on the project. The format should be roughly the same as the annual columns of the project operations plan, but it should show revisions which have been made in the plan, and actual accomplishments. That report might also include the CPM chart, with lines showing activity finished to date, plus some brief comments on the points at which the project has fallen behind.

How can the effects of a project be reported? There is no easy direct way of measuring the increased production and income each year that are direct results of the project. Let us set that problem aside for a moment. Going back to basic systems terms, we can measure the *volume* and *coverage* of a project. These are direct task outputs. Data are easy to obtain on the number of loans issued, the *coverage* factor, and on the quantity of fertilizer and other supplies and equipment sold, *the volume* factor. That will give us a basis for assessing the *efficiency* of the project, i.e., whether the work was done at the expected cost in time and money.

Evaluation

But did the project get real results? Did it change the state of the system of the clients? Did the farmers covered actually grow more crops and earn more income as planned with the inputs they bought? Was the project *effective?*

Crop statistics alone will not tell. An increase in production may be due to the project, or it may be due to weather or to acreage shifts in response to price expectations.

Direct project effectiveness can only be evaluated by statistical sampling. A sampling of production and yields on farms covered by the project, against a sampling of comparable farms not covered, will provide figures on increased production and income for the average farm covered. Such a sample survey will also indicate what practices are and are not being adopted. Sampling can also give a figure for the average hectare converted to improved practices, on a project which is converting farms gradually to an improved system.

These unit figures, averages derived from sampling, can then be multiplied by volume and coverage figures to estimate the total increase in production and income resulting from the project. In sum, there are two formulas for evaluation:

Data on the Books	x	Statistical Sample	=	Summary Evaluation		
Loans Issued	x	Increased Production Per Farm	=	Increased Production	x	Current Prices =
Supplies Sold	x	Increased Production Per Hectare				Increased Income

Replanning

Many assumptions and estimates based on very limited data are used throughout the planning process. As plans go into action many of the costs, coefficients, task requirements, manpower requirements, and activity times prove false. Fortunately, planning according to formats recommended in this book can easily be revised to reflect lessons learned and new realities.

Week-by-week scheduling by CPM is highly vulnerable to rapid obsolescence. In a typical application of CPM to a basic agricultural project, things may go smoothly during the first third of the campaign. Time may be lost here and there, but the CPM tool helps managers focus efforts enough to stay on schedule along the critical path.

By the middle of the campaign, however, two things are likely to be happening. *First*, delays on noncritical paths eat up all their slack, making several paths "critical." *Second*, project managers find important tasks that were completely overlooked. Such contingencies can usually be met without a general revision of the schedule. Additional lines can be drawn on the network to reflect paths of additional tasks.

By the last third of a typical application, however, it is usually necessary to revise the schedule. So many things have gone wrong that it is necessary to change the logic of the network, to resequence the remaining tasks and events, and to take some undesired but unavoidable risks in the scheduling. Even the best projects look messy on a CPM chart as they enter their final phase. But it is precisely by revealing this messiness in all its ramifications that CPM increases the ability of project managers to complete their projects successfully in spite of unforeseen delays and mishaps.

Multiyear planning formats should be updated annually, applying the lessons of monitoring and evaluation feedback. In each year of project operation, feedback should provide better planning data, and better empirical bases for the next set of assumptions and estimates.

Thus planning, like policymaking and coping, is a continuous process. If proper management tools are used, it can be an improving process. Just as the process of basic agricultural development continuously improves the operation of the farmers, building success upon success, so basic agricultural program management can build on success and lay the base for broader and more effective development—provided it uses adequate tools from the start.

With proper management and control methods, developmental possibilities are enlarged in spite of limited resources and talent. With method and discipline, simple programs can provide the success experience and the institution building which can lead to broader and deeper development.

APPENDIX TO CHAPTER 12

CRITICAL PATH METHOD--STANDARD CODE

A STANDARD ALPHAMNEMONIC CODE OF EVENTS FOR RURAL DEVELOPMENT

CODE SYSTEM

First Letter--general type of activity or task
Second Letter--more precise task descriptor — Work
Third Letter--specific event — Package

FIRST-LETTER CODES

A = Agreements or Authorizations to be negotiated
B = Buying
C = Construction
D = Demonstration
E = Evaluation survey or study
F = Financing, other than by agreement
G = Growing, or crops or animals
I = Implementation in the rural communities
L = Land clearing, irrigating, or other improvement
M = Marketing
O = Organizing, or a committee, agency, coop, or enterprise
P = Plan or Procedure preparation
R = Regulation
S = Staffing
T = Training
X = Externally determined date

CATALOG OF EVENTS

FIRST LETTER	SECOND LETTER*	THIRD LETTER
A Agreement or Authorization	B = Board C = Committee D = Department I = International M = Ministerial P = Private	D = Drafted O = Originating office approval B = Bilateral approval C = Committee approval F = Final approval
B = Buying	E = Equipment F = Fertilizer H = Herbicide M = Machine S = Seed or Sire V = Vehicle	R = Requirements determined S = Specifications written O = Ordered C = Confirmed P = Produced, ready to ship W = Warehoused A = Arrival on site I = Installed D = Distributed
C = Construction	B = Bridge C = Clinic D = Dam F = Factory H = Housing M = Meeting O = Office S = School W = Warehouse	L = Location determined D = Design completed A = Authorized T = Tenders invited C = Contract let M = Materials ordered F = Foundation complete S = Structure/Surface complete I = Interiors complete O = Occupied or Operating

*The second letter should be modified to describe the task or activity.

D = Demonstration	R = Results PS = Practices	L = Location decided C = Cooperators secured P = Plowed or Planted H = Harvested V = Visited by farmers R = Reported and analyzed
E = Evaluation	E = Effectiveness F = Feasibility L = Locations M = Means available P = Problem	B = Begin survey F = Fieldwork completed D = Data collected P = Processing of data complete S = Submission for comment A = Approval of report
F = Financing	B = Budget L = Loan S = Special fund	N = Needs determined S = Source selected C = Commitment received D = Documentation complete R = Release of funds
G = Grow	Use initial of the crop or livestock variety	B = Born L = Land prepared D = Distributed (e.g., calves) P = Planted or Plowed C = Cultivated R = Ready for harvest or sale H = Harvested S = Stored, Shipped, or Sold
I = Implementation	P = Pilot Village B = Beginning Village E = Ending Village	V = Volunteers selected P = Presentation of Program to villagers S = Survey of farms or land O = Organize farmer group R = Requests for assistance submitted A = Approval of requests D = Distribution of material U = Usage of material F = Followup
L = Land	C = Clearing C = Conservation I = Irrigation P = Plowing T = Terrassing	R = Requested S = Surveyed A = Authorized O = Ordered—tractors or service E = Equipment on site B = Basic earthwork complete F = Final earthwork complete U = in Use
M = Marketing	Use initial of the crop or livestock variety	S = Survey market P = Price determined G = Growers engaged C = Contract signed W = Warehouse capacity engaged T = Transport arranged B = Beginning shipment F = Final shipment

O = Organization	A = Agency C = Committee or Coop or Club E = Enterprise P = Primary society	P = Purpose approved S = Structure and Staff approved C = Call for first meeting O = Officers elected or appointed F = Functioning
P = Plans and Procedures	G = Guidelines M = Manual orders P = Project (multiyear) W = Workplan (annual)	D = Drafted O = Originating agency approval C = Concurrences received A = Authorization complete
R = Regulation	C = by Circular D = by Decree L = by Law	D = Drafted O = Originating office approval M = Ministry approval C = Cabinet approval L = Legislative approval P = Publication
S = Staffing	A = Advisers C = Clerks F = Field Agents P = Professionals S = Secondments V = Volunteers	R = Requirements determined D = Documentation complete P = Publication of Position N = Nomination of candidates A = Acceptance of candidates C = Contract signed O = On board
T = Training	A = Academic F = Farmers M = Managers P = Professionals S = Subprofessionals V = Volunteers	M = Material prepared O = Organization completed S = Selection of participants P = Precourse orientation B = Beginning of course E = End of course
X = Externally Determined	As determined by: C = Crop season B = Budget cycle	B = Must Begin by F = Must Finish by E = Earliest possible date L = Latest possible date

13
The Organizational Dimension

Everything in this book has organizational implications. Much has been said about them at one place or another. In this chapter we present a technique for making detailed descriptions of the organization of projects and programs of agricultural development. More precisely, we here examine *one aspect* of what the organization of an agricultural development effort is. This aspect is a combination of the *structures* and *functions* necessary to design and implement a program.

A large number of relationships and activities are necessary for an effective agricultural program. These relationships and activities do not fit neatly within the formal framework of any one organization. Intense efforts are often made to solve the organizational problems of agricultural development by creating some kind of "autonomous agency" to take charge and do everything, and thus to eliminate the need for interagency coordination and cooperation.

These efforts are doomed to failure, except occasionally for very small programs or pilot projects. They fail because it is practically impossible to create an effective autonomous organization for agricultural development. Such an organization is bound to invade the normal jurisdictions of other agencies.

There is no way to escape the power of ministries of finance and planning. It is often impossible to completely bypass the authorities of territorial government units such as provinces and districts. So agricultural development faces the problem of designing and implementing a *system of action* which involves relationships and activities among several different sets of formal organizations.

One aim of this chapter is to make this point utterly clear. The kinds of action patterns essential to effective agricultural development efforts will be described. This will make it possible for you to think deliberately and clearly about these organizational matters. We shall present a technique for mapping relationships and administrative activities typical of an agricultural development effort. In principle, this technique can be used not only to map but also to help *rationalize* the working organization. It is important to note, however, that this presentation of the organizational dimension of agricultural development is incomplete. It deals with *structures* and *functions*. It does not address the more basic problem of *incentives* and *motivations*.

To plan a rational system of action on paper will not necessarily produce it in fact. If one does not know what such an arrangement looks like, there is no way to produce it. But plans are not self-fulfilling.

Our present task stops short of attacking difficult and complicated problems of motivation and incentives which (along with resources) are necessary to convert paper schemes into living systems. This chapter poses several questions:

1. How can we think in effective and practical terms about the organizational dimension of agricultural development?
2. How can we portray the organizational structures and functions necessary to design and implement a program?
3. How can we determine the possibility of organizing and operating the needed action system?

To address this last question we must examine the organizational requirements for our project or program. These can be identified by making an organizational responsibility chart, and then asking: In a particular situation, is it probable, or even possible, to meet the necessary conditions of an effective organizational arrangement? Can the essential structures and functions be established? Are the needed incentives and motivations available? If the answers are more negative than affirmative, serious issues are raised about the soundness of a project or program which may be otherwise economically and financially sound. The importance of these hard questions stems from one hard fact: More projects and programs fail for organizational reasons than for any other.

MAPPING A SYSTEM OF ACTION

Conventional organizational charts, which show the formal structures of organizations, are useful for some purposes; but they ignore many important realities. They do not, for example, show informal working relationships. They do

not describe the complex flows of activities within a single organization. More important, they do not describe the activities which flow across the boundaries of two or more organizations. This is particularly important in the case of agricultural development: the field staffs of several organizations must usually cooperate on a significant number of farms.

The Problem

For country X, Diagram 13.1 presents the general structure of its agricultural services and the organizational chart of its Ministry of Agriculture. The structure combines features found in francophone and anglophone countries, and is generally representative. Note that the extension and cooperative staffs are formally united only at the level of secretary-general. Recognize that these staffs also have working relationships outside the ministry with cooperatives, with the agricultural development bank, with marketing boards, and with the local administration. In many countries the list of relevant ministry field staffs, special agencies, and parastatal bodies involved in agricultural development is much longer.

Many developing countries have tried to find means of integrating these complex structures by setting up:

1. **Provincial-level interagency committees**, which can consult and solve some conflicts, but which have little or no power.

2. **Special provincial or regional coordinators**, whose authority often conflicts with authorities of the various departments.

3. **New rural development agencies or parastatal bodies**, which tend to:

   a. duplicate ministry field staffs;

   b. compete for scarce manpower and talent;

   c. undermine established functions of the Ministry of Agriculture; and

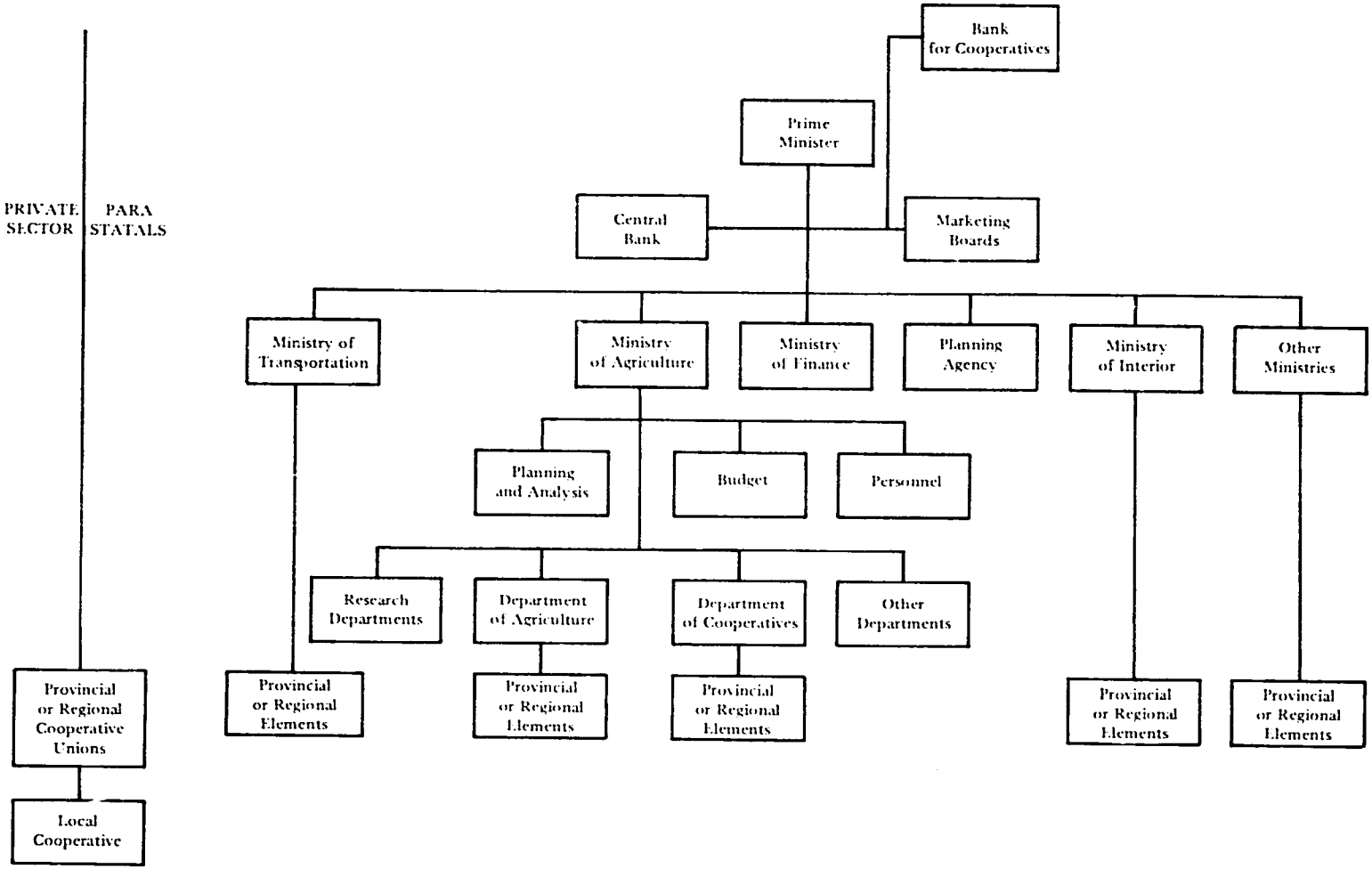
   d. create the same confusion and conflict as the special coordinators.

The Beginning of a Response

The substantive problem is to establish an effective system of activities and relationships. To examine this problem, it is necessary to have a better map of the necessary action system than a conventional organization chart can provide. This will not solve the substantive problem, but it will enable us to describe it, to diagnose its features, and to find possible solutions.

The technique presented, *Organizational Responsibility Charting* (ORC), is truly a type of mapping activity. A territorial map presents a vast amount of

DIAGRAM 13.1 ILLUSTRATION OF ORGANIZATIONS RELEVANT TO AGRICULTURAL DEVELOPMENT TO AGRICULTURAL DEVELOPMENT



material in highly condensed form. (Think of the number of words required to write a description of the relationships and connections between four or five places in a country, in contrast to the succinct statement which a map provides.) Similarly, an organizational map condenses a large amount of relevant information. A territorial map might present topographical data, show transport arrangements, or display the locations of key structures. The organizational maps used in this chapter present information about the locations and the relationships of functions and responsibilities. A territorial map may tell you that "you can't get to place A from place B." An organizational map might indicate that certain substantive relationships, important to effective action, are lacking. Mapping is not problem solving: it is a form of description which may provide the basis for problem solving.

Basic Features of ORC

Organizational Responsibility Charting (ORC) identifies the organizational elements involved in getting a job done. It also lists the functions of each unit and indicates who is responsible for each task.

Table 13.1 represents core ORCs for the basic agricultural development effort in country X. Note that they have the following features:

1. **There is an ORC sheet for each field of activity.** The tables in the text present ORCs for planning, extension (including the coordination of work scheduling), credit, and supply. Other relevant Ministry of Agriculture activities would include research, marketing, irrigation, land development, mechanization, and agricultural education. The ORCs for personnel, finance, and general administration might be common to all ministries of the government.

2. **Positions are listed hierarchically across the top of the chart.** Each field of activity has a given set of players. Those in the ministry are listed hierarchically across the top, from left to right. Departments with high-level roles are listed to the left. Positions in other relevant organizations are listed to the right. A position is a role rather than a particular individual or post. One individual may play different roles.

3. **Functions and tasks are listed.** The actual work or steps of work in the area are broken down into *tasks.* On the charts, each task is identified by a number. The types of activity necessary to the performance of each task are indicated horizontally across the chart by symbols which also specify who is to perform each one. Tasks are grouped for convenience into broader *functions,* and tasks are listed in a combination of sequences:

a. **Importance and Frequency.** The most important and least frequent tasks are placed at the top of the ORC. Less important and more frequent tasks are located below these.

b. **Time sequence.** Tasks are listed in the order in which they should be done.

c. **Policy–Planning–Transactions–Coping.** Tasks are arranged by their contributions to these broad categories of effort.

4. **Tasks-Position Relationships (TPRs).** These are noted at the intersections of the task line and the position column in accordance with a code given in the upper left-hand corner. TPRs state precisely *who* is supposed to do *what*, within the matrix of organizational units and necessary tasks.

MAPPING TASK–POSITION RELATIONSHIPS

Action (A) (see Table 13.1, the symbol *A* in the upper left-hand area, and the symbol as it appears at various places in the table) includes gathering necessary facts, drafting necessary documents, and consulting with others. *A* includes responsibility for transactions by dealing directly with the individuals or outside organizations involved. On policy tasks, *A* includes recognizing when policy decisions should be brought to the attention of superiors, and gathering and preparing the relevant facts and documents. On planning tasks, type *A* activity covers responsibility for gathering relevant facts and drafting all or part of the plan. *A*-type activities include analyses and computation of resource requirements. On trouble-shooting tasks, *A* includes responsibility for any direct activity necessary to solve the problem.

Helps (H) means supporting responsibility for a minor part of Action, generally at the request of and coordinated by *A*.

Must Be Consulted (C) indicates that the person in this position must be informed before action is taken to allow an expression of views. If suggestions are not accepted by *A* or *D*, *C* may shift the matter to a higher level.

Technical Coordination (T) covers the responsibility for specifying the technical requirements and the form of the action. It includes *C*.

Initiates (I) means responsibility for authorizing or requesting *A*, the necessary action on that particular task. It includes *C* and may include *T*, if no one else is assigned that TPR.

Expedites (E) covers responsibility for accomplishing the action on schedule. *E* includes the function of keeping close track of progress and bringing delays to the attention of superiors at the earliest possible moment.

TABLE 13.1 ORGANIZATIONAL RESPONSIBILITY CHART

Area: 03-01: MINISTRY OF AGRICULTURE–PROGRAM PLANNING Date: 30 Aug 1972

sk-Position Relationship Code

: Action — M: Merge Requirements
Must Be Consulted — S: Signoff
: Direct Supervision — T: Technical Coordinate
Expedite — V: Verify by Spot-Check
: General Supervision — X: Approve Policy Exceptions
: Help
Initiate Action — *: Optional or Alternate

					Plan Office						Department of Agriculture																Coop Dept						
	Functions and Tasks	Budget Dept	Planning Dept	Minister of Agr	Secretary Gen'l	U/Secy Finance	Chief Economist	Sr Econ Res'rch	Jr Econ Res'rch	Sr Econ Plan'ng	Jr Econ Plan'ng	Statistician	Commissioner	Dep Commis'nr	A/C Program	A/C Extension	A/C Spcl Proj	Project Dir	A/C Others	Reg Agr Dir	Reg Econ Stat	Reg AO Sp Prj	Reg AO Other	Prov Ag Ofr	Dep Prov AO	APAO Stats	APAO Sp Prj	APAO Other	Dist Ag Of	Commis'ner Coop	Dep Commis'ner	A/C Sply Mktg	A/C Program	Prov Coop Of	Marketing Boards	Prov Coop Unions
0	Overall Programming																																			
–10	Major Policy Guidelines		C	G	D	A	C	C		C			C																	C					C*	
–20	Annual Planning Guidelines	S		G		T				A		C	C	C	C															C	C		C			
–30	Multiyear Program Submission		S	S	S	M	G	C		D	H		S	E	A	C	A*	A	C*	C	A	A	C				C			S	E	C	A		C	C*
–40	Annual Program Submission–Ministry Budget	S		S	S	M				G	H		S	D	A	C	H			C	H									S	D		A			
0	Basic Agricultural Zone Plans																																			
–10	Zone Definition				S		D			A	H	C			C						H											C				
–20	Zone Modal Farm Acreage–Yield Model						G	C	C*	D	E	C									A			C	C	H										
–25	Zone Modal Farm Labor Input Model						G	D	A	C	C									C	H			C		H*										
–30	Annual Price–Market Projections by Crop						G	D	A	C	C	H																				C			A*	
–40	Modal Farm Optimum Programs						G	D	A	C	H	C			C																					
–50	Promotion Strategy Guidelines				S			C*		T	E			D	C	A			C*	C				C*											C	C
–60	Storage & Working Capital Requirements						S			T	E	C			C						A									S	G	C	M	H		C
–70	Multiyear Operation & Financial Plans		S	S	S		G			D	A		S	C	C					C	A*			C						S	C		C	C*	C	C
–75	Multiyear Plan Description		T	S	S		G			D	A				C						H										C					
–80	Annual Project Plan–Extension	S			S					T		C*	S	G	M	D			C*		A			C		H										
–85	Annual Project Plan–Supply & Marketing	S			S					T		C														H				S	G	A*	A	C		
–90	Quarterly Plan Adjustments	S				M							S	G	D	C				C				C	A	H					G		D	A		
0	Special Projects–Production Promotion																																			
–10	Project Scope		C	G*	G		D			A			C				H													C	C				C*	C*
–20	Farm Economics Analysis						G	D	A			C			C		C	C*	C*		H*															
–30	Price & Marketing Projections						G			D	A	H																				C	C			A*
–40	Promotion Strategy Guidelines			S*	S					T	E		G	D	C	C	A	H*	C*			H					C*									
–50	Supply/Marketing Procedures & Staffing			S	S					T	E						H	H*												G	D	A	C	C*	A*	C
–60	Multiyear Operations & Financial Plan		S				G			D	A		S	C	C		H	H*	C*	C																
–70	Annual Project Plan	S			S	S					H		S	G	M		D	A	C*			H				H	H									
–80	Quarterly Project Plan Adjustments	S				S								S	M		G	A				A*					H		C							
0	Special Projects–Processing & Storage (on next page)																																			

TABLE 13.1 ORGANIZATIONAL RESPONSIBILITY CHART (PAGE 2)

Area: 03-02 MINISTRY OF AGRICULTURE–EXTENSION & FIELD COORDINATION Date: 10 Sept 1972

Task-Position Relationship Code

A: Action
C: Must Be Consulted
D: Direct Supervision
E: Expedite
G: General Supervision
H: Help
I: Initiate Action
M: Merge Requirements
S: Signoff
T: Technical Coordinate
V: Verify by Spot-Check
X: Approve Policy Exceptions
*: Optional or Alternate

Functions and Tasks	Minister of Agr	Secretary Gen'l	Commissioner Ag	Dep Commis'ner	AC Extension	Informat'n Dir	Tech Liaison	AC Program	AC Engineering	AC Spc Projects	Project Dirs	AC Research	Sr Scientists	Regional Ag Dirs	RAO Informat'n	RAO Sp Project	RAO Adapt'n Tr'l	Prov Agr Ofcr	Deputy Prov AO	APAO Ad Trial	APAO Others	Dist Ag Ofcr	Ag Assistnt	Monitor	Prov Coop Ofr	APCO Credit	APCO Coop Opn	Dist Coop Of	Coop Asstnt	Prov Union Mgr	Pr Soc Committee	Pr Society Mgr	Vil Gp Leader	FARMER	District Chief	T'ship Chief	Village Chief
	Ministry of Agriculture: Agriculture Department																								Ministry of Agriculture: Coop Dept					Cooperatives					Local Admin		
page 2:																																					
10 Adaptation Trials																																					
−10 Policy Guidelines	S	S	G	E	D		A	H	C*	C		H	C				C*																				
−20 Long Range Plan	S	G	S	D	A		H	M	C	C		H	C	C			C																				
−30 Annual Technical Guidelines			S	G	D		A	M	C	C		H	C																								
−40 Annual Plan by Zone			S	S	G		D	E			C		C*	C		C	A	C	C	H*	C*				C												
−45 Annual Plan by District																	T	G	E	D		A			C										C		
−50 Secure Demonstrators																							D	H*							C		A	C	C	H	H*
−60 Supervise Demonstration Trials																				V		G	A	H*									H	C		C	H
−70 Evaluate and Report Results																	G	C	E	D	C*	A	H								C		C				
−80 Summarize Results			S	G	C		M					T	C	D			A	C		H																	
20 Basic Zone Project Extension Preparations																																					
−10 Policy Guidelines	S	G	D	E	A		H	H						C*				C	H																		
−20 Overall Technical Guidelines			S	G	D	A	H	C	C*																												
−25 Technical Guidelines by Zone					G	T	T*							D	A			D	A						C	C	H			C							
−30 Preliminary Project Plan (from area 03-01)																		D	A			C					C										
−40 Critical Path Schedule of the Annual Campaign								T						G				D	A	C*	C*					C	H			C							
−45 Zone Field Staff Work Schedules								T						G				D	A	H	H*																
−50 Materials for Staff Training														G	T			D	A						A	H	H			H							
−60 Conduct of Staff Training–Technical														G				G	A			H			H					H							
−65 Conduct of Staff Training–Campaign Operations														G																							
−70 Schedule Revision														V																							
30 Basic Zone Project Extension Operations																																					
−10 Presentation of Package to Society Committee																		G	T			A	H					C	C		C	C			C	C	
−20 Presentation to Farmers–Organize Village Meetings																						G	D	H					C		C	C	A	C		C	H
−25 Presentation to Farmers–Hold Village Meetings																							A	H					H			H	C	C		C	C
−30 Select Demonstrator Farmers																							A	H								C	H	C			C
−40 Lay Out Demonstration																		G				D	A	H										C			
−45 Supervise Demonstration																		V				G	D	A									C	C			C
−50 Commune Level Field Day Organization																		G				D	A						C		C	C	C		C	H	
−55 Commune Level Field Day Operation																			G			D	A	H							C	C	C	C			
−60 Village Level Field Day																						G	A	H									H	C		C	H
−70 On-Farm Skill Training																						G	D	A									H	C			C

TABLE 13.1 ORGANIZATIONAL RESPONSIBILITY CHART (PAGE 3)

Area: 03-03 MINISTRY OF AGRICULTURE - PRODUCTION CREDIT Date: 2 Sept 1972

Task-Position Relationship Code

A: Action
C: Must Be Consulted
D: Direct Supervision
E: Expedite
G: General Supervision
H: Help
I: Initiate Action
M: Merge Requirements
S: Signoff
T: Technical Coordinate
V: Verify by Spot-Check
X: Approve Policy Exceptions
*: Optional or Alternate

				Ministry of Agriculture																			Coop Bank					Cooperatives					Local Adm	
								Agriculture Dept								Cooperatives Dept												Prov		Local				
	Functions and Tasks	Ministry Finance	National Bank	Minister of Agr	Secretary Gen'l	Chief Economist	Sr Econ Plan'ng	Commission'r Ag	AC Extension	Tech Liaison	AC Engineer'g	Reg Agr Ofcr	Prov Ag Ofr	Dist Ag Of	Agr Asst	Monitor	Commis'ner Coops	Dep Commis'ner	AC Credit	Cdt Registrar	Credit Review	AC Program	AC Coop Opns	Methods & Trng	Prov Coop Ofcr	Dist Coop Ofr	Coop Asst	Coop Bank Gen Mgr	Operations Dir	Chf Accntant	Reg Branch Mgr	Prov Loan Ofr	Prov Union Mgr	Credit Manager	PS Committee	PS Manager	FARMER	T'ship Chief	Village Chief
10	Registry of Primary Societies for Credit																																						
-10	Policy Guidelines		S	S*	S	C		C*	C								G	D	A		H	C		C				S	C	C*								
-20	Procedures for Registry																S	G	D	A			C	H					C	C								
-30	Application for Registration													C	I*				G	T	S				D	E	H						C	I	A			
-40	Approval of Societies for Registration											C*					X	G	D	M	A				I					C			C					
-50	Maintenance of Creditworthy Societies Registry																	G	D	A									C	C								
-60	Individual Borrower Registration														C*	H										G	D					X		A	M	I	C*	C
-70	Action on Societies in Arrears													C	C										S	A	H				G	D	C	C	C		C	
-80	Deregistration of Societies												C	C			X	G	D	C	A				C							I	H	C	C			C	
20	Annual Credit Programming																																						
-10	General Policy on Credit for Agriculture	G	C	S	D	A*	H	C*									A	I	C									C	C									
-20	Projection of Annual Credit Requirements (from area 03-02 plus non-project requirements)	G	D	S	S	C	T					C					C		M			C			I			C			A	H						
-30	Annual Credit Allocation to Projects & Provinces	S	G	S	S	T											C	C				C			C			D	A	M	C	C	C					
-40	Quarterly Adjustments in Credit Allocation		C										C					C*	C			C						G	D	M	A	C	C					
30	Short-Term Lending																																						
-05	Primary Society Indents of Requirements													C	C										S	D	E				G	V	C	M	A	H		
-10	Union Indents of Requirements																								H				G	M	D	H	S	A				
-15	Releases of Funds to Unions																											G	D	A				C				
-20	Releases of Funds to Primary Societies																								G	C*	C						D	A		I		
-30	Solicitation of Borrowers (area 03-02 on projects)														D	A*										G	T								A	H	C	C	C
-40	Approval of Borrowers															H										G	V					X			A	H	C	C	C
-50	Release of Funds & Material to Borrowers															H											G									A	C		
-60	Followthrough Supervision of Use of Loan														D	A										G	V								C*		C	C	H
-70	Collection of Repayments															H										G	D								C	A	C		C
-80	Action on Delinquent Borrowers -preliminary																									G	T								D	I	C	C	A
-85	Action on Delinquent Borrowers major																								G	D	A				X	I		C	H	C	C	H	C
40	Medium-Term & Comprehensive Lending																																						
-10	Preliminary Package Design (from area 03-01)																																						
-20	Final Package Terms						C		C*	H*	H*						X	G	A				C	H					C		C*		C*						
-30	Release of Funds to Unions (continued)																								E				D	A				I					

TABLE 13.1 ORGANIZATIONAL RESPONSIBILITY CHART (PAGE 4)
Area: 03-04 MINISTRY OF AGRICULTURE-SUPPLY Date: 15 Sept 1972

Task-Position Relationship Code

A: Action
C: Must Be Consulted
D: Direct Supervision
E: Expedite
G: General Supervision
H: Help
I: Initiate Action
M: Merge Requirements
S: Signoff
T: Technical Coordinate
V: Verify by Spot-Check
X: Approve Policy Exceptions
*: Optional or Alternate

Functions and Tasks	Planning Dept	Finance Dept	Commerce Dept	Ministry of Agriculture: Minister of Agr	Secretary Gen'l	Chief Economist	Sr Econ Plan'ng	Agricultural Dept: Commissioner Ag	Tech Liaison	Reg Agr Ofcr	Prov Agr Ofr	Dep Prov AO	Dist Ag Ofr	Ag Assistnt	Monitor	Cooperatives Dept: Commis'ner Coop	Dep Commis'ner	AG Supply Mktg	Supply Dirs	AG Program	Prov Coop Ofcr	APCO Supply	Dist Coop Ofr	Coop Asst	Cooperative Unions: Central: Cntrl Un'n Gen Mgr	Deputy Manager	Procurement Dir	Distribut'n Dir	Province: Prov Un'n Gen Mgr	Inventory Clrk	Shipping Clrk	Local Level: Pr Society Mgr	Vlg Grp Leader	FARMER	T'ship Chief	Village Chief	Central Tender Bd	Private Firms
10 Policy																																						
–10 Long-run Sources of Supply	G	C	A	C	C	C										C	C	C	H*						C	C	H*											C*
–15 Immediate Sources of Supply			C														G	D	A						C	C	H										S	
–20 Product Technical Standards									A								G	D	H								C	C										
–30 In-Country Inventory Levels		C	C		C	C										G	D	A	H						C	C	C	C										C
–40 Channels of Distribution	C		C	C	C	C	H									G	D	A							C	H	C											C
–50 Pricing of Supplies			C	S	C	C										S	G	D	A							H	C											C
–60 Subsidies on Supplies	C	C	C	S	C	C	H	C								G	D	A							C	C												C
11 Planning (combining project & non-project)																																						
–10 Project Supply & Equipment Requirements (area 03-01)																																						
–20 Long-Run Requirements Projections	G		C		S	D	H									S	C	D	A						C	C												C
–30 Annual Requirements Forecast by Region										C							G	D	A		H							C	C									
–35 Annual Nat. Supply Plan (including allocation to provinces)			C	S	S	C	C			C						G	D	A	H		C					C												
30 Procurement–Central Union Importing																																						
–10 Final Technical Specifications									H*										H						G	D	A											
–20 Quantitites & Delivery Specifications by Quarter																		C	H		C*				G	D	A	C										
–30 Preparation of Call for Tenders																			H*						G	D	A										C	
–40 Tender Review & Approval			X															C	C							C	H										A	
–50 Direct Negotiation			X															C	C						G	D	A											
–60 Expediting of Shipments																			H*						G	D	A		C*									
–70 Arrangements for Storage																			C*						G	D		A		A*								
40 Procurement–Prov. Unions From Private Firms																																						
50 Distribution																																						
–10 Prov. Union Quarterly Inventory Plan																					G	H							D	A	C							
–20 Current Prov. Union Inventory Maintenance																						C*							G	A								
–30 Deliveries from Central to Prov. Unions																									G	D		A	C*	I	E							
–40 Primary Society Orders																						X	G	H								A	I*					
–50 Deliveries to Primary Societies																						E*	E*						G	C	A	C						
–60 Deliveries to Farmers														C*	E									G								A	H	C	C*	C		

Merge Requirements (M) may apply if several individuals have jurisdiction over action on a planning or policy task. *M* is then a responsibility for collecting and documenting the work of the various *A*s. It includes a further responsibility for seeing that all the elements are consistent and compatible with the resources available. *M* involves necessary consultation to eliminate inconsistencies or bring them to the attention of superiors. *M* includes *C* and may include *T*.

Direct Supervision (D) refers to responsibility for overseeing *A* closely enough to initiate corrective action in a few days. On policy and planning tasks, *D* includes close review and approval of work. *D* may be responsible for consulting with superior *C*s. On transactions and trouble-shooting, *D* must approve all individual actions which may be in exception to policy. *D* includes *T*, *I*, *E*, and *M* if they are not specifically assigned elsewhere.

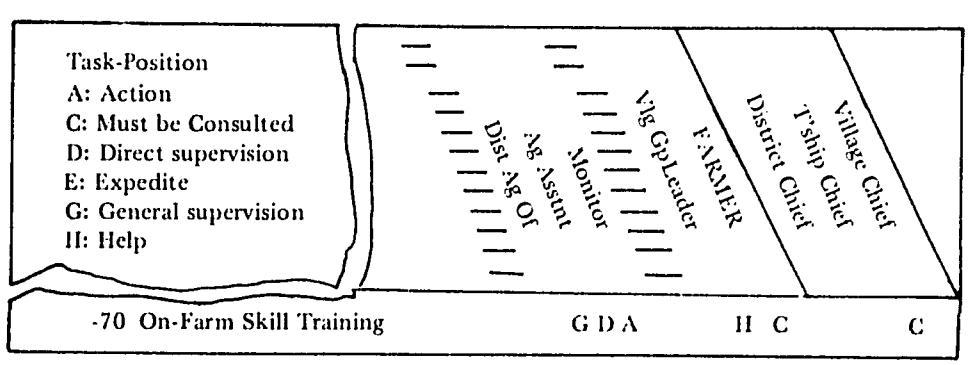
General Supervision (G) covers responsibility for overseeing *A* and *D* in order to evaluate overall performance and the problems being encountered. On policy and planning tasks, *G* includes review and approval of details. On transaction and trouble-shooting tasks, *G* involves periodic work reviews and recommendations about longer range action to solve problems.

Signoff (S) covers responsibility for approving all policy and planning submissions of a task without necessarily reviewing the details. A person performing *S* may approve an action on the basis of a brief explanation from *G* or *D*.

Approve Exceptions to Policy (X) covers responsibility for reviewing and approving any trouble-shooting, transactions, or plans not in accordance with states policies.

Verification by Spot-Check (V) means checking into a small sample of the plans or transactions of a large-volume task to see if standards are being met.

Note that all tasks must have an *A* and a *G* somewhere on the task line, but not necessarily a *D*. Thus, line -70 of Table C, "On-Farm Skill Training," reads:



A is assigned to the monitor. He must carry out the transaction, visit the farmer, show him how to do it (perhaps handling a new piece of equipment), and work with him until he is competent.

D is assigned to the agricultural assistant. He must make sure the monitor is doing his task properly and on schedule. He must follow the action closely enough to take necessary remedial action.

G is assigned to the district agricultural officer. He must see that the work is properly guided and planned, then occasionally spot-check to see if, in general, it is being done properly and on time. He need not follow the work as closely as the agricultural assistant.

C is assigned to the village chief and the farmer. For the village chief, *C* means that the field assistant must let him know what he plans to do and when. For the farmer, *C* means that he is the client, the recipient of the transaction, who must be consulted.

H is assigned to the village group leader, the chairman of the borrower-group. He must perform a minor part of the action, perhaps some of the initial work scheduling in the village and some of the followup on the training. He does this under the guidance and coordination of the monitor.

Organizational Responsibility Charting—Additional Features

As you have noted, when a code symbol is located under a particular position, along the horizontal line for a given task, a task-position relationship is established. The specific nature of the code symbol designates the character of that relationship. The aim is to identify and document the major responsibilities within the action system.

Generally, one position has only one TPR on a given task. Primary TPRs such as *A*, *D*, and *G* include others, such as *C*, *T*, *I*, *E*, *M*, and *X*, when they are not explicitly assigned elsewhere.

There will invariably be some ambiguities in any ORC; for example, if *D* and *M* are specifically assigned, which of the two has *T* and *E*? This will usually be obvious from the TPR pattern of the task.

An ORC cannot cover all possible nuances and contingencies. It does seek to indicate all of the important elements of the system.

For purposes of ORC making, we refer to four types of tasks:

1. **Transactions:** the actual work of an organization—direct dealings with individuals and outside organizations that produce substantive results—generally on a routine basis.

2. **Planning:** resource allocation and scheduling of transactions.

3. **Policy:** the establishment of rules and standard procedures for handling certain classes of transactions.

4. **Trouble-shooting:** nonroutine activity to correct deviations from plans and policy and to deal with unforeseen problems.

The sequence of function-task listing on an ORC should go from top to bottom as follows:

1. **Policy Tasks** in order of declining generality and importance
2. **Planning Tasks**
3. **Transaction Tasks**
4. **Trouble-shooting**

DIAGNOSTICS

General Pattern

In drafting an Organizational Responsibility Chart, it is important to keep in mind four criteria of effective actions:

1. Delegation must be adequate to avoid decision bottlenecks.
2. The locus of control must be effective and appropriate to each task.
3. Communication must be adequate but not overburdening.
4. Workloads must be well distributed and not overburdening.

Experienced individuals must make the best possible judgments about these matters. The ORC technique can at least help bring the issues into focus.

ORC patterns can indicate possible trouble spots, but further investigation, analysis, and judgments are necessary to clarify the problem. ORC mapping can be used to help determine the possibility of a solution.

Delegation

A healthy pattern of delegation is suggested by a steady cascade of TPRs from upper left to lower right:

Policy–Major	G	D	A	C	C	C	C	C	C					C		C	C
Policy–Minor	S	G	D	A	C		C	C	C							C	
Planning–Long Run	S	S	G	D	M	A	H	C	C							C	C
Planning–Annual	S	S	S	G	M	D	A	H	C								
Planning–Quarterly				S		X	G	D	A								
Transaction #1									X		G	D	A	H		C	
Transaction #2											G	D	A				
Transaction #3													G	A			
Trouble-shooting–Minor							X		G		D	A	H				
Trouble-shooting–Major				X	C		G	C	D		A	C					C

The *G*, *D*, and *A* responsibilities should move steadily "southwest," with a sweepback on trouble-shooting. This suggests that high-level matters are being handled at high levels, while less important but more frequent tasks are being performed in the broader, lower reaches of the hierarchical pyramid.

In diagnosing and solving delegation problems, two devices are particularly useful. Following is a typical case of a delegation bottleneck: the small purchase which requires multiple high-level approvals.

– 80. Buy Pencils   S S S G M D C C A C I

The first step in a remedy is to recognize the need for a policy exercise, rather than to handle this class of lecision on a case-by-case basis.

– 78. Set Office Supply Procurement Policy   S G D A C C C C C C C C C
– 80. Purchase Supplies   X G M D A I

The second remedy is to distinguish between major and minor transactions.

– 78. Set Office Supply Procurement Policy   S G D A C C C C C C C C C
– 80. Purchase Supplies over $100   X G M D C A I
– 82. Purchase Supplies under $100   X G A

Now the man who needs a pencil can buy his own, and the commissioner is no longer involved.

We must note, however, that there is a profound difference between *diagnosis* and *prognosis.* ORC can map the problem. It cannot and does not state the underlying causes, nor the cures. Unless those causes are understood and changed, working distinctions between policy and action will not be made, nor will major and minor transactions be treated differently.

If an ORC mapping exercise for a particular effort indicates a high level of centralization of many essential elements of the action system (on the basis of established practice), this raises serious issues about the organizational feasibility of the venture.

There indeed are places where pencils, lightbulbs, and paper can be purchased only with top-level approval, and where there is no working concept of "expendables" in the administrative system. To modify such patterns, it is not enough to note that they are wrong. Relatively radical shifts in institutional norms and processes may be necessary, but not necessarily possible.

Locus of Control

Excessively centralized control (illustrated above) and lack of control are common problems in developing countries. Loans in default, operations behind schedule, idle men and equipment, and demonstrations not followed up may indicate lack of control.

Action on delinquent loans is a delicate matter, a policing function which conflicts with the usual benevolent service role of the extension field agent or the coop society manager. On Table 13.1, responsibility is given to the village chief for tasks 30-80 and 30-85. On major delinquencies it is shifted back to the coop assistant, assisted by the provincial loan officer and the province officer. Of course, the crux of the matter is to get the arrangement to actually work. As noted at the beginning of this chapter, problems of motives and incentives are involved.

Adaptation trials, function number 10 on Table 13.1, are another area where special control is needed. These trials, more experimental in nature than the demonstration of a tested and proven package, need higher level technical guidance. The action on task 10-50, to secure demonstrators, is handled by the village group leader.

The supervision of the demonstration trials, task 10-60, is handled by the agricultural assistant, who ordinarily delegates responsibility for package demonstrations to his field assistant. The assistant province agricultural officer for adaptation trials further controls this task by verification spot-checking. In evaluating and reporting results, the level of action moves back further (task 10-70). A sweepback of TPRs is designed to provide control at critical points.

Concerning the credit area (Table 13.1), supervision and action for this one function can be shifted between organizations as necessary. For the purpose of fulfilling certain tasks, an employee or officer can report to task supervisors in another agency. Failing to recognize this, agricultural credit organizations have often insisted on fielding their own extension staffs instead of working with regular extension services. Note how on Table 13.3 the main TPRs shift between organizations:

	Agricultural Department	Coop Department	Primary Society	Local Administration
30 Short-Term Lending				
– 30 Solicitation of Borrowers	D A	G	A	
– 40 Approval of Borrowers	H	G	A	
– 50 Release of Funds and Material	H	G	A	
– 60 Followthrough Supervision	D A	G		H
– 70 Collection of Repayments	H	G D	A	
– 80 Action on Delinquents		G	D	A

Interorganizational collaboration is, as noted earlier, a sheer necessity for the operation of all but the smallest agricultural development efforts. It does not follow that such arrangements are possible in any given setting. Indeed, the general tradition of administration in most countires, rich as well as poor, goes against this kind of cooperation. Once again a hard test is posed by ORC mapping. Project and program designers will be wise to examine the probability that the given administrative system is c able of meeting the need.

Communication and Coordination

These two administrative activities are often thought to be inherently good. There is often a temptation to assert that everyone must be consulted. But excessive communication and coordination can slow programs to a halt.

Consultation should generally be maximized on policy tasks and minimized on transaction tasks. Minor trouble-shooting tasks should be handled with little or no consultation; major trouble-shooting may require a moderate amount of consultation.

To avoid excessive consultation and to distribute the workload, planning functions should be divided into two types of tasks: modules, or planning for a piece of the action system, and synthesis, to put the pieces together. Thus:

Module #1				G				D	A				C	C	
Module #2				G		D	A					C			
Module #3				G						D	A				C
Synthesis	S	S	G	D	A	C	H	H	C	H		C	C	C	C

On Table 13.1, program planning, note the pattern of function 20, basic agricultural zone planning. Tasks -20 through -60 are modules. The action shifts between the Planning Office, the Department of Agriculture, and the Coop Department; and consultation is limited. Tasks -70 through -85 are syntheses putting the modules together. Here the pattern of communication and coordination is much more comprehensive.

Efforts at the quarterly updating of plans frequently fail because they involve excessive consultation. The pattern is similar to a lack of delegation:

Quarterly Plan Adjustments	S C C C G D M A H C C C C C

In principle, the solution is to reduce the volume of consultation required by inserting a policy exercise:

Policy on Quarterly Adjustments	S S S G D A C C C C C C C C
Quarterly Plan Adjustments	X M C A

Where are the key needs for the coordination of extension, credit, and supply in the ORCs illustrated in this chapter? They are partly in program planning: no number of committee meetings will make up for lack of a plan. Perhaps even more important are three tasks on Table 13.1: 20-40, critical path scheduling; 20-45, field staff work scheduling; and 20-70, schedule revision. Here the deputy province agricultural officer must consult the province-level chiefs of all concerned agencies and work out an acceptable schedule for the annual campaign. If this actually happens, time-consuming committee meetings can be minimized.

Workloads

A long column of *D*s and *A*s under any position may indicate an excessive workload. Note, however, the column of *A*s on Table 13.1 under the procurement director of the central cooperative union. Except for the review and approval of tenders, his is the job of procurement abroad. He presumably has little to do in other ORC areas. The total of a person's involvement in all ORC fields of action determine whether he is overworked.

Good ORCs become a guide for considering the shifting of TPRs to balance workloads. Insofar as there is genuine flexibility to do this, such shifts can leave ministers and secretary-generals of ministries free to concentrate on reshaping and adapting their organizations and programs to changing conditions, to neglected opportunities and problems, and to the needs of tomorrow.

USING THE ORC TECHNIQUE

Initial Drafting

Fields of Activity and Positions. The fields of activity within agricultural organizations suggested earlier in this chapter can serve as a starting point. Next make a rough list of the positions. If more than 45 positions are needed, it is possible to break a field of activity into upper and lower levels, and to treat the two as separate but related.

Functions and Tasks. The best way to define a task is to list the functions, and then try to identify the transaction tasks. From these, work back to the planning and policy tasks, and forward to the trouble-shooting tasks.

The planning and policy task breakdown may tend to be somewhat artificial. Policy is set more often on a case-by-case basis than in separate decision exercises. Nevertheless, the players are different if there clearly is a policy issue involved, so this somewhat artificial distinction does have meaning in ORC mapping.

Task-Position Relationships. It is useful to start with a separate worksheet for each function. Once a function-task list has been prepared and entered on worksheets, a few senior people of the organization can agree on how the organization works at present.

Diagnosis and Redesign

Analyze the various fields of activity which are vulnerable. Then sketch possible changes by presenting each revised function on a separate sheet, showing the "before" and suggested "after" task structures and TPRs. Very often the solution will call for modifying the task list as well as the TPRs. The plausibility of proposed solutions is a crucial consideration.

OCR Maintenance and Revision

Once each quarter, management should meet to consider organizational problems. Participants in a management committee should first express their current organizational concerns. The officer responsible for maintaining the ORCs should then suggest possible revisions which might solve those problems. Insofar as these are accepted by top management, new ORCs can be issued incorporating the changes.

CONCLUSION

This chapter, and this entire book, focuses upon techniques. It seeks to present those techniques, along with explanations and exercises, in ways which enable the user to become a doer.

Many of the techniques in earlier chapters have been demonstrated through the use of real information about aspects of agriculture- e.g., about the effects of tractor plowing, the use of fertilizer, and the modification of cropping patterns. *In practice,* the agricultural information used to design and implement basic agricultural development must fit the particular place where the effort is made. It is generally possible to get this information. Much of it is technical, and most of it can be tested for soundness on the basis of situational knowledge.

In this final chapter we have dealt with another basic dimension of agricultural development—the organizational dimension, with particular attention to the functions and relationships of public sector organizations. Here the information problems are different and more difficult. They are the problems of knowing how organizations work and how they might be made to work. This chapter contains the makings of fierce difficulties for those who wou'd design and operate agricultural development efforts—difficulties which go beyond the chapter into realms of judgment and concerns with motivation and incentives. There is little tested technology for addressing these organizational problems. Yet they confound efforts to develop basic agriculture more than any others.

We have shown how to map the organizational action system in a way more comprehensive and condensed than conventional organization charts. This technique is of real use in identifying important organizational problems. Their solutions, however, lie beyond our capacity to generalize, apart from the few brief prescriptions we have presented.

APPENDIX

Solutions to Exercises

Chapter 5
Exercise 1, page 65
ZONE Y SYSTEM
POTENTIAL INCREASED INCOME
FROM YIELD-RAISERS

Crop	Average Ares*	Net Increase** Gross Marg/Ha.	Net Increase Gross Marg/Farm
Cotton	75	$17	$13
Millet	50	11	6
Peanuts	30	49	15
Maize-1	12	20	2
Maize-2	8	10	1
			$37 = 45% over $84

NOTE: All figures rounded to the nearest dollar.

* From Table 4.1.

** From Table 5.1.

Chapter 5
Exercise 2, page 65
YIELDS NEEDED TO PRODUCE
100% RETURN ON INVESTMENT IN N2

Crop	Invest in N2 Per Ha.		Crop Price	Kgs. to Pay For Investment*		Total Yield Needed for N2**
Cotton	$30	÷	$.17	= 177 kgs. x 2	+	500 = 854 kgs.
Millet	26	÷	.06	= 434 kgs. x 2	+	900 = 1768 kgs.
Maize-1	33	÷	.05	= 660 kgs. x 2	+	1200 = 2520 kgs.

*Kilos of increased yield needed to pay for N2 fertilizer.

**Total yield needed to cover fertilizer cost and provide a 100% return on the fertilizer investment.

Chapter 6
Exercise 1, page 89
OPTIMUM NON-MECHANIZED SOLUTION

	Ares Prog	Gross Margin	May	June	July	Sept	Oct	Nov
1 Cereal		$ 60/H	30	20	10	5	25	10
2 Legume		80	16	16	10	20	20	0
3 Fiber		80	10	12	10	15	0	30
Gross Margin Per Manday								
4 Cereal			$2	$3	$6	12	$2	$6
5 Legume			5	5	8	4	4	
6 Fiber			8	7	8	5		3
Minimum Solution								
7 Cereal	100	$ 60	30	20	10	5	25	10
8 Legume	50	40	8	8	5	10	10	0
9 Total	150	$100	38	28	15	15	35	10
10 Maximum Mandays Available			50	40	40	40	40	40
11 Slack Mandays Available			12	12	25	25	15	30
Key Month June								
Key Crop Fiber								
12 Fiber Constraint Ratio			0.8	1.0	0.4	0.6		1.0
Addition of 100 Ares of Fiber								
13 Cereal	100	$ 60	30	20	10	5	25	10
14 Legume	50	40	8	8	5	10	10	0
15 Fiber	100	80	10	12	10	15	0	30
16 Total	250	$180	48 (50)	40 (40)	25 (40)	30 (40)	35 (50)	40 (40)
17 Slack Mandays Available			2	0	15	10	15	0

NOTE: Trade-off opportunities are discounted here, as the ares of cereal and legume are at a minimum. For the labor intensive months of May and June, the gross margin per manday month is significantly higher for fiber.

Chapter 6
Exercise 2, page 90
OPTIMUM SEMI-MECHANIZED PROGRAM

	Ares Prog	Gross Margin	May	June	July	Sept	Oct	Nov
2 Legume		$ 70/H	8	8	10	20	20	0
5 Legume			$9	$9	$7	$3	$5	
Minimum Solution								
7 Cereal	100	$ 60	30	20	10	5	25	10
8 Legume	50	35	4	4	5	10	10	0
9 Total	150	$ 95	34	24	15	15	35	10
10 Maximum Mandays Available			50	40	40	40	50	40
11 Slack Mandays Available			16	16	25	25	15	30
Key Month October								
Key Crop Legume								
12 Legume Constraint Ratio			0.5	0.5	0.4	0.8	1.3	
Addition of 100 Legume								
13 Cereal	100	$ 60	30	20	10	5	25	10
14 Legume	125	87	10	10	13	25	25	0
15 Total	225	$147	40 (50)	30 (40)	23 (40)	30 (40)	50 (50)	10 (40)
16 Slack Mandays Available			10	10	17	10	0	30
Addition of 100 Fiber								
17 Cereal	100	$ 60	30	20	10	5	25	10
18 Legume	125	87	10	10	13	25	25	0
19 Fiber	67	53	7	8	7	10	0	10
20 Total	292	$200	47 (50)	38 (40)	30 (40)	40 (40)	50 (50)	20 (40)
21 Slack Mandays Available			3	2	10	0	0	20
Legume-Fiber Tradeoff (September is Key Month, but May-June restricts trade-off)								
22 Cereal	100	$ 60	30	20	10	5	25	10
24 Legume	100	80	10	12	10	15	0	30
25 Total	300	$216	48 (50)	40 (40)	30 (40)	40 (40)	45 (50)	40 (40)
26 Slack Mandays Available			2	0	10	0	5	0

Chapter 6
Exercise 1, page 99
295 ARES MAXIMUM LAND

	Ares Prog	Gross Margin	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Slack Allocation														
22 Cotton-1 Constraint Ratio				.7	.6	.7	.4	.2	.2	.2	.3	1.2	1.3	.7
Add 75 Ares Cotton-1														
23 Cotton-1	150	$153	0	27	21	26	14	6	9	8	12	36	39	27
29 Total	235	$217	11	37	29	30	31	29	24	15	13	38	40	27
30 Slack Mandays Available			29	13	11	10	19	21	26	25	27	2	0	13
Second Slack Allocation														
21 Peanuts Constraint Ratio			.3	.8	1.1	.5	.9	1.3	.8	.8				
Could add 78 ares, but would exceed acreage. Limited to 60 ares additional.														
32 Peanuts	85	$77	9	9	11	4	14	23	18	18	0	0	0	0
33 Total	295	$271	17	43	36	33	41	45	37	28	13	38	40	27
34 Slack			23	7	4	7	9	5	13	12	27	2	0	13

NOTE: The only reducible crops are Peanuts and Cotton-1, and the land constraint pre. 'nts augmentation without land trade-off. Any trade-off would, however, decrease the gross margin by substituting lower margin crops per acre.

Chapter 6
Exercise 2, page 100
ADDITION OF DAIRY ENTERPRISE

	Ares Prog	Gross Margin	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Cattle, basic requirements/head														
22 Cattle (2)		$200	10	10	10	10	10	10	10	10	10	10	10	10
23 Gross Margin/mo			$20	20	20	20	20	20	20	20	20	20	20	20
Slack Allocation—Cattle (2)														
24 Cattle	100	$200	10	10	10	10	10	10	10	10	10	10	10	10
25 Cotton-1	75	76	0	14	11	13	7	3	5	4	6	18	19	14
26 Cotton-2	0													
27 Millet	40	26	6	6	3	2	10	12	7					
28 Peanuts	25	23	3	3	3	1	4	7	5	5				
29 Maize-1	12	10	2	1	2	1	1	4	2	1				
30 Maize-2	8	5					2		1	1	1	2	1	
31 Total	260	$340	21	34	29	27	34	36	30	21	17	30	30	24
32 Slack			19	16	11	13	16	14	20	19	23	10	10	16
Slack Allocation														
33 Cotton-1 Constraint Ratios				1.1	1.3	1.3	.6	.4	.3	.3	.3	2.4	2.6	1.1
Add 38 Ares of Cotton-1														
34 Cotton-1	113	$115		20	16	19	10	5	7	6	9	27	29	20
35 Total	298	$379	21	40	34	33	37	38	32	23	20	39	40	30
36 Slack			19	10	6	7	13	12	18	17	20	1	0	10
Slack Allocation														
37 Peanuts Constraint Ratios			.5	1.0	2.2	.7	1.3	2.2	1.2	1.2				
Add 44 ares of Peanuts														
38 Peanuts	69	$63	7	7	9	3	12	19	14	14				
39 Total	342	$419	25	44	40	35	45	50	41	32	20	39	40	30
40 Slack			15	6	0	5	5	0	9	8	20	1	0	10

Chapter 6
Exercise 3, page 101
NEW VARIETY OF MAIZE-2

	Ares Prog	Gross Margin	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Corrected Lines														
6 Maize-2		$54	9	0	0	0	20	6	7	6	7	0	13	17
Gross Margin/Manday Month														
12 Maize-2			$8				$3	$11	$10	$11	$10		$5	$4
18 Maize-2	8	$4	1	0	0	0	2	1	1	1	1	0	1	1
19 Total	160	$139	12	24	19	17	24	27	20	11	7	18	20	15
20 Maximum			40	50	40	40	50	50	50	40	40	40	40	40
21 Slack			28	26	21	23	26	23	30	29	33	22	20	25
Slack Allocation														
22 Cotton-1 Constraint Ratios				.7	.6	.7	.4	.2	.2	.2	.3	1.1	1.3	.7
Add 75 Ares Cotton-1														
23 Cotton-1	150	$153	0	27	21	26	14	6	9	8	12	36	39	27
24 Total	235	$213	12	37	29	30	31	30	24	15	13	36	40	28
25 Slack			28	13	11	10	19	20	26	25	27	4		12
Slack Allocation														
26 Peanuts Constraint Ratio			.4	.8	1.2	.5	.9	1.4	.8	.8				
Add 75 Ares Peanuts														
27 Peanuts	100	$91	10	10	13	5	17	27	21	21	0	0	0	0
28 Total	310	$281	19	44	39	34	44	50	40	31	13	36	40	28
29 Slack			21	6	1	6	6		10	9	27	4		12
Trade-off Maize-2 (+32) for Cotton-1 (-15)														
30 Cotton-1	135	$138	0	24	19	23	12	5	8	7	11	32	35	24
31 Maize-2	40	22	4	0	0	0	8	2	3	2	3	0	4	7
32 Total	327	$284	15	34	37	31	48	50	41	31	14	32	39	31
33 Slack			25	16	3	9	2		9	9	26	8	1	9

Chapter 6
Exercise 4, page 102
SEMI-MECHANIZED

	Ares Prog	Gross Margin	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1 Cotton-1		$102	0	9	7	12	7	4	6	5	8	24	26	18
2 Millet		65	16	12	7	6	26	31	18	0	0	0	0	0
3 Peanuts		91	10	5	13	5	17	27	21	21	0	0	0	0
4 Maize-1		80	14	3	13	6	8	37	20	5	0	0	0	0
5 Maize-2		60	0	0	0	0	10	0	13	6	7	23	13	0
Gross Margin/Manday Month														
6 Cotton-1			$0	$11	$15	$ 9	$15	$20	$17	$20	$13	$4	$4	$6
7 Millet			4	5	9	11	3	2	4	0	0	0	0	0
8 Peanuts			9	18	7	18	5	3	4	4	0	0	0	0
9 Maize-1			6	27	6	13	10	2	4	15	0	0	0	0
10 Maize-2			0	0	0	0	6	0	5	10	9	3	5	0
Minimum Solution														
11 Cotton-1	75	$76	0	7	5	9	5	3	5	4	6	18	19	14
12 Millet	40	26	6	2	3	2	10	12	7	0	0	0	0	0
13 Peanuts	25	23	3	2	3	1	4	7	5	5	0	0	0	0
14 Maize-1	12	10	2	3	2	1	1	4	2	1	0	0	0	0
15 Maize-2	8	5	0	0	0	0	1	0	1	1	1	2	1	0
16 Total	160	$140	11	14	13	13	21	26	20	11	7	20	20	14
17 Maximum			40	50	40	40	50	50	50	40	40	40	40	40
18 Slack			29	36	27	27	29	24	30	29	33	20	20	26
Slack Allocation														
19 Constraint Ratios for Cotton-1			0	.3	.3	.5	.3	.2	.2	.2	.3	1.2	1.3	.7
Add 75 ares Cotton-1														
20 Cotton-1	150	$153	0	14	11	18	11	6	9	8	12	36	39	27
21 Total	235	$217	11	21	19	22	27	29	24	15	13	38	40	27
22 Slack			29	29	21	18	23	21	26	25	27	2		13
Slack Allocation														
23 Constraint Ratios for Peanuts			.3	.2	.6	.3	.7	1.3	.8	.8	0	0	0	0
Add 79 ares Peanuts														
24 Peanuts	104	$95	10	5	14	5	18	28	22	22	0	0	0	0
25 Total	314	$289	18	24	30	26	41	50	41	32	13	38	40	27
26 Slack			22	26	10	14	9		9	8	27	2		13
Trade-off Cotton-1 (-8 ares) to Maize-2 (+14 ares)														
27 Cotton	142	$145	0	13	10	17	10	6	9	7	11	34	37	26
28 Maize-2	22	14	0	0	0	0	2	0	3	1	2	5	3	0
29 Total	320	$290	18	20	29	25	41	50	43	31	13	39	40	26
30 Slack			22	30	11	15	9		7	9	27	1		14

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Exercise, page 129
Exercises 1-5, pages 136-37
PROJECT PACING AND OUTPUT COMPUTATION

PACE OF ADOPTION	Phases: A	B	C	D
1	15	75	450	660
2	20	60	240	80
3	30	60	180	330
4	30	120	450	
5	40	120	240	

PACING	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Phase A @ 25	1 25	5 125	20 500	40 1,000	34 850		
Phase B @ 75		1 75	5 375	20 1,500	40 3,000	34 2,550	
Phase C @ 300			1 300	5 1,500	20 6,000	40 12,000	34 10,200
New growers	25	200	1,175	4,000	9,850	14,550	10,200
Total growers	25	225	1,400	5,400	15,250	29,800	40,000

PACING	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Phase A @ 30	1 30	5 150	15 450	29 870			
Phase B @ 60		1 60	5 300	15 900	29 1,740		
Phase C @ 180			1 180	5 900	15 2,700	29 5,220	
Phase D @ 330				1 330	5 1,650	15 4,950	29 9,570
New growers	30	210	930	3,000	6,090	10,170	9,570
Total growers	30	240	1,170	4,170	10,260	20,430	30,000

PACING	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Phase A @ 20	4 80	32 640	44 880				
Phase B @ 60		4 240	32 1,920	44 2,640			
Phase C @ 220			4 880	32 7,040	44 9,680		
New growers	80	880	3,680	9,680	9,680		
Total growers	80	960	4,640	14,320	24,000		

PACING	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Phase A @ 20	1 20	4 80	16 320	32 640	27 540		
Phase B @ 60		1 60	4 240	16 960	32 1,920	27 1,620	
Phase C @ 220			1 220	4 880	16 3,520	32 7,040	27 5,940
New growers	20	140	780	2,480	5,980	8,660	5,940
Total growers	20	160	940	3,420	9,400	18,060	24,000

PACING	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Phase A @ 20	1 20	4 80	16 320	24 480	24 480	11 220	
Phase B @ 60		1 60	4 240	16 960	24 1,440	24 1,440	11 660
Phase C @ 220			1 220	4 880	16 3,520	24 5,280	24 5,280
New growers	20	140	780	2,320	5,440	6,940	5,940
Total growers	20	160	940	3,260	8,700	15,640	21,580

NOTE: Year 8: 11 communities in phase C, 2,420 new growers, 24,000 total growers

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Exercises 6-9, page 137

PROJECT PACING AND OUTPUT COMPUTATION

OUTPUTS	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Total growers	25	225	1,400	5,400	15,250	29,800	40,000	
Cereal @ .3 tons	8	68	420	1,620	4,575	8,940	12,000	
Fiber @ .4 tons	10	90	560	2,160	6,100	11,920	16,000	
Income @ $150*	4	34	210	810	2,290	4,470	6,000	

OUTPUTS	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Total growers	80	960	4,640	14,320	24,000			
Cotton @ .6 tons	16	192	930	2,860	4,800			
Peanuts @ .7 tons	56	672	3,250	10,025	16,800			
Income @ $26	2	25	120	372	624			

OUTPUTS	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Total growers	20	160	940	3,420	9,400	18,060	24,000	
Cotton @ .6 tons	12	96	565	2,120	5,640	10,840	14,400	
Millet @ .2 tons	4	32	190	685	1,880	3,610	4,800	
Peanuts @ .8 tons	16	131	770	2,805	7,520	14,450	19,200	
Maize @ .3 tons	7	53	310	1,130	2,820	5,420	7,200	
Income @ $125	3	20	120	425	1,175	2,260	3,000	

OUTPUTS	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Total growers	20	160	940	3,260	8,700	15,640	21,580	24,000
Cotton @ .6 tons	12	96	565	1,960	5,220	9,380	12,950	14,400
Millet @ .2 tons	4	32	190	650	1,740	3,130	4,320	4,800
Peanuts @ .8 tons	16	131	770	2,610	6,960	12,510	17,260	19,200
Maize @ .3 tons	7	53	310	980	2,610	4,690	6,470	7,200
Income @ $125	3	20	120	410	1,090	1,960	2,700	3,000

*Net increase in cash income, in $000s.

Chapter 9

Exercise, page 150

APPLICATION OF CONSOLIDATED COST FACTORS

Recomputation of Zone Y Plan as Shown on Table 9.1

	Planning Factors	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	
Coverage									
1 Primary in A		1	4	16	32	27			
2 societies in B			1	4	16	32	27		
3 by phase in C				1	4	16	32	27	
4 Townships		1	4	16	16	16	16	16	
5 Districts		1	4	4	4	4	4	4	
Budget									
6 Per PS in A-	$ 600	3	10	19					Years 1-3 only
7 Per PS in A	4200	4	17	67	38	38			$1200 in year 4, $1400 in 5
8 Per PS in B	900		1	4	14	29	24		
9 Per PS in C	1600			2	6	26	51	43	
10 Per new township	3500	4	11	42					
11 Per old township	2700		3	11	43	43	43	43	
12 Per new district	6000	6	18						
13 Fixed costs		18	18	15	15	15	10	10	
14 Total		35	78	160	116	151	128	96	Total 764

Recomputation of Above Plan at Low Pace of Expansion

Coverage									
15 Primary in A		1	4	12	32	31			
16 societies in B			1	4	12	32	31		
17 by phase in C				1	4	12	32	31	
18 Townships		1	4	12	16	16	16	16	
19 Districts		1	4	4	4	4	4	4	

Budget									
20 Per PS in A-	$ 600	3	7	19					Years 1-3 only
21 Per PS in A	4200	4	17	50	38	43			$1200 in year 4, $1400 in 5
22 Per PS in B	900		1	4	11	29	28		
23 Per PS in C	1600			2	6	19	51	50	
24 Per new township	3500	4	11	27	14				
25 Per old township	2700		3	11	32	43	43	43	
26 Per new district	6000	6	18						
27 Fixed costs		18	18	15	15	15	10	10	
28 Total		35	75	128	116	149	132	103	Total 738

NOTE: All costs in $000s

Chapter 9

Exercise 1, page 152

ZONE Y FOUNDATION PACKAGE BASIC AGRICULTURAL PROJECT

		Year 1		Year 2		Year 3		Year 4		Year 5		
1 Increased Cash Income			3		36		164		450		700	@ $25 per improved grower (net, in $000s)
2 Increased	cotton	24		288		1,310		3,580		5,600		@ .2 tons per improved grower in tons
3 production	peanuts	24		288		1,310		3,580		5,600		@ .2 tons per improved grower in tons
4 Improved	total	120		1,440		6,560		17,880		28,000		
5 growers	new	120		1,320		5,120		11,320		10,120		@ Pace of Adoption: 30 in A, 90 in B, 230 in C
6 Coverage of	Phase A	4		32		44						
7 primary	Phase B			4		32		44				Total of 80 primary societies
8 societies	Phase C					4		32		44		in 16 townships, 4 districts
Staff & Budget		No.	Cost	No.	Cost	No.	Cost	No.	Cost	No.	Cost	Total Cost
9 Monitors		4	3	18	13	40	28	40	28	40	28	100 1 per 2 PSs @ $700
10 PS managers (subsidy)		4	3	36	21	80	40	80	24	80	24	112 @ $600 in A, $400 in B, $200 in C
11 T'ship ag ass'ts		4	9	16	35	16	29	16	29	16	29	131 @ $1,800 + $500 for motorbike*
12 Dist ag officer		4	12	4		4		4		4		12 @ $3,000 for car*
13 Dist coop officer		4	12	4		4		4		4		12 @ $3,000 for car*
14 Total staffing cost			39		69		96		81		81	366
Promotion Costs												
15 Demonstrations		32	3	44	4							7 @ $100 per PS in year before A
16 Farmer subsidies		4	1	32	12	44	16					29 @ $360 per PS in A ($12 per farmer)
17 Publicity			3		3		3		3		3	15
18 Miscellaneous			5		5		5		5		5	25
19 Total budget			51		93		120		89		89	442 line 14 + lines 15-18

Credit Expansion									increase in expansion per year
20	Seasonal Production		3	26	103	227	202	561	@ $20 per improved grower
21	Warehouse	new loans		4	32	44			@ $100 per PS in B
22	construction	repaid				-4	-8		on 10-year terms
23	loans	net increase		4	32	40	-8	68	
24	Working capital		4	40	154	340	304	842	@ $30 per imrpoved grower
25	Total cdt. expansion		7	70	289	607	498	1,471	lines 20 + 23 + 24
26	Total investment		58	163	409	696	587	1,913	credit expansion + budget
27	Net	annual	-55	-127	-245	-246	-113		line 1 minus line 26
28	benefits	accumulative	-55	-182	-427	-673	-560		positive after year 5

NOTE: All costs etc. in $000s.

*First year in project only

Chapter 9

Exercise 2, page 152

ZONE Y PROJECT OPERATIONS PLAN—ACCELERATED ALTERNATIVE

		Year 1		Year 2		Year 3		Year 4		Year 5		Sources of Data (Lines & Coefficients)
1	Increased Cash Income		10		120		580		1,790		2,880	Line 6 x $125 in yrs. 1-4 x $120 in yr. 5
2	Increased Production (in tons) — Cotton	48		576		2,784		8,592		14,880		Line 6 x .6 in yrs. 1-4, x .62 in yr. 5
3	Millet	16		192		928		2,864		1,680		Line 6 x .2 in yrs. 1-4, x .07 in yr. 5
4	Peanuts	66		787		3,800		11,742		28,800		Line 6 x .82 in yrs. 1-4, x 1.2 in yr. 5
5	Maize	26		317		1,530		4,726		7,200		Line 6 x .33 in yrs. 1-4, x .3 in yr. 5
6	Improved Growers — Total	80		960		4,640		14,320		24,000		Line 7 cumulated
7	New	80		880		3,680		9,680		9,680		Based on Pace of Adoption:
8	Primary Societies Covered — Phase A	4		32		44						Phase A = 20 per PS
9	Phase B			4		32		44				Phase B = 60 per PS
10	Phase C					4		32		44		Phase C = 220 per PS
11	Phase C+							4		36		Total 80 PSs in the zone
12	Townships Covered	4		16		16		16		16		District coverage given on line 16
	Staff numbers & costs	No	Cost	No.	Cost	No.	Cost	No.	Cost	No.	Cost	Total
13	Monitors	4	3	36	25	84	59	108	76	88	62	225 1 per PS in A-B, 2 in C, @ $700
14	T'ship Agr Assistants	4	9	16	35	16	29	16	29	16	29	131 1 per Township @ $1800 + $500 vehicle
15	Coop Assistants	4	9	8	16	8	14	8	14	8	14	67 1 per 2 Townships @ $1800 + $500 vehicle
16	Dist Agr Officer	4	12	4		4		4		4		12 1 per district @ $3000 for vehicle
17	Dist Coop Officer	4	12	4		4		4		4		12 1 per district @ $3000 for vehicle
18	Project Coordinator	1	6	1	3	1	3	1	3	1	3	18 1 Ast. Prov. Ag. Ofr. @ $3000 + vehicle
19	Total Staff Cost		51		79		105		122		108	465

Other Budget Items						
20 Demonstrations	19	26				45 @ $600 per PS in Phase A-
21 Subsidy to New Growers	12	96	132			240 @ $150 per new grower in A only
22 PS Mgr Salary Subsidy	1	10	20	9		40 @ $300 in A, $200 in Phase B
23 Monitor Training	1	6	10	5		22 @ $200 per new monitor (#13)
24 Publicity & Brochures	5	5	2	2	2	16
25 Miscellaneous	5	10	10	10	10	45 Including general staff training
26 Total Project Budget	94	232	279	148	120	873 Includes staff cost
Production Inputs						Seed and chemicals in tons
27 Peanut Seed	11	119	497	1,307	1,310	Line 7 x .135 (local replacement after 4 yrs.)
28 Sulphate of Ammonium	16	192	928	2,864	4,800	Line 6 x .2
29 Single Superphosphate	6	72	348	1,074	3,120	Line 6 x .075 yrs. 1-4, x .13 yr. 5
30 Ox Equipment Sets	80	880	3,680	9,680	9,680	Line 7 x 1 (Need 2 oxen per set)

NOTE: All income and costs in $000s.

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Exercise 1, 2, and 3, page 159
STORAGE

	month:	JAN		FEB		MARCH		APRIL		MAY		JUNE		JULY		AUG		SEPT		OCT		NOV		DEC	
	half:	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Exercise 1																									
Cereal	Inflow																					20	30	30	20
	Outflow	-10	-10	-10	-10	-10	-10															-10	-10	-10	-10
	Balance	50	40	30	20	10	0															10	30	50	60
	Sq. Mtrs.	35	28	21	14	7	0															7	21	35	42
Legume	Inflow																			10	30	30	20	10	
	Outflow	-10	-10	-10	-10															-10	-10	-10	-10	-10	-10
	Balance	30	20	10	0															0	20	40	50	50	40
	Sq. Mtrs.	30	20	10	0															0	20	40	50	50	40
Total square meters		65	48	31	14	7	0													0	20	47	71	85*	82
Exercise 2																									
Fiber	Inflow	10	20	30	30	10																			
	Outflow	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	*Maximum			
	Balance	5	20	45	70	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0	Storage			
	Sq. Mtrs.	5	20	45	70	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0	Required			
Total square meters		70	68	76	84	82	70	65	60	55	50	45	40	35	30	25	20	15	10	5	20	47	71	85*	82

Exercise 3

a) Farmers can store 150 tons of peanuts on their farms, equivalent of 75 square meters of storage.

b) If no peanuts are stored on the farms, peak storage requirements are 310 square meters, 2nd half of August (bottom of Table 9.2).

c) On-farm storage saves 75 square meters of community storage, reducing the peak requirement to 235 square meters.

*Bottom of Table 9.3

Chapter 10

Exercises 1 and 2, page 163

COMPUTATION OF CREDIT EXPANSION

	Year 1	Year 2		Year 3		Year 4		Year 5		Year 6		Year 7		Year 8	Year 9	Year 10	Year 11	Year 12
		lend	repay	lend	repay	lend	repay	lend	repay	lend	repay	lend	repay	repay	repay	repay	repay	repay
Exercise #1																		
a. 5-Year Payback																		
1st-Year Loans	5		-1		-1		-1		-1		-1							
2nd-Year Loans		34			-7		-7		-7		-7		-6					
3rd-Year Loans				187			-37		-37		-38		-37	-37				
4th-Year Loans						595			-119		-119		-119	-119	-119			
5th-Year Loans								1,435			-287		-287	-287	-287	-287		
6th-Year Loans										2,080			-416	-416	-416	-416	-416	
7th-Year Loans												1,425		-285	-285	-285	-285	-285
Totals	5	34	-1	187	-8	595	-45	1,435	-164	2,080	-452	1,425	-865	-1,144	-1,107	-988	-701	-285
Credit Expansion	+5	+33		+179		+550		+1,271		+1,628		+560		-1,144	-1,107	-988	-701	-285
Diff from Table 10.1				+5		+30		+113		+289		+504		+502	+61	-513	-701	-285
Cumulative Difference				+5		+35		+148		+437		+941		+1,443	+1,504	+991	+290	+5
b. 2-Year Payback																		
1st-Year Loans	5		-3		-2													
2nd-Year Loans		37			-17		-17											
3rd-Year Loans				187			-94		-93									
4th-Year Loans						595			-298		-297							
5th-Year Loans								1,435			-718		-717					
6th-Year Loans										2,080			-1,040	-1,040				
7th-Year Loans												1,425		-713	-712			
Totals	5	37	-3	187	-19	595	-111	1,435	-391	2,080	-1,015	1,425	1,757	-1,753	-712			

COMPUTATION OF CREDIT EXPANSION - *Continued*

Credit Expansion	+5	+34	+168	+484	+1,044	+1,065	-332	-1,753	-712			
Diff from Table 10.1		-2	-6	-36	-114	-274	-388	-107	+456	+475		
Cumulative Difference		-2	-8	-44	-158	-432	-820	-927	-471	+4		
Exercise =2												
Seasonal Loans	1	5	29	100	246	364	255					
3-Year Production Loans — lend	25	200	1,175	4,000	9,850	14,550	10,200					
3-Year Production Loans — repay		-8	-75	-467	-1,790	-5,010	9,465	-11,530	-8,250	-3,400		
3-Year Production Loans — net	25	192	1,100	3,533	8,060	9,540	735	-11,530	-8,250	-3,400		
10-Year Storage Loans — lend		5	25	100	200	170						
10-Year Storage Loans — repay			-1	-3	-13	-33	-40	-40	-40	-40	-40	-40
10-Year Storage Loans — net		5	24	97	187	137	-40	-40	-40	-40	-40	-40
Working Capital	1	10	59	200	493	728	510					
Total Cdt. Expansion	27	212	1,212	3,930	8,896	10,769	1,460	-11,570	-8,290	-3,440	-40	-40

Chapter 11

Exercise 1, page 194

FIELD AGENT WORK SCHEDULE–ZONE Y MONITORS REVISED

	Work Activity	Meeting With	Per Day	Do With	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
1	Monitor Training at provincial office							2		2				2		5
2	Present package to PS committee	1 PS	1													(1)
3	Present package to Vil. Gps.–preparations	4 VG	2													(2)
4	Present package to Vil. Gps.–meetings	4 VG	1		(4)											
5	Survey farms of loan applicants	160 frm	4		(4	17	14	5)								
6	Clear applications with PS committee	160 frm	20				(3	5)								
7	Complete farmer signoff on loans	100 frm	20					(5)								
8	Distribute oxen to borrower groups	10 BG	1						(10)							
9	Punch oxen	10 BG		8												
10	Distribute ox plows	4 VG	1						(4)							
11	Distribute seeder-weeder attachments	4 VG	1							(4)						
12	Train oxen–presentation	10 BG	1						(8 2)							
13	Train oxen–followup#1	100 frm	5							(14	6)					
14	Train oxen–followup #2	10 BG	2								(5)					
15	Prepare 1st season farmer workplans	100 frm	13													
16	Distribute 1st season seeds & fertilizer	4 VG	1								(4)					
17	Train use of seeder–presentation	10 BG	1									(8)				
18	Train use of seeder–followup	100 frm	6									(9	8)			
19	Guide 1st season cultural practices	100 frm		18												
20	Train use of weeder–presentation	4 VG	1										(4)			
21	Train use of weeder–followup	100 frm	6										(5	12)		
22	Recheck 1st season practices	100 frm	5											(5	15)	
23	Prepare 2nd season workplans	100 frm		22												
24	Get 1st season yield samples	10 frm	2												(2	3)
25	Distribute 2nd season seeds	4 VG		22												
26	Check Cotton spraying	100 frm	6		9)											(6
	Total Days				17	17	17	17	22	22	17	17	17	17	17	17

NOTE: "Meeting With" code: PS = Primary Society, VG = Village Group, BG = Borrower Group, Frm = Farm; "Per Day" = number of meetings of visits possible per average day; "Do With" = activity can be done simultanwously with indicated activity number; ( ) = period during which the activity can be done.

Chapter 11

Exercise 2, page 194

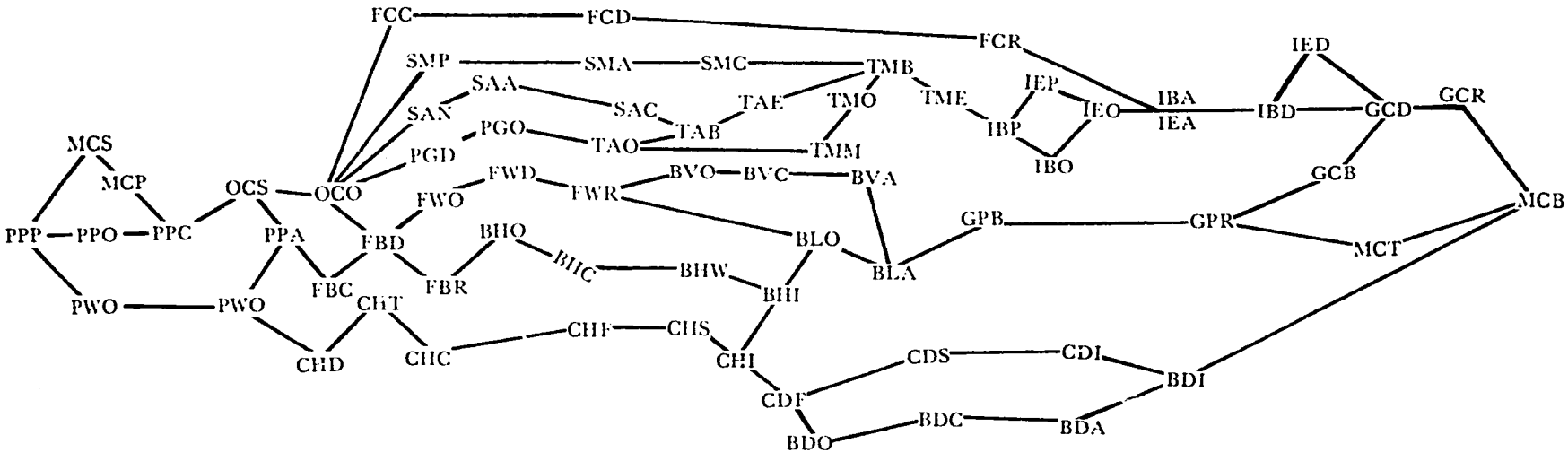
FIELD AGENT WORK SCHEDULE—ZONE Y FOUNDATION PACKAGE MONITORS

Work Activity	Meeting With		Per Day	Do With	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
1 Monitor Training at Province Office											2		2			4
2 Present Pkg. to PS Committee	2	PS	1		2											
3 Present Pkg. to Vlg. Groups—Preparations	8	VG	2		4											
4 Present Pkg. to Vlg. Groups—Meetings	8	VG	1		8											
5 Survey Farms of Loan Applicants	400	Frm	5			20	20	20	20							
6 Clear Applications with PS Committee	400	Frm	25							16						
7 Complete Farmer Signoffs on Loans	300	Frm	25							4	8					
8 Distribute First Season Seed and Fertilizer	8	VG	1									8				
9 Explain First Season Recommended Practices	8	VG		8												
10 Follow-up on First Season Practices	30	BG	1									2	20	8		
11 Recheck First Season Practices	30	BG	1											10	20	
12 Prepare Second Season Workplans				11												
13 Distribute Second Season Supplies	8	VG													8	
14 Get First Season Yield Samples	20	Frm	2												5	5
15 Check Cotton Spraying	30	BG	2		6											6
Total Days by Month					20	20	20	20	20	20	20	20	20	20	13	15

NOTE: See chapter 11, exercise 1, page 194 for explanations of codes and conventions.

Chapter 12
Exercise 1, page 220
POULTRY SCHEME CPM NETWORK

BD	**Buy Dressing Equipment**	O	Occupied	O	Organization of borrower-groups	D	Drafted
BH	**Buy Hatchery Equipment**	**FB**	**Finance Buildings**	A	Approval of loans	O	Originating agency approval
BL	**Buy Foundation Layer**	**FC**	**Finance Credit (farmers)**	D	Distribution of material	C	Concurrences received
BV	**Buy Vaccines**	**FW**	**Finance Working Capital**	**OC**	**Organize Cooperative**	**SA**	**Staff Assistants**
O	Ordered	C	Commitment received	S	Structure approved	**SM**	**Staff Monitors**
C	Confirmed	D	Documentation complete	O	Officers appointed	P	Positions advertised
W	Warehoused	R	Release of funds	F	Functioning	N	Candidates Nominated
A	Arrival at site	**GC**	**Grow Chickens**	**MC**	**Market Chickens**	A	Candidates Accepted
I	Installed	**GP**	**Grow Parent Stock**	S	Survey market	O	On board
CD	**Construct Dressing Plant**	B	Born	P	Price determined	**TA**	**Train Assistants**
CH	**Construct Hatchery**	D	Distributed	T	Transport arranged	**TM**	**Train Monitors**
D	Designed	R	Ready for sale	B	Begin deliveries	M	Materials prepared
T	Tenders invited	**I**	**Implement**	**PP**	**Plan Project**	O	Organized
C	Contract signed	**B**	**Beginning Village**	**PW**	**Plan Workplan**	B	Begin course
F	Foundation complete	**E**	**Ending Village**	**PG**	**Plan Guidelines**	E	End course
S	Structure complete	P	Presentation of program				
I	Interior complete						

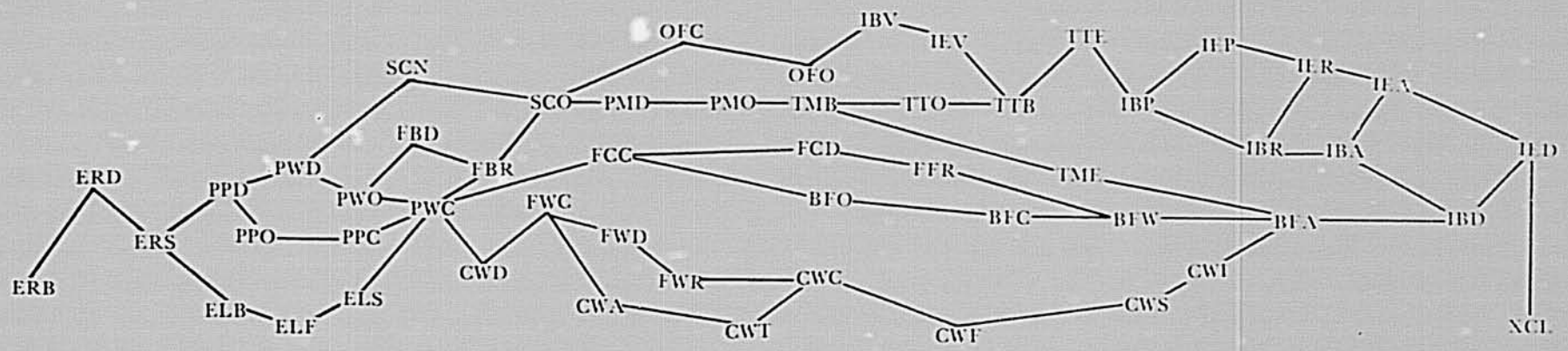


Chapter 12

Exercise 2, page 220

RICE FERTILIZER SCHEME CPM NETWORK

BF	Buy Fertilizer	FC	Finance Credit (farmers)	PP	Plan Project
O	Ordered	FW	Finance Warehouse Construction	PW	Plan Workplan
C	Confirmed	C	Commitment received	PM	Prepare Manual
W	Warehoused	D	Documentation submitted	D	Drafted
A	Arrived on site	R	Release of funds	O	Originating agency approval
CW	Construct Warehouses	OF	Organize District Federation	C	Concurrences
D	Designed	C	Call for first meeting	SC	Staff Coordinator position
A	Approved	O	Officers elected	N	Nominated
T	Tenders invited	I	Implement	O	On board
C	Contract let	B	Beginning Village	TM	Train Managers
F	Foundation complete	E	Ending Village	TT	Train Teachers
S	Structure complete	V	Volunteers secured	O	Organize course
I	Interiors complete	P	Presentation of program	B	Begin course
ER	Evaluate Fertilizer Recommendations	S	Survey of farms	E	End course
EL	Evaluate Locations	O	Organization of borrower-groups	XCL	Externally Determined by crop: latest date
B	Begin survey	R	Requests submitted		
F	Finish survey	A	Approval of loans		
D	Data analyzed	D	Distribution of material		
S	Submit recommendation				
FB	Finance Budget				



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