December 22, 1971

To the Graduate Council:

I am submitting herewith a dissertation written by Noel S. P. Rebello entitled "Agricultural Program Planning to Reflect Potentials of Small Farms with Applications to Mysore State, India." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Agricultural Economics.

Major Professor

We have read this dissertation
and recommend its acceptance:

Accepted for the Council:

Vice Chancellor for
Graduate Studies and Research

AGRICULTURAL PROGRAM PLANNING TO REFLECT POTENTIALS OF SMALL FARMS WITH APPLICATIONS TO MYSORE STATE, INDIA

A Dissertation

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

---

by

Noel S. P. Rebello

March 1972

ACKNOWLEDGMENTS

I am extremely grateful to the people of the United States and their government who made it possible for me to study for the Ph.D. degree through the United States Agency for International Development. I am also grateful to the Government of India and the University of Agricultural Sciences who deputed me for these studies.

I wish to acknowledge the contribution of the following to this dissertation:

Dr. David W. Brown, who was Chief Advisor, for his constant counsel, encouragement and repeated challenge which made this dissertation what it is.

Drs. Merton B. Badenhop, Charles L. Cleland, Luther H. Keller, Robert S. Dotson and Frank F. Bell, who served on the Advisory Committee for their assistance.

Drs. Luther H. Keller, Dr. Ray Daniel, Mr. Gerald V. Eagan and Mr. Tom Elam, who advised freely on computational problems.

Dr. Thomas J. Whatley, who provided great understanding and physical facilities.

Mr. A. H. Mitchell, who helped solve problems in documentation.

Miss Melitta Stoutt and Mrs. Marcia DeWitt, who helped prepare the final draft.

I am also grateful to the faculty of Agricultural Economics, Economics and Agricultural Extension, especially Dr. Keith E. Philips, with whom I took courses.

1014738

To Drs. Lewis H. Dickson and D. Mallory Thorpe, Mrs. Peggy D. Wood and Mrs. Mioko Y. Oliver of the International Agricultural Programs of the University of Tennessee.

To Mrs. Mary E. Berry and others of the staff of the Department of Agricultural Economics.

Finally, I am grateful to my wife Olive and children, Margaret and Alec, whose companionship helped me stand the demands of the program, and who had so little of my time for so long.

ABSTRACT

India, under its Fourth Five Year Plan, is placing greater emphasis on helping small farmers to increase their productivity and incomes. Small Farmer Development Agencies (SFDA) have been established in selected districts of Mysore and other states to coordinate the activities of relevant government agencies. The concern of this dissertation was with the program results that might potentially be achieved if the resource constraints, production capabilities, and motivations of the small farmers themselves are taken adequately into account. Possible reasons why small farmers fail to respond to assistance programs were diagnosed. A general approach was suggested for selecting representative farmers, analyzing their potential responses to such help as more credit and irrigation, and assessing the aggregate implications in terms of program benefits and resource needs. This approach was then illustrated to the extent possible with available farm data from a distributory in the Tungabhadra Irrigation Project in Mysore State.

Bearing in mind the likely limitations in time and analytical capacity of district level agencies, a three-stage approach for using information about farmer situations and potential to help determine program content was suggested:

Stage I: The application of budgeting or linear programming to representative farms to ascertain their potential output response and input needs associated with alternative assistance

proposals, taking into consideration the individual resource constraints, technical capacities, and interests that they reflect.

Stage II: Aggregation of these results to estimate the area-wide benefits to small farmers and costs to the Agency stemming from each program alternative.

Stage III: Use of benefit-cost or linear programming analysis to obtain an optimal SFDA program mix, considering the net benefits estimated in Stage II, the resource constraints of the Agency, and its objectives.

The Tungabhadra illustration drew on survey data for 40 small farms and related production input-output information that had been synthesized from several sources. In this particular application, irrigated land area and operating capital were found to be the resources that most severely constrained farmers from achieving higher incomes. The linear programming analysis also brought out the fact that it is important to have detailed information about farmers' production constraints, such as seasonal distribution of available family and hired labor, if farmer response potentials are to be realistically estimated. When SFDA assistance in the form of production credit and/or more irrigated land was assumed, the additional credit generally came out as contributing more to incomes than additional irrigated land, especially on the larger representative farms. Labor was not a constraint except under very liberal assumptions about additional capital and irrigated land area. The overall implication for this Tungabhadra situation at

least was that if SFDA wants to maximize its net contribution to small farmer incomes, it would not necessarily provide the same "mix" of assistance to every farmer, nor would it rationally expect all farmers to respond with identical changes in crops or practices.

This study also explored, using the Tungabhadra data to illustrate where possible, some modifications in the basic procedure that might be considered by agencies like SFDA. These included: (1) use of principal component and factor analysis to divide farms into homogeneous groups for linear programming and aggregation purposes; (2) estimation of output changes and input needs, given the reality that farmers do not all take advantage of new opportunities at the same pace; and (3) simple approaches that SFDA workers might consider in the near future to improve the collection and analysis of farm level information for program planning purposes.

TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION	1
	The Background	1
	The Problem	5
	The Objectives	6
	The Organization of the Dissertation	7
II.	THE SMALL FARMERS DEVELOPMENT AGENCY AND ITS CONCERNS	8
	The Pilot SFDA Projects	9
	The Structure of the SFDA	15
	The Concerns of the SFDA	19
	Identification of the Clientele	21
	Identification of Goals	26
	Strategies to Reach the Clientele	30
	Implementation of the Programs	36
	Evaluation of Progress	39
	The Use of Farm Management Data	40
III.	POSSIBLE CONTRIBUTIONS OF FARM LEVEL ANALYSIS TO PLANNING OF PROGRAM CONTENT	43
	Possible Causes of Differences Between Planner Expectations and Farmer Response	44
	A Possible Approach to Program Design	54
	Problems of Aggregation	65
	Alternative Methods for Grouping Farms	70

CHAPTER PAGE

Some General Observations on the Linear Programming and Aggregation Approach 72

IV. AN EMPIRICAL APPLICATION OF THE SUGGESTED PROCEDURE FOR SFDA PLANNING TO A SITUATION IN TUNGABHADRA 75

Empirical Results When Water Rate and Interest Are Ignored 85

The Results When Water Rates and Interest Charges Are Considered 105

The Use of Principal Components Analysis in Setting Up Representative Farms 119

Results When Groups Are Based on Principal Component Analysis 122

The Use of Factor Analysis in Setting Up Representative Farms 126

Results When Groups Are Based on Factor Analysis 129

V. IMPLICATIONS FOR THE SFDA AND SOME POSSIBLE REFINEMENTS . . 133

Types of Information Needs 134

Data Collection by SFDA 137

Levels of Analysis and Personnel Requirements 140

VI. POSSIBILITIES FOR FURTHER REFINEMENTS 147

VII. SUMMARY AND CONCLUSIONS 155

BIBLIOGRAPHY 162

APPENDIX 169

VITA 177

LIST OF TABLES

TABLE		PAGE
1.	Distribution of Farms by Size in Mysore State, 1955-56 . . .	12
2.	Distribution of Farms by Size in Bangalore District, Mysore State	14
3.	An Illustrative Plus-Minus Decision-Making Chart	31
4.	The Relevance of Farm Management Information Types in the Concerns of the SFDA	42
5.	Inventory of Resources of Forty Sample Farmers in the Fortieth Distributory of the Tungabhadra Irrigation Project, Mysore State, 1971	77
6.	The Technical Coefficients Matrix (Units Per Acre)	79
7.	Correlation Matrix of the Resources of Small Farmers, Forty Farms, Fortieth Distributory, Tungabhadra Project . .	80
8.	The Resource Picture of Representative Farms A, B and C, Forty Small Farmers, Fortieth Distributory, Tungabhadra Project	82
9.	The Resource Ratios of Representative Farms A, B and C, Forty Small Farmers, Fortieth Distributory, Tungabhadra Project	83
10.	Optimal Plans for Representative Farm A, Fortieth Distributory, Tungabhadra Project	86
11.	Optimal Plans for Representative Farm B, Fortieth Distributory, Tungabhadra Project	87

TABLE PAGE

12. Optimal Plans for Representative Farm C, Fortieth Distributory, Tungabhadra Project 89

13. Resource Requirements of the Optimal Plans for Representative Farm A, Fortieth Distributory, Tungabhadra Project . 90

14. Resource Requirements of the Optimal Plans for Representative Farm B, Fortieth Distributory, Tungabhadra Project . 91

15. Resource Requirements of the Optimal Plans for Representative Farm C, Fortieth Distributory, Tungabhadra Project . 92

16. Additional Resources Required Under the Optimal Plans for Representative Farm A, Fortieth Distributory, Tungabhadra Project 93

17. Additional Resources Required Under the Optimal Plans for Representative Farm B, Fortieth Distributory, Tungabhadra Project 94

18. Additional Resources Required Under the Optimal Plans for Representative Farm C, Fortieth Distributory, Tungabhadra Project 95

19. Unutilized Owned Resources Under Optimal Plans for Representative Farm A, Fortieth Distributory, Tungabhadra Project 97

20. Unutilized Owned Resources Under Optimal Plans for Representative Farm B, Fortieth Distributory, Tungabhadra Project 98

TABLE PAGE

21. Unutilized Owned Resources Under Optimal Plans for Representative Farm C, Fortieth Distributory, Tungabhadra Project 99

22. Benefit-Cost Estimates of Different Program Alternatives When All Farmers Adopt, Fortieth Distributory, Tungabhadra Project 101

23. Benefit-Cost Estimates of Different Program Alternatives When a Limited Proportion of Farmers Adopt, Fortieth Distributory, Tungabhadra Project 104

24. Optimal Plans for Representative Farm A, Fortieth Distributory, Tungabhadra Project 107

25. Optimal Plans for Representative Farm B, Fortieth Distributory, Tungabhadra Project 108

26. Optimal Plans for Representative Farm C, Fortieth Distributory, Tungabhadra Project 109

27. Resource Requirements of the Optimal Plans for Representative Farm A, Fortieth Distributory, Tungabhadra Project . 111

28. Resource Requirements of the Optimal Plans for Representative Farm B, Fortieth Distributory, Tungabhadra Project . 112

29. Resource Requirements of the Optimal Plans for Representative Farm C, Fortieth Distributory, Tungabhadra Project . 113

30. Benefit-Cost Estimates of Different Program Alternatives When All Farmers Adopt, Fortieth Distributory, Tungabhadra Project 115

TABLE PAGE

31. Benefit-Cost Estimates of Different Program Alternatives When Limited Proportions of Farmers Adopt, Fortieth Distributory, Tungabhadra Project 116

32. Benefit-Cost Estimates of Different Program Alternatives When Different Proportions of Farmers Adopt, Fortieth Distributory, Tungabhadra Project 118

33. The Resources of Representative Farms P, Q and R, Forty Farms, Fortieth Distributory, Tungabhadra Project 121

34. Optimal Plans and Additional Resource Requirements for Representative Farm P, Fortieth Distributory, Tungabhadra Project 123

35. Optimal Plans and Additional Resource Requirements for Representative Farm Q, Fortieth Distributory, Tungabhadra Project 124

36. Optimal Plans and Additional Resource Requirements for Representative Farm R, Fortieth Distributory, Tungabhadra Project 125

37. Benefit-Cost Estimates of Different Program Alternatives When Farmers Are Grouped by Principal Components Analysis, Fortieth Distributory, Tungabhadra Project . . . 127

38. The Resource Picture of Representative Farms X and Y, Forty Farmers, Fortieth Distributory, Tungabhadra Project 128

TABLE PAGE

39. Optimal Plans and Additional Resource Requirements for Representative Farm X, Fortieth Distributory, Tungabhadra Project 130

40. Optimal Plans and Additional Resource Requirements for Representative Farm Y, Fortieth Distributory, Tungabhadra Project 131

41. Benefit-Cost Estimates of Different Program Alternatives When Farms Are Grouped by Factor Analysis, Fortieth Distributory, Tungabhadra Project 132

CRANES CREST

LIST OF FIGURES

FIGURE		PAGE
1.	Mysore State Districts with Program for Development of Small and Marginal Farmers	16
2.	Program Spreading Strategy Continuum	37
3.	Examples of Possible Differences Between Program Plans and Farmer Interests	46
4.	Minimum Subsistence Levels and Acceptance of Change	50
5.	Problems in Program Design Arising Out of Differences in Production Functions	53
6.	A Path for Program Design	56
7.	Possible Combination of Approaches in Data Gathering	62

CHAPTER I

INTRODUCTION

Mysore State, India, is basically agricultural. Consequently development plans are based upon agriculture. These are essentially of two types:

1. Plans to achieve national goals, which are drawn up for five year periods. These lay down policy directives and contain directional statements, as well as list major projects and their priorities.

2. Plans for the activities of what may be termed "Development Departments", such as the Departments of Agriculture, Animal Husbandry and Fisheries. These are prepared annually for the state as a whole.

Much of the success of these plans, especially the second type, depends upon their appropriateness in the context of those whom they benefit. The methods used in preparing the plans will often affect their "reality" and appeal to the farmers, and are therefore important.

The Background

State and regional action programs provide a means of achieving national goals, which are expected to reflect the aspirations of the people. The central objective of these programs is to initiate, accelerate and sustain changes in the technology, of agriculture in this case, and the infrastructure that supports it. Goals, however, differ at different levels. Yet they are not essentially contradictory and means can be found to circumvent or eliminate conflicts. In fact, this is essential in program planning.

The democratic process is an essential part of the philosophy behind the Indian constitution. Though planning has been accepted as a means for speedy development, the creation of incentives for the individual farmers to encourage them to channel efforts towards the achievement of national objectives, rather than use of force is consistent with this philosophy. It is then necessary to consider useful means for motivating individual farmers when designing programs. Programs that do not include measures to satisfy the needs and interests of farmers are bound to be self defeating.

The prime interests of the farmers, or most groups for that matter, and the stated goals of society are rarely, if ever, identical. Thus in a specified region the social goal may be to increase the production of a food crop, say rice, while the farmers may be interested in increasing their income and prefer sugar cane or tobacco. Further, it is possible that farmers may be interested in minimizing cash expenses or in keeping risks at a minimum. It is essential in such cases to explicitly consider these aspects and provide suitable incentives when drawing up programs as vehicles to reach social goals.

It might be worthwhile noting that were the system of government not democratic or "free", but instead some form of a "command" economy, there would still be need to create incentives to farmers to motivate them to respond in a fashion consistent with the development objectives. It is possible that in this case the incentives may be "negative" in nature, such as threats of fines or reduced status. Basically these too are forms of adjustments that make conformity or cooperation profitable

to the individuals. The essential difference in the two systems is in policy making procedures. They differ in "who" establishes the goals and the accepted modes of achieving them. But "how" to induce individuals to respond to programs remains an important question.

Development plans are drawn up on a five year basis in India. The Central Planning Commission coordinates all planning activity. It lays down policy directives and priorities in consultation with state planning cells, which in turn work with advisory bodies at the district level.[1]

Agricultural development action programs are drawn up annually for the state level. District, regional and state level technical administrators and subject matter specialists draw up these programs based on their experience, results of research in experiment stations and area statistics compiled by the Department of Statistics. Activities and targets are set for the state as a whole and these are then divided among the districts.[2]

---

[1]This is a personal observation on a highly complex process. Since the description or criticism of the current procedures is not an objective here, no attempt is made to discuss it in depth. Some works that analyze the planning process in India include: S. R. Sen, The Strategy for Agricultural Development and Other Essays on Economic Policy and Planning, Second Edition (New York: Asia Publishing House, 1966); S. R. Sen, "Planning Machinery in India," Indian Journal of Public Administration, Volume 8, Number 3, August 1961; P. K. B. Nayar, Leadership Bureaucracy and Planning in India (New Delhi: Associated Publishing House, 1969); and A. Vasudevan, The Strategy of Planning in India (Meerut: Meenakshi Prakashan, 1970).

[2]These are again personal and superficial observations based on experience dating up to 1968. Works that give insights into the working of state agricultural programs are the work by Nayar cited earlier and S. J. Higginbotham, "Patterns and Sources of Indian Bureaucratic Behavior

The important point about action program development at present in India is that it is top downward. Plans are drawn up for the state, taking into consideration mainly the national goals and priorities set by the national five year plan. The individual goals and capabilities of farmers are not explicitly considered and as a result the plans often do not create as much response as the planners desired or hoped for. They tend to rely on aggregative level rather than farm level information. They tend to lay down desirable action from the point of view of society and gloss over realities. As a result they often do not contribute as much to the development of the state and the nation as is possible or desirable.

Yet another important consideration in action program planning is that the resources at the disposal of government agencies are limited and have many alternate uses. It is important then to insure that these resources are utilized to the best possible advantage to society. Sometimes, however, political expediency or other reasons necessitate the adoption of less than the economically optimal alternatives. In such cases it is useful to know what economic sacrifice is involved in adopting the less effective alternative, so that the social goal can be achieved at least cost.

In India, many farmers who fail to avail themselves of the facilities of development programs are those who operate small units.

--Organizational Pressures and Ethic of Duty in Tamil Nadu Development Program" (unpublished doctoral thesis, Massachusetts Institute of Technology, Cambridge, 1970), Chapters II to IV.

These constitute the majority in number and they operate nearly one half or in many areas more than one half the total cultivated area. The Indian planners have therefore decided to set up a Small Farmers Development Agency (SFDA) on a pilot basis in about 20 districts (4 districts in Mysore State) to get the small farmers involved in the development effort. These bodies will have to decide on programs that will motivate small farmers to participate in them.

The Problem

There is then a need to investigate approaches to action program planning that explicitly take into account the interests and capabilities of individual farmers. The use of farm management information could make the results more realistic from the point of view of the farmer as well as that of the planners and implementation agencies. Also there is a need to develop "cost" and "benefit" information not only for a single program as is done at present but for alternative programs, so that decision-making results in a more efficient program or program combination being selected.

The focus here is on applying micro-level analytical procedures, such as budgeting and/or linear programming, to the estimation of possible returns from alternative programs. This is helpful in adopting cost-benefit approaches to evaluate program alternatives and decide on the best use of resources. The major effort is to develop the use of farm management information in the decision-making process in order to formulate programs that are more effective, as compared to the current situation, from the point of view of both society and the farmers.

The thesis here is that the use of farm management (farm level) data in development action program formulation and evaluation, as compared with present methods using research data, will yield programs that contribute more to development, by explicitly taking into account the possibilities, goals and constraints at the farm level. The problem is studied in the context of the SFDA set up on a pilot basis in selected districts during the Fourth Five Year Plan.

The Objectives

The specific objectives of this dissertation are, in the context of the SFDA, the following:

1. To apply budgeting and linear programming procedures, using farm level data about technical possibilities and constraints, to generate information useful to development planners to evaluate, compare and establish priorities of alternative programs possible within the limited resources available to an agency.
2. To identify problems in the use of this basically micro-level analysis for macro-level decisions and the possibilities for refinement.
3. To explore possible criteria for grouping farms for the purposes of such program analysis.
4. To explore the implications of the proposed analytical approach for SFDA action.

The extent to which these objectives are pursued here is limited by the fact that it is not possible to visit India to collect data for

the purpose of testing the method suggested. Data collected by someone else are used. The data were collected for a different purpose and do not contain information sufficient to permit rigorous testing of the methods suggested. Therefore, the author has been forced to propose some ideas and approaches which could be developed and tested further, by himself and others, later.

The Organization of the Dissertation

The development and organization of the SFDA are discussed in Chapter II. Its concerns are then identified and some aspects of these, other than program planning procedures, are presented. In Chapter III some possible reasons why development action programs may not deliver all that they are expected to do are diagnosed, and an approach to program design that could control them to some extent is presented. Some problems that may arise in the use of this approach are also brought out. Chapter IV presents the empirical results of the application of this approach to the evaluation of program alternatives and development of a suitable program design with data from Mysore. The implications for the SFDA of this procedure for program analysis are laid out in Chapter V. Chapter VI deals with the limitations of the approach, some possible refinements and alternative procedures. Finally, Chapter VII summarizes the foregoing analysis.

CHAPTER II

THE SMALL FARMERS DEVELOPMENT AGENCY AND ITS CONCERNS

Article 39 of the constitution of India in the directive principles of state policy, stresses the right of all citizens to adequate means of livelihood, the need for resources to be distributed so as to subserve the common good and the undesirability of the concentration of wealth and the means of production.[1] Article 46 makes it the obligation of the state to promote with special care the education and economic interests of the "weaker" section of the people.[2] The Parliament of India declared by a resolution in 1954 that the objective of economic policy should be a socialistic pattern of society. This underscored the idea that it is not only important to develop, but that the benefits of economic development must reach more and more to the relatively less privileged classes of society as well. The Indian Second Five Year Plan document stated:

> The accent of the socialistic pattern is on the attainment of positive goals; the raising of living standards, the enlargement of opportunities for all, the promotion of enterprise among the disadvantaged classes and the creation of a sense of partnership among all the sections of the community.[3]

---

[1] V. N. Shukla, The Constitution of India (fifth edition; New Delhi: Eastern Book Company, 1969), p. 181.

[2] Ibid., p. 186.

[3] Government of India, Planning Commission, Second Five Year Plan (New Delhi: Manager of Publications, Government of India, 1956), p. 24.

The Pilot SFDA Projects

The planning task in India has been described in the (current) Fourth Five Year Plan as:

> . . . to organize the efficient exploitation of the resources of the country, increase production and step up the tempo of economic activity in general and industrial development in particular, to the maximum possible extent. The basic goal is a rapid increase in the standard of living of the people, through measures which also promote equality and social justice. Emphasis is placed on the common man, the weaker sections, and the less privileged.[4]

Regarding the need to pay special attention to the problems of the weaker producers the policy statement states:

> It is only the adoption of this approach to area and activity development that can enable the common man throughout the country to participate in the benefit from the growth of the economy.[5]

In the section on agricultural development of the Fourth Five Year Plan draft it is specifically stated that:

> One of the main objectives of the fourth plan, in the agricultural sector, is to enable the small farmers to participate in development and share its benefits.[6]

This is to be done by making special provisions and arrangements to see that the small farmers are able to utilize the general facilities provided for minor irrigation, agricultural credit and animal husbandry.

---

[4]Government of India, Planning Commission, Fourth Five Year Plan, 1969-74, Draft (New Delhi: Manager of Publications, Government of India, 1969), p. 4.

[5]Ibid., p. 16.

[6]Ibid., p. 115. The term small farmer is used throughout to indicate one who operates small land area. However, the level of other resources available is also generally low.

It is also stated that:

> The second direction of the effort will be pilot experiments in about 20 selected districts. It is contemplated that a small farmers development agency will be set up in each of these districts.[7]

Laying down the specific approach that these agencies will take to achieve their objective, it is stated that:

> The principal function of the agency will be to identify the problems of the small but potentially viable farmers in the area and help ensure the availability of inputs, services and credit. To the maximum extent possible, this will be sought to be done through the existing institutions--public, cooperative and private--as also local authorities such as Zila Parishads. The agency may give assistance to small farmers in respect of other services, such as land leveling, machinery and marketing.[8]

This idea of the SFDA has its genesis not only in the constitutional directive that the state should ensure that the "weaker" sections of the people obtain an equitable share in the fruits of development, but also in a problem that has perturbed the leaders in recent times. It has become apparent that the response to development programs has come largely from farmers who operate relatively large farms. Farmers operating relatively small size units have remained outside the development effort. This may be because the returns to the efforts of the change-agency personnel are usually higher in the case of operators of large farms. These not only operate larger land areas but generally

---

[7] Ibid., p. 116. A district is a revenue and administration unit. It is larger than a county. Each state is divided into districts, taluks and villages.

[8] Ibid., p. 116. The Zila Parishad or District Council is an elected body for local government and is a part of the Panchayat Raj or representative government effort at the district, taluk and village levels.

have more funds and other resources, are more creditworthy, have higher education and social status and are better able to withstand risks. As a result, they respond to change-agency efforts more easily than small farmers.[9] It is not surprising then that change-agency personnel, who are evaluated on the basis of achievement of targets, prefer to concentrate on the more innovation prone farmers since the return per visit or per hour spent is higher here, both in terms of the number adopting new practices and the area covered or production increases generated.

This concentration of efforts on the farmers operating relatively large size farms may be justifiable in terms of maximizing the returns to the limited resources of personnel and services available with the change-agencies. However, the number of farmers who operate relatively small size holdings is large. The distribution of the farms by the area operated in Mysore State is presented in Table 1.[10] Slightly less than half of all the farms are less than five acres in size.[11] Farms that are less than 10 acres in size form well over two-thirds of the total number of farms in the state. Hence, small farmers can be said to constitute a majority in the state. In terms of the total area under

---

[9]These statements are essentially an effort to explain observed situations based on personal experience. No scientific studies appear to have been undertaken to investigate the matter.

[10]Government of Mysore, Bureau of Economics and Statistics, Economic Development of Mysore 1956-69 (Bangalore: Manager, Government Press, 1970), p. 49.

[11]A hectare is equal to 2.471 acres. Hence, five acres is slightly over two hectares and 10 acres is slightly in excess of four hectares.

TABLE 1

DISTRIBUTION OF FARMS BY SIZE IN MYSORE STATE, 1955-56

Size of Holding in Hectares[a]	Farms		Area[b]	
	Number	Percent of Total	Hectares	Percent of Total
Below 2.00	1,164,400	47.3	1,119,420	10.3
2.00 - 3.99	540,300	21.9	1,585,580	14.6
4.00 - 5.99	263,400	10.7	1,313,820	12.1
6.00 -11.99	316,600	12.8	2,674,620	24.7
12.00 -23.99	138,500	5.6	2,150,960	19.8
24.00 -40.50	29,600	1.2	895,050	8.3
Over 40.50	13,700	0.5	1,106,870	10.2
Total	2,466,500	100.0	10,846,320	100.0

[a] 1 Hectare = 2.471 acres.

[b] The area is that owned rather than operated. But in the case of small farms the two are more or less equal since the house, etc., occupy relatively little space and more space is utilized for other purposes on larger farms. So the percentages in terms of area operated tend to be underestimated in the case of smaller farms and overestimated in the case of larger farms.

Source: Bureau of Economics and Statistics, Government of Mysore.

cultivation in the State of Mysore, about a tenth is cultivated by farmers operating less than five acres and about a fourth by those operating less than 10 acres. So even in terms of area small farmers are important. Table 2 presents the distribution of farms according to size for Bangalore District.[12] Thus, over an eighth of the holdings are less than 10 acres in size and cover over half of the total area cultivated, while two-thirds are less than five acres and cover a quarter of the total area. So the development will be slow as well as incomplete unless operators of smaller size farms enter the mainstream of the development activity. Further, the problem of poverty and inequality of income distribution tends to be aggravated instead of solved. Of even greater significance is the fact that it is the small farmers who generally have a low resource base and greater problems in achieving higher production or income levels.

The Fourth Five Year Plan for the State of Mysore states:

> The schemes for small but potentially viable farmers represent a new initiative by the Central Government to ensure that the benefits of the "green revolution" are not enjoyed only by the farmers who are comparatively well to do. It has been observed that the benefits of increasing irrigation facilities and the opportunities to increase agricultural yields by adopting a package of practices based on technological advance are not being enjoyed by a large mass of agriculturists who do not have the capital required to take advantage of them.[13]

---

[12] Government of Mysore, The Small Farmers Development Agency, Bangalore (Bangalore: Manager, Government Press, 1971), p. 14.

[13] Government of Mysore, Planning Department, Fourth Five Year Plan, 1969-74, Policy and Programme (Bangalore: Manager, Government Press, 1970), p. 133.

TABLE 2

DISTRIBUTION OF FARMS BY SIZE IN BANGALORE DISTRICT, MYSORE STATE

Size of Holding in Acres	Farms		Area[a]	
	Number	Percent of Total	Acres	Percent of Total
Less than 5 acres	75,654	66.36	167,836	24.05
5 acres to less than 10 acres	23,716	20.80	218,619	31.32
10 acres to less than 15 acres	6,998	6.14	83,908	12.02
15 acres to less than 30 acres	5,620	4.93	113,064	16.20
30 acres to less than 45 acres	1,163	1.02	41,711	5.98
45 acres to less than 60 acres	395	0.35	21,415	3.07
60 acres to less than 75 acres	172	0.15	11,464	1.64
75 acres to less than 100 acres	124	0.11	10,494	1.50
100 acres to less than 150 acres	95	0.08	12,080	1.73
150 acres and over	62	0.06	17,346	2.49
Total	113,999	100.00	697,937	100.00

[a]The area is that owned rather than operated. But in the case of small farmers the two are more or less equal since the house, etc., occupy relatively little space. So the percentages in terms of area operated tend to be underestimated in the case of small farmers and overestimated in the case of larger farmers.

Source: Government of Mysore, The Small Farmers Development Agency, Bangalore (Bangalore: Manager, Government Press, 1971), p. 14.

In the State of Mysore, pilot SFDA's are proposed to be set up in Mysore, Bidar, North Kanara and Bangalore districts.[14] (See map in Figure 1.)

The policy of concentrating efforts on the development of small farmers is taken as a "given" for the purpose of this dissertation study. No attempt is made either to justify it or compare it with alternative strategies for development. The investigation is entirely confined to the possible solutions to the problems faced by the SFDA, mainly in decisions on program alternatives.

The Structure of the SFDA

The Fourth Five Year Plan for the State of Mysore lays down the functions of the SFDA stating:

> In addition to liberalized financing of small farmers, subsidies will also be given to induce small farmers to take to improved methods of agriculture and to augment their incomes by having subsidiary occupations dairying and poultry keeping, horticulture, rural arts and crafts, etc. All these operations will be entrusted to an independent agency to be called the Small Farmers Development Agency which will be set up in each of the districts where the program is implemented.[15]
>
> The plan also proposes to make available Rs. 15,000,000 to each agency for the five year period.[16]

The primary function of the SFDA then is to coordinate and channel the services of the development agencies of government to small farmers. However, it has also some independent funds available, which it will use for administration as well as, hopefully, for direct

---

[14] Ibid., p. 134. Similar programs to help marginal farmers are being introduced in Tumkur and Bijapur districts.

[15] Ibid.

[16] Ibid. The official exchange rate is Rs. 7.50 to $1.00.

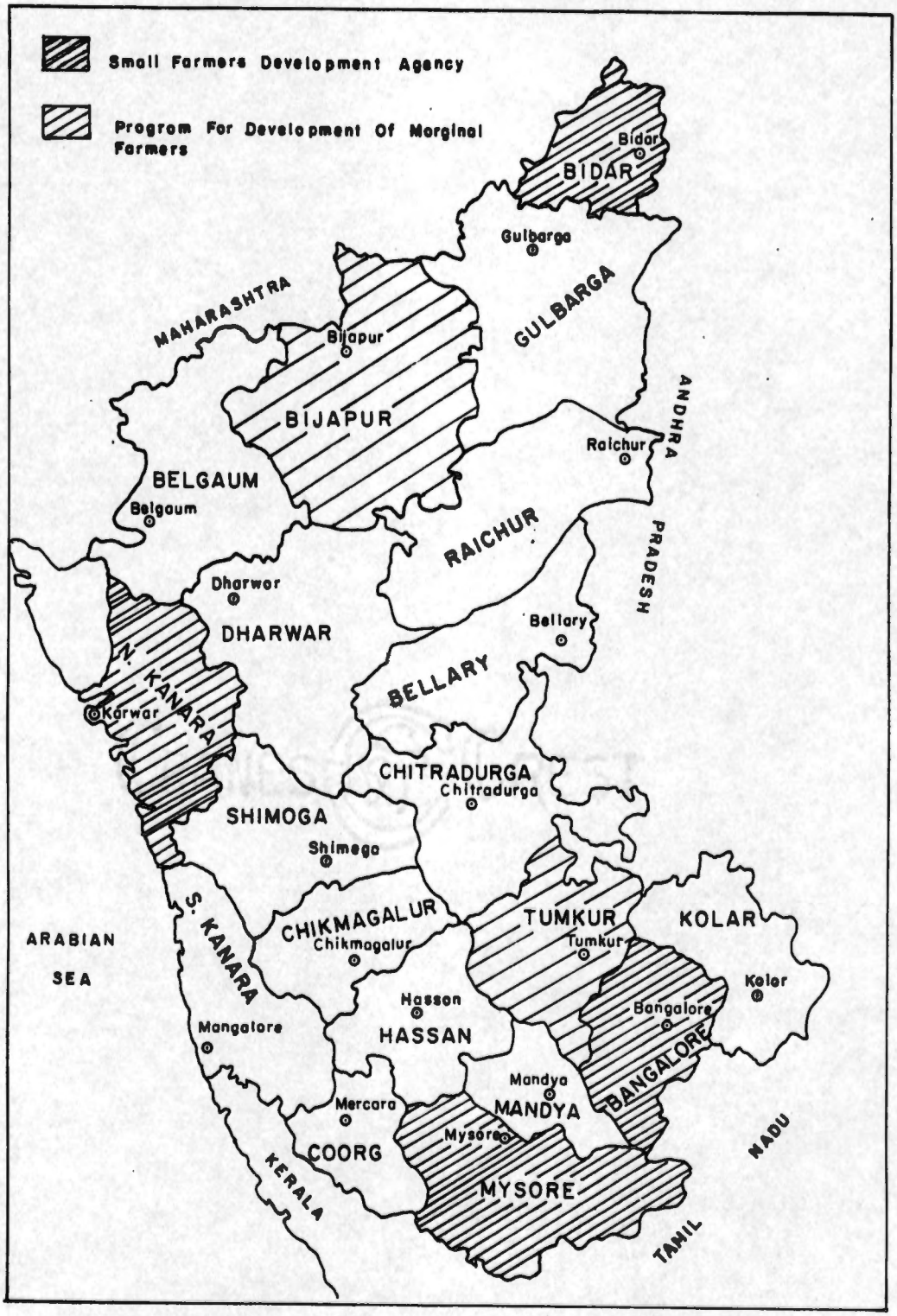


Figure 1. Mysore State districts with program for development of small and marginal farmers.

action by itself or for allocation to line agencies for specified purposes or programs.

The Agency is to be made up of representatives of the central government, state government and development departments, cooperative and other public sector agencies, and nonofficials. It has a small staff to assist in its work. Though there appears to be some variation in the actual composition of the agencies proposed for the four districts, the composition proposed for Mysore District is a good example. It will consist of the following:[17]

1. The Divisional Commissioner, Mysore--Chairman.
2. A representative of the Ministry of Agriculture, Government of India.
3. A representative of the Planning Commission, Government of India.
4. The Joint Registrar of Cooperative Societies, Mysore.
5. The Joint Director of Agriculture, Mysore.
6. The Superintending Engineer in charge of Minor Irrigation.
7. The Deputy Commissioner, Mysore.
8. A representative of the District Cooperative Central Bank, Limited, Mysore.
9. A representative of the State Land Development Bank, Limited, Mysore.

---

[17] Small Farmers Development Agency, Mysore District, A Pilot Project on the Agricultural Development of the Small Farmers of Mysore District (Mysore: Project Officer, Small Farmers Development Agency, 1970), pp. 58-59.

10. The Regional Deputy Director of Animal Husbandry, Mysore.
11. A representative of the Finance Department of the Government of Mysore.
12-15. Four nonofficial members to be nominated by the Government of Mysore.
16. The Managing Director, State Cooperative Marketing Society.
17. A representative of the Agro-Industries Corporation.
18. The Superintending Engineer (Electrical), Mysore State Electricity Board, Mysore.
19. The District Horticultural Officer, Mysore.
20. A representative of the Department of Industries.
21. The Project Officer and Secretary (will be a Deputy Director of Agriculture).
22. The Joint Secretary (will be an Assistant Registrar of Cooperative Societies).

The SFDA will have a full time staff consisting of the following:

1. Project Officer and Secretary.
2. Joint Registrar.
3. Farm Management Specialist.
4. Water Management Specialist.
5. Office Manager.
6. Cashier.
7. Clerk.
8. Stenographer.
9. Typist.

10. Driver (chauffeur).

11-13. Three Peons (messengers).

14. Watchman.

It is this staff that will be primarily involved in the investigation of program alternatives, working with the existing line agencies, coordinating their efforts and channelizing them to small farmers, reporting the progress and the like.

The Concerns of the SFDA

The objective of the SFDA is to mobilize small viable farmers to participate in the development efforts and share in the benefits. If the SFDA is to maximize its effectiveness in doing so, it will need to give careful attention to several elements of program design. Important among these are the following:

1. The clientele will need to be identified. This involves the basic problem of defining a "small viable farmer". Most of the pilot project proposals in Mysore use the area of land operated as the sole criterion, interpreting the term "small farm" literally. However, the problem is more complex due to variations that exist in soil potential, tenure, availability of other resources and even personal characteristics of the farmer and his family.

2. The explicit action oriented goals and the subgoals of the clientele need to be identified. It is necessary to ascertain the extent to which the specific goals, interests and motivations of the small farmers are consistent or inconsistent with the general program

goals as a basis for the introduction of appropriate incentives, supplies and services.

3. Some decisions on the strategies that are to be used in reaching significant numbers of the clientele have to be made. Priorities need to be developed regarding whom to approach first and guidelines laid down on whether to concentrate efforts on a specific type of situation or area.

4. Action programs to help small viable farmers develop need to be formulated. This involves first and foremost an analysis of the current situation relative to what is desired or achievable and the identification of actions most appropriate for reducing this problematic gap. It is also necessary to estimate the service and supply needs and the institutional requirements. They will entail the use of systematic procedures and appropriate facts for formulating and evaluating alternatives. Analytical procedures may need to be tailored to fit the time pressures and data limitations. Additional facts may be required. These assessments need to be based on likely impacts at the individual-farm level. Feasible approaches for such analysis of program content by the SFDA is the main concern of this dissertation.

5. The programs that are chosen will have to be implemented. This involves making the clientele aware of the programs, creating an interest and nurturing it and motivating the farmers towards adoption. It entails both technical and administrative aspects.

6. The results of the programs implemented have to be evaluated periodically. This will be useful both in estimating the progress made

and in the identification of bottlenecks. The latter will help in making adjustments in the programs in order to increase their efficiency.

The use of farm level analysis to help in the formulation of program content by the SFDA is the focus of investigation in the subsequent chapter. However, the insight that results from such analysis also carried useful implications for the other concerns of the SFDA, as elaborated in the remainder of this chapter.

Identification of the Clientele

The problem of defining a "small viable farmer" is complex. The pilot projects in the four districts of Mysore State have initially used the land area operated as the sole criterion. Thus, in Bangalore District only maximum limits have been set--at 5.0 acres for dry land and 2.5 acres for irrigated land.[18] No attempt has been made in the proposal to consider viability in terms of potential for development. In Mysore District 2.5 acres and 4.9 acres have been tentatively suggested as the limits for the inclusion of farms in the SFDA pilot project.[19] The corresponding limits proposed for North Kanara District are 1.0 acres and 5.0 acres.[20] In Bidar District it is suggested that dry land farmers

---

[18]The Government of Mysore, op. cit., p. 14.

[19]Small Farmers Development Agency, Mysore District, op. cit., p. 5.

[20]Small Farmers Development Agency, North Kanara District, Project Report for the Economic Development of Small Farmers in North Kanara District, Mysore State (Karwar: Project Officer, Small Farmers Development Agency, 1971), p. 23.

operating between 2.5 and 10 acres and irrigated area farmers operating between 2.5 and 5.0 acres be included.[21]

This is a rather gross approach. It is true that small land area often goes with a low level of other resources and farmers operating large size units have relatively higher levels of other resources, such as capital, equipment, credit worthiness and even education and knowledge. But it is not the sole criterion for classification. In Chapter IV the resource information with respect to 40 sample farmers in the fortieth distributory of the Tungabhadra Project area in Mysore State is presented. A perusal of the same indicates there is wide variation in the makeup of farms of the same land area, as well as the size groups made. Tenure could be another important factor. Owner-operated farms can be expected to generally have greater flexibility and credit worthiness, as well as greater security for investments made than rented farms. The quality of land may be another important factor. The educational level of the operator may also have considerable influence on the potential for change and earnings. Even the age of the operater may be relevant to the situation.[22] Rogers and Shoemaker[23] state with reference to

---

[21]Small Farmers Development Agency, Bidar District, Project Report, 1970-74 (Bidar: Project Officer, Small Farmers Development Agency, 1971), p. 10.

[22]Noel S. P. Rebello, "Adoption of Hybrid Corn in Tungabhadra Region of Mysore State" (unpublished paper for the Department of Agricultural Economics and Rural Sociology, The University of Tennessee, 1970), pp. 5, 6. The adopters of corn, who had increased their income considerably, were generally younger and better educated than other farmers. The study did not include a control group and these observations are based on comparison with the mean characteristics of all farmers.

[23]Everett M. Rogers and F. Floyd Shoemaker, Communication of Innovation (New York: The Free Press, 1971), p. 186.

U. S. farmers in general that earlier adopters have more years of education than later adopters. Differences in age are not apparent. Cashdollar[24] found the area developed for irrigation a key factor in stratifying farms in the fortieth distributory of the Tungabhadra Irrigation Project in Mysore State. This suggests that the approach of using size alone may not be appropriate and even prove misleading at times.

Income, in particular operator and family income,[25] can be expected to play an important part in the decision-making process of the operators. It may be a more suitable indicator of farmer well-being and therefore a criterion to delineate priority groups to receive SFDA assistance than farm size. But in subsistence cases the fact that farming produces food stuffs, and perhaps other items which are consumed by the farm family, makes it somewhat difficult to measure the actual income as against the cash income.

The future income possibilities could to some extent be indicative of the responsiveness of the farmers. This oncome potential could reflect (a) the technical farm possibilities and (b) the farmer's "progressiveness". Thus, the income possibilities could be a good, though not perfect, criterion to identify small viable farmers.

---

[24]Parker Cashdollar, "An Economic Analysis of Crop and Land Use Localization in Tungabhadra Irrigation Project of Mysore State, India" (unpublished doctoral dissertation, The University of Tennessee, Knoxville, 1971), p. 34.

[25]The income after deducting all actual cash payments made by the operator for land, material inputs and services is what is referred to here.

The assets owned by the farmer is another possible basis for defining small viable farmers. Land is only one of the forms in which assets are held. While it is true that some minimum land area is essential for proper operation, other farm assets also play important parts in the decision-making process. One other advantage of this approach is that the tenure conditions could be taken into account when the total value of assets is considered.

Summing up, the SFDA could identify the clientele by using at least three kinds of criteria: (a) the farmers' resource situations such as total land or assets, (b) the farmers' present incomes or some other measure of well-being, or (c) the farmers' future income potentials per effective acre which may indicate responsiveness. An index which incorporates important characteristics, such as land area, fertility, and tenure could be developed. Whatever the approach taken, farm level information can help in identifying the relevant characteristics and in classifying individual farms or farming areas accordingly.

Parthasarathy[26] demonstrates the use of farm management analysis in the identification of small viable farmers in a recent study in Andra Pradesh, India. In his attempts to define small farmers, Parthasarathy considered land, all assets, output, volume of business transactions measured by the quantity marketed or inputs purchased, employment potential, farm business income, and cost per unit of output in relation to

---

[26]Gugula Parthasarathy, Agricultural Development and Small Farmers--A Study in Andra Pradesh (Bombay: Vikas Publications, 1971), pp. 6-11.

an optimum. But he did not find any of these satisfactory. He finally used the minimum income requirement of the average household as a means of defining small farmers. He accepted the requirement of Rs. 1,200 per annum used in land legislation as the upper limit. He assumed the net income from agricultural production to be about half of the gross value of the output. So, for the purpose of defining small farmers he set the upper limit at the area estimated to be necessary to yield a gross income of Rs. 2,400 per annum in each district. Since he used published data on area of holdings, he had, however, to work within the limitations placed by the size groups adopted by the statistical service and other government agencies in compiling information. The upper limit set by him then varied from 5.0 acres to 15.0 acres of land in different districts included in his study. The lower limit on area that he worked out as being necessary for independent and reasonably viable existence varied from 2.5 acres to 5.0 acres, respectively. Hence, he defined small viable farmers as those operating from 2.5 acres to 5.0 acres in areas with high income potential at the one extreme to those operating between 5.0 acres and 15.0 acres in areas with low income potential at the other. This work illustrates not only the complexities involved in defining small viable farmers, but also points out the need to make these decisions at the local level. Thus, it is possible that the definition may differ between districts.

In considering the income producing potential of land, not only the physical characteristics but also institutional factors may need to be considered. Such could be tenure arrangements, tax and other laws,

the market for credit and the rate of interest, and the like. Thus, this matter can be treated with varying degrees of refinement. However, some trade off between the accuracy that can be achieved when any one indicator used and the data needs will have to be considered. So, whereas in one situation the gross criterion of area operated alone may suffice, in another, a complex criterion may have to be devised.

Identification of Goals

Planned development centers around programs to achieve national goals. Yet, programs are meant for individuals and have to be implemented through them. And these individuals have their own goals too. Hence, the development programs will succeed fully only when the two sets of goals coincide. However, it is possible, and often is true, that programs devised basically to achieve national goals may fail to achieve their full potential because they do not motivate individual farmers, especially the small farmers, if the two sets of goals differ.

The identification of the goals of small farmers then is a prerequisite for program planning. Goals may and do often differ at different levels. On the one hand, there is the national goal. For agriculture in India a dominant aim is to increase the production of food and other agricultural products in order to meet the needs of an underfed and fast growing population. Then there are the goals of the other sectors of society. Urban dwellers and industrial workers want cheap food stuffs, while the rural population want higher prices for its products. There are also the goals of the individuals within agriculture who are the real units of production in the development activity.

Goals at different levels and groups, as well as within groups, often differ though it need not always be so. Speaking of the agricultural sector in the U. S., Heady states:

> Conflicts surround policy because the groups affected seldom have common interests. What is best for one group need not be for another. In and around agriculture, there are many conflicting groups. Prairie farmers prefer high feed grain prices while those of east and maritime provinces prefer low feed grain prices. It is these types of interests, more than differences in basic values, which cause conflicts over policy.[27]

The SFDA then needs to ascertain the goals of the farmers it is to serve before it can prepare action programs. As with most people, income or profit maximization is apparently a prime goal of the small farmers. The national goal of increased production of food and other commodities will be meaningful to them only insofar as increased output results in increased profits. It is possible that a farmer in an area may not be interested in increasing the production of say rice if he can obtain higher profits by growing sugarcane or tobacco. Within his experience the author has observed so-called "illiterate" farmers divert fertilizer earmarked for rice under "Grow More Food" programs in Mysore to sugarcane and chili (green pepper) which yielded higher profits at the time.

The primary goal of the farmer is often modified by subgoals arising out of the conditions under which he operates. These are often the result of experience over many generations and are even a part of

---

[27] Earl O. Heady, "Criteria for Policy" (A paper presented at the U.S.-Canadian Conference on Agricultural Policy, Edmontin, 1967), p. 2.

his tradition". The small farmers, especially, operate under severe limitations of capital, both owned and borrowed. Capital assets and capital are not only scarce, but they are also hard to obtain and almost impossible to replace if once lost. So, the farmer may have an inbuilt fear of or resistance to heavy investment, especially borrowed capital, since it could mean risking assets built up by hard work and much sacrifice over generations. This resistance is often buttressed by social mores, as evidenced by the lower social status of debtors. This tradition and outlook is reflected in the heavy risk estimate and discount that the farmer apparently places on possible income that might result from enterprises that need heavy cash expenses. Hence, the small farmer may be, in general, interested in keeping cash requirements at a minimum, rather than maximizing returns.

There may also be constraints placed on the profit maximizing goal by cultural and religious practices and beliefs. Thus, rearing beef may be unacceptable in one community and rearing hogs in another. Even poultry rearing may not be attractive to those unused to it. Habits and special interests also often play an important part in the farmers' decisions. It is essential to take these preferences and inhibitions into account in program planning, since they affect acceptance of the programs. It would be reasonable and sometimes necessary to have special programs to change preferences and break down barriers. But it would be unrealistic to ignore them when drawing up programs for development.

The subsistence needs are often important to small farmers. Having little ready cash available to meet family necessities, the farmer may tend to grow his own food requirements to make sure that he and his family do not starve. Under these circumstances tastes stand out and hinder the acceptance of new crops and varieties. The subsistence needs may also result in diversification. When combined with the fact that the land area is small, this can create problems in drawing up programs for development.

Once the goals and subgoals of the farmers have been identified, it is necessary to ascertain their priorities. Two approaches can be used for this purpose. The first would be an ordinal arrangement. The goals can be arranged in the decreasing order of their importance. A second approach would be to attempt a rating in terms of an intensity scale. Such a rating would be helpful in evaluating or grading alternative programs at the decision-making stage. Such would be a decision between a program with high income possibilities but contrary to a high intensity goal and another with lower income possibilities but opposed to a low intensity goal.

Farm level information is important in ascertaining and evaluating goals. This is, however, more difficult since the information may not be easily quantifiable. Investigative approaches that can be used are: (a) feedback from village level workers and other extension personnel, (b) farmer advisory panels, and (c) field surveys. Even if it is not possible to ascertain farmer goals or action results in quantifiable terms, probing of farmers and people who know them well can bring to

light the kinds of aims and constraints most dominant in their minds and toward which they are attuned. Such information in turn suggests the kinds of results, along with national development goals, that need to be considered in assessing trade offs among SFDA action alternatives. One useful device for summarizing qualitative judgments is the "plus-minus" chart as illustrated in Table 3.

Thus, the essential function of goal delineation is to translate SFDA goals into more operational ones and reconcile or identify conflicts. Of special relevance are those that can be used to create interest and motivate farmers to response and participation. Goal identification has two dimensions, i.e., kinds and intensity. It is important to study possibilities of partial substitution of one goal for another and the possible trade offs between goals. This involves the use of an approach based on the indifference curve analysis in utility theory.

Strategies to Reach the Clientele

The number of small farmers in any district is large. The SFDA project proposals for the four pilot districts in Mysore State, cited earlier, show that the number of small farmers, using a rather narrow definition, that the SFDA's in the different districts have to assist are as below:

Bangalore District	- 75,654
Mysore District	- 50,805
North Kanara District	- 36,761
Bidar District	- 46,977

TABLE 3

AN ILLUSTRATIVE PLUS-MINUS DECISION-MAKING CHART

Program Alternatives	Farmer Goals				
	Maximize Profit	Minimize Cash Needs	Minimize Risks	Diversification	Subsistence
Irrigation program	+++	--	++	--	---
Credit program	++	-	-	+	+
Irrigation and credit program	++++	---	+	---	---

The resources of personnel, supplies and funds available with the SFDA are comparatively small. In order to reach all the small farmers in the district in the shortest possible time, some strategy or approach has to be decided upon.

Three possible approaches can be suggested:

1. The Demonstration or Model Farm Approach. Such farms can be scattered throughout the district. Intensive efforts are made to set up "show places" to demonstrate the possibilities of the programs. An outstanding success story can be built up which can be used to motivate nearby farmers to copy their methods. Farmers are brought to visit by organizing field days. This approach has been used in Mysore with respect to state farms. But there is a danger here that the farmer may fail to identify his own situation with that on such institutions, which operate under entirely different conditions. The Test-Demonstration program in Tennessee is another case in point. The Tennessee Test-Demonstration Program Evaluation Committee[28] in its report for 1958-59 found this approach had considerable success in Tennessee.

2. An Island Approach. This is similar to the above, except that entire localities are tackled instead of individuals. Communities or villages could be selected all over the district and efforts of the agency concentrated on all the individuals within them. The people round about would then follow the example of those within these communities. In this approach there is more likelihood of different operating conditions being included.

---

[28]Tennessee Test-Demonstration Program Evaluation Committee, C. L. Cleland, Chairman, "Report for 1958-59" (Knoxville: Unpublished report, 1959).

3. The Shotgun Approach. Here the agency efforts are spread over a large number of people throughout the district at the same time. There is no room for intensive work here but a larger portion of the clientele is involved directly with the agency.

Kulp[29] describes five different approaches to the problem of spreading development programs.

1. The Oil Spot or Vector Approach. Here the effort is started with a nucleus and is expanded into contiguous locales. This is helpful in supervision and logistics and is similar to the island approach mentioned above.

2. The Even-Spread Approach. This, on the other hand, is a broad approach and no concentrated effort is made. It involves working with a large number of persons at the same time. This is similar to the shotgun approach mentioned above.

3. The Greatest-Payoff-First Approach. In this case the agency concentrates attention where it expects the returns to its efforts to be maximum. It is not only the recipients of direct assistance that may be taken into account, but the total direct and indirect effects in the area as a whole. This strategy can be of special importance where it is important to show immediate results.

4. The Greatest-Need-First Approach. The area that is in need for greatest help is selected for the initial action by the agency. Unlike in the previous strategy, there is no conscious effort to

---

[29]Earl M. Kulp, Rural Development Planning--Systems Analysis and Working Methods (New York: Praeger Publishers, 1970), pp. 76-77.

maximize returns to agency efforts. This approach could be useful when special "eyesore" areas exist.

5. The Highest-Bidder Approach. The agency depends in this case on the clientele for guidance. It renders assistance wherever it expects local contribution to be maximum and therefore the demand on its own resources to be less. This can be of great use when the resources available with the agency are limited, and can be a means of ensuring maximum returns to the overall agency effort.

Mosher[30] suggests yet another slant to the problem of fixing priorities. He suggests that this problem can be approached from three different angles.

1. The area can be classified on the basis of the possibilities of the land, as that which have "immediate growth potential", those with "future growth potential" and the rest with "low growth potential".

2. The nature of economic urgency can also be used in classifying the area. Using the crops or enterprises that are of prime importance under the existing conditions, the area that is suitable for producing these crops or enterprises can be separated from that which is not suitable for them.

3. The readiness of farmers to innovate can be similarly used to classify the area.

These can in a way be looked on as criteria in using the last three of the approaches suggested by Kulp.

---

[30]A. T. Mosher, Creating a Progressive Rural Structure to Serve a Modern Agriculture (New York: Agricultural Development Council, Inc., 1969), pp. 54-59.

The categorization of adopters of innovations made by Rogers and Shoemaker[31] can be useful in using some of these approaches, especially the demonstration farm approach, the greatest-payoff approach and the highest-bidder approach. They divide U. S. farmers into innovators, early adopters, early majority, late majority and laggards. Here the focus will be on early adopters mostly. They state that earlier adopters, when compared with later adopters, have greater empathy, are less dogmatic, have greater rationality and intelligence, a more favorable attitude to change risk, education and science, a less fatalistic attitude, greater sense of achievement motivation and higher aspirations, and more social participation. They are also more highly integrated with the social system, more cosmopolite, and more likely to belong to well integrated systems with modern rather than traditional norms. They have, besides greater change agent contact, greater exposure to mass media and communication channels, greater knowledge of innovations, of which they seek information, and a higher degree of opinion leadership. This was confirmed in Rebello's[32] study in the Tungabhadra area of Mysore State with reference to education, exposure to mass media, contact with change agents, cosmopoliteness and integration with the system and leadership. Shetty[33] found in South Kanara District of Mysore State that size of farm, education, subsidiary occupation and socioeconomic status have

---

[31]Rogers and Shoemaker, op. cit., pp. 187-189.

[32]Rebello, loc. cit.

[33]N. S. Shetty, "Agricultural Innovations: Leaders and Laggards," Development Digest Vol. 7 (Washington, D.C.: Agency for International Development, 1969), p. 15.

greatest influence on the speed with which farmers respond to innovations. Schluter[34] found that adoption of new varieties by small farmers in North India is directly influenced by the size of the farm.

The strategies discussed earlier are not essentially independent but constitute in fact a continuum, as demonstrated in Figure 2. At one end of the spectrum is work involving few people, intensive in nature involving mainly personal contact and intensive effort, while at the other end is work involving a large number of people with minimal individual work and personal contact, extensive effort and mostly use of mass media approaches. It is possible to develop approaches that involve a combination of these characteristics.

Information on the characteristics of a farmer can be useful in deciding the strategies to be used as well as in using the strategies selected. Farm management data can be of great assistance in securing the necessary information. It is necessary to keep this use in mind while collecting information and designing investigations.

Implementation of the Programs

Program implementation is in large part an administrative matter and no attempt is made here to discuss it. However, it does involve psychological and sociological aspects as well. The psychological aspects involve some aspects of motivation and legitimation. It is essential to build incentives to farmers into programs so that they

---

[34]Michael Schluter, Differential Rates of Adoption of the New Seed Varieties in India: The Problem of the Small Farmers (Ithaca: Cornell University, Occasional Paper No. 47, 1971), p. 9.

Number of People	Small	Medium	Large
Individual Attention	Heavy	Medium	Slight
Agency Effort	Intensive	Moderately Intensive	Extensive
Focus	Highly Concentrated	Concentrated	Dispersed
Mode of Contact	Personal	Personal and Group	Group and Mass Media
Strategy Type	Demonstration Farm	Model Village	Shot-Gun Approach

Figure 2. Program spreading strategy continuum.

are motivated to adopt them. Motivation directly involves the explicit understanding of the goals and interests of the clientele. This has been discussed earlier. But whereas motivation is something that is entirely concerned with clientele, legitimation may go beyond it. It is possible that the legitimators in an area are not the small farmers, but others of a socioeconomic status that is different. Legitimation could even involve individuals outside the farm sector itself. Thus, they could be from among the farmers, their wives or children, moneylenders, leading farmers in the area, or even leaders from other areas. These motivational and legitimation problems may be called the behavioral aspects of program requirement in contrast with the structural or organizational aspects. Farm management information can be helpful in providing the answers involved here, such as the interests that can be used to motivate farmers and the relationships within and without the clientele groups.

Another facet that farm management information can provide some useful insight about is that of slippages. Slippages exist at two major levels:

1. Between the program and the agency.
2. Between the agency and the clientele.

They result from physical factors such as engineering problems, availability of materials, transportation and other facilities, as well as psychological and sociological factors such as the outlook of the people and the internal differences and factions that exist. Possible slippages need to be considered in drawing up programs, for the net program which

will produce results is the total program after allowing for the slippages. Some of these slippages are associated with:

1. Program organization, i.e., whether a package approach is taken, flexibility exists, etc.
2. Program phasing, i.e., what sequencing is planned, and whether the action will be one-shot one or repetitive.
3. Other aspects such as what is the programming unit, what are the agencies through which program action is to be channeled, etc.

Implementation also involves the administrative concerns of the agency itself. But these are not discussed here.

Evaluation of Progress

Evaluation of programs is approached generally as a study of progress over time. This is no doubt an important function of evaluation. Estimation of the results periodically to find out the impact of the program is important since planning for development is a continuous process. Such evaluation does yield useful information for the planning of future programs.

There are, however, other as important purposes to which evaluation of programs can contribute.

1. The identification of bottlenecks. The most carefully selected and planned programs develop problems that arise from factors that were not foreseen initially or those side effects that developed subsequently. These problems may be physical in nature, such as shortages in material requisites, shortages of services and facilities,

technical in nature such as chemical and biological effects as with salinity in irrigated lands or pests and diseases associated with new crops or animal enterprises, and psychological or sociological such as human reactions to the new conditions. It is important to know these problems and find solutions for them so as to make necessary changes and adjustments in the programs while they are still current.

2. The identification of problems as the programs spread geographically. This is of special relevance when pilot projects are expanded to cover other areas. They arise also when the demonstration or island approach is used due to geographic, agronomic or socioeconomic differences.

3. The identification of problems as the programs progress over time. Every program is phased and it is possible that during the subsequent stages of the thrust different conditions may arise which call for changes in the content and the phasing of the program. This is especially important when a program is phased over a considerable period of time.

The information needs for such evaluation are to a great extent similar to those when planning programs originally. Farm management type of investigations and data can be very helpful in this type of evaluatory work.

The Use of Farm Management Data

As has been discussed under the relevant section, farm management data have an important role in all the concerns of the SFDA discussed in this chapter. Its use of different types of farm management information

for the different concerns can be summarized as in Table 4. But the most important use of farm management information is in preparing programs themselves, and this role is discussed in the next chapter.

CRANES CREST

TABLE 4

THE RELEVANCE OF FARM MANAGEMENT INFORMATION TYPES IN THE CONCERNS OF THE SFDA

Basic Information Types	SFDA Concerns				
	Identification of Clientele	Identification of Goals	Strategy Decisions	Implementation	Evaluation
Bench mark type of descriptive information	Relevant	Relevant	Relevant	Relevant	
Analysis of future adjustment potential		Relevant	Relevant	Relevant	
Appraisal of changes brought about		Relevant		Relevant	Relevant
Farmer panel type of continuous reporting		Relevant	Relevant	Relevant	Relevant

CHAPTER III

POSSIBLE CONTRIBUTIONS OF FARM LEVEL ANALYSIS TO PLANNING OF PROGRAM CONTENT

It has been suggested in the previous chapter that the effectiveness in planning, implementing and evaluating development action programs can be enhanced by utilizing information on the farmer, goals, interests, capabilities and constraints. This is especially true in planning the program content where difficult choices need to be made about how to allocate limited agency resources so as to maximize desired response on the part of small farmers. Realistic information about feasible farmer response to technical help, credit, irrigation facilities or other assistance being considered is necessary if meaningful program emphases and priorities are to be established.

This chapter will diagnose the type of farm management analysis that could be used and the kinds of farm level information that are needed for planning the content of development action programs. Specifically, this chapter investigates the possibilities of using budgeting and linear programming procedures in program planning with special reference to the requirements of the SFDA. The approach could be equally applicable, with minor modifications if necessary, to other development action oriented bodies.

Possible Causes of Differences between Planner Expectations and Farmer Response

Development action agencies are generally faced with limitations on resources available as well as scarcity of information. Agencies such as the Department of Agriculture in Mysore State have had to plan programs under constraints of funds, using as little time and personnel as possible. A similar situation will be faced by the SFDA as well.

The general framework used in preparing programs[1] is to consider an effective way to achieve general objectives, mostly social objectives, using research and other information available along with the experience of the planning personnel, generally district and state level extension personnel. Explicit benefit-cost analysis is not attempted in most cases; decisions are made on a more or less intuitive basis. However, a cost-benefit consideration is implicit in the process since the results of experiments are evaluated and taken into account. But these estimates can be upset if the expectations of planners, based on limited trial and demonstration data, fail to materialize under farm conditions.

The factors that contribute to the differences between the expectations of the planners and the results obtained can stem from three elements:

1. Fewer farmers responding than the program planners estimated. Many of the farmers that would have been expected to avail themselves of

---

[1] No attempt is made here to describe the planning process exhaustively or to criticize it. The few observations made here reflect the personal experience of the author in extension work in Mysore State.

the program may fail to do so. The possible causes of this could be the following:

(a) The program may lack sufficient incentives to motivate the farmers. This happens often when the program has been drawn up mainly to achieve social or national goals and the interests and desires of the individuals have been ignored or bypassed. In a democratic setting social goals stem more or less from a composite of all the sections of society. But they do not necessarily reflect the goals and motivations of any one sector, much less one individual. Illustrative of this is the class of interests that arises when the social goal is to increase the production of a staple food in a district, while the farmers are interested in some other crop which increases their earnings. Therefore, it is important to consider the interests of the farmers in the area or in the group when formulating programs for their development.

(b) The program content may not coincide with the interests of the farmers. Figure 3 illustrates situations of this type. Thus the program may include some fields, enterprises or operations that the farmer is not interested in, while some others in which he is interested may not be included in the program. This creates a situation where the farmer feels that he has either to do or accept some things which he does not like in order to obtain the assistance he needs, or he is disappointed that he has to go to some other agency to obtain some things he needs.

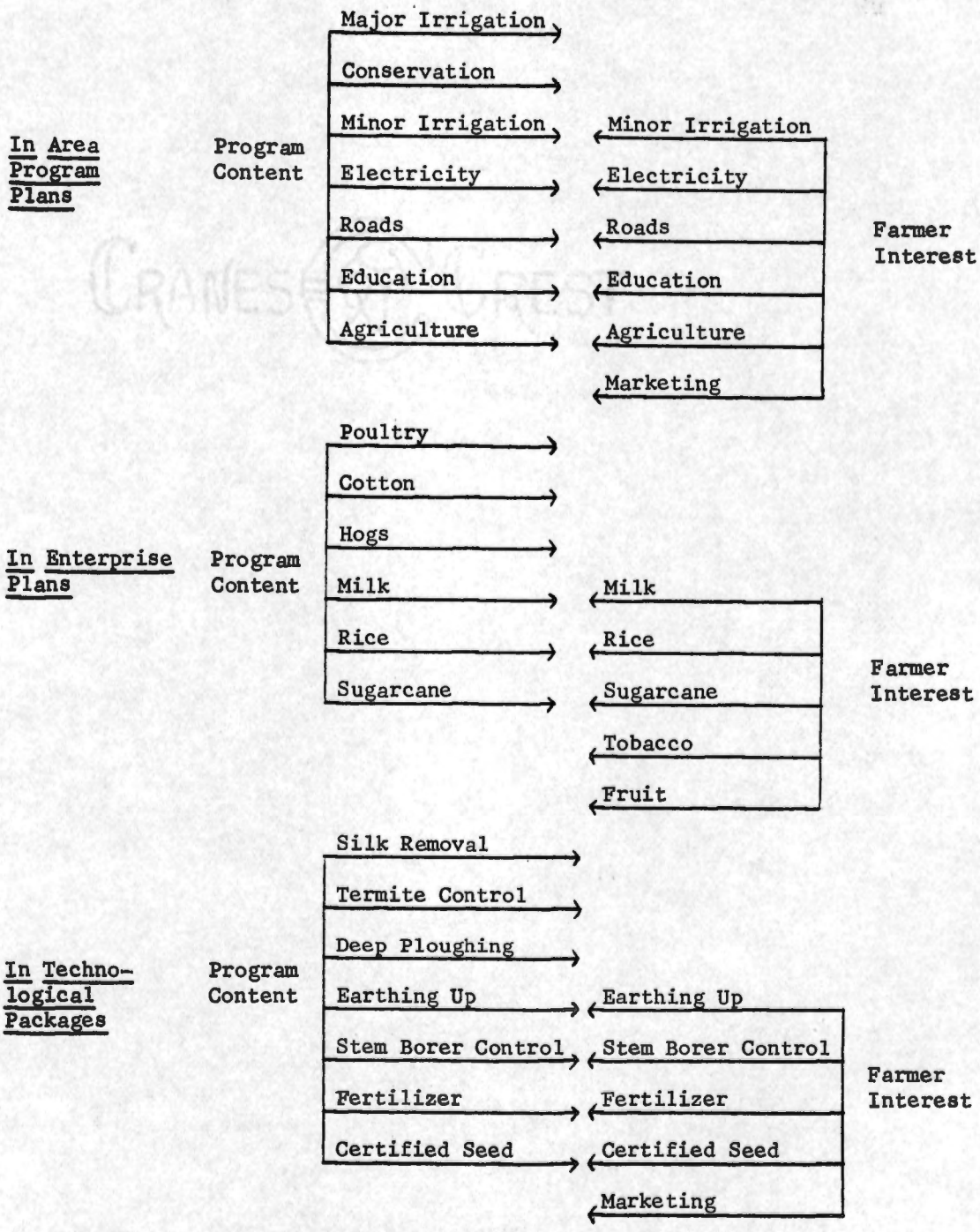


Figure 3. Examples of possible differences between program plans and farmer interests.

Both these situations create a psychological condition which tends to alienate him from the agency.

There is another circumstance where a similar reaction can be expected. In the present organization of services and supplies different agencies have responsibilities for different things. Thus, whereas the Department of Agriculture advises on technology, the supplies of seed, fertilizer and most production requisites, as well as credit, have to be obtained from cooperative societies, electrical connections from the Electricity Board, water from the Irrigation Department, etc. Unless all these are well planned and synchronized and the different agencies act as a single unit, it will cost the farmer considerably and tend to alienate him. As a result, he is likely to ignore the entire program.

(c) The program may be based on situations or conditions that are not specific to the farmer. Program planners generally use production information from experiments and trials. This information, while it may represent the region reasonably well, is based on "mean" estimates and does not give an accurate picture of the risks involved from the point of view of the individual. The probability of a loss of crop associated with the yield estimates used may be relatively low. For example, the probability of bacterial blight rendering a crop of high yielding variety of rice a total loss may be as low as 10 percent, or in the case of hybrid jowar this probability may be high because of susceptibility to shoot damage. Most farmers may not be willing to

consider the average yields in their calculations under these conditions, but may want to apply some discounts to them. Speaking of this, Schluter says:

> Farmers probably consider the use of the new varieties involves uncertainty. This may be due to variability of yields of the new varieties being greater, inexperience in methods of cultivation, or bad experience with previous recommendations of the Extension Service.[2]

Speaking in the context of subsistence agriculture, Wharton says:

> The typical subsistence or peasant farmer has his own subjective rate of discount for the introduction of a new technology on his farm. Despite its listing by the central, regional or local experiment station, on neighboring farmers' fields, the subsistence farmer has learned from bitter, historical experience to be wary of "technological gifts", which as he sees them have been insufficiently adapted and evaluated for his particular situation.[3]

Farmers operating close to their subsistence level are also likely to be wary of new technology for fear of falling below their minimum physiological subsistence level, since this may mean starvation to themselves and their families. Speaking of this, Wharton, Jr., states:

> When the subsistence farmer confronts a possible innovation he will be concerned with two questions: Will the new method, taking its probable cost into account, produce an expected yield appreciably

---

[2]Michael Schluter, Differential Rates of Adoption of New Seed Varieties in India: The Problem of the Small Farmer (Ithaca: Cornell University, Occasional Paper No. 47, 1971), p. 7.

[3]Clifton R. Wharton, Jr., "Risk, Uncertainty and the Subsistence Farmer," War on Hunger, Vol. 3, No. 5, May 1969, p. 14.

> higher than his old method? Is there a reasonable probability that something will go wrong, and that the new method will result in a net yield below his minimum subsistence level? Even if the answer to the first question is yes, the farmer will not change his methods unless the answer to the second question is no. He will not wish to gamble or risk the life of his family.[4]

Miracle[5] distinguishes between a "Minimum Physiological Level of Living" (MPL), which is the minimum level of consumption necessary to maintain life, and a "Minimum Desired Level of Living" (MDL), which is the level of consumption that an individual feels he is expected to attain. He suggests that the response of farmers to new technology depends upon the loss or risk estimates they made as well as their existing position relative to the two levels of living. The possible positions with reference to the levels of living are illustrated in Figure 4. Farmer A is very close to the MPL level and is therefore relatively sensitive to the probability of loss since a small loss will push him below MPL. As a result, he is less likely to accept change than farmer B who is considerably above his MPL and has less fear of falling below it as a result of any risks he may take. On the other hand, farmer B is below his MDL level and hence has greater motivation to adopt income increasing technology than farmer C who is already above his MDL level. Thus, subsistence farmers,

---

[4] Ibid., p. 15.

[5] Marvin P. Miracle, "Subsistence Agriculture: Analytical Problems and Alternative Concepts," American Journal of Agricultural Economics, Vol. 50, 1968, p. 295.

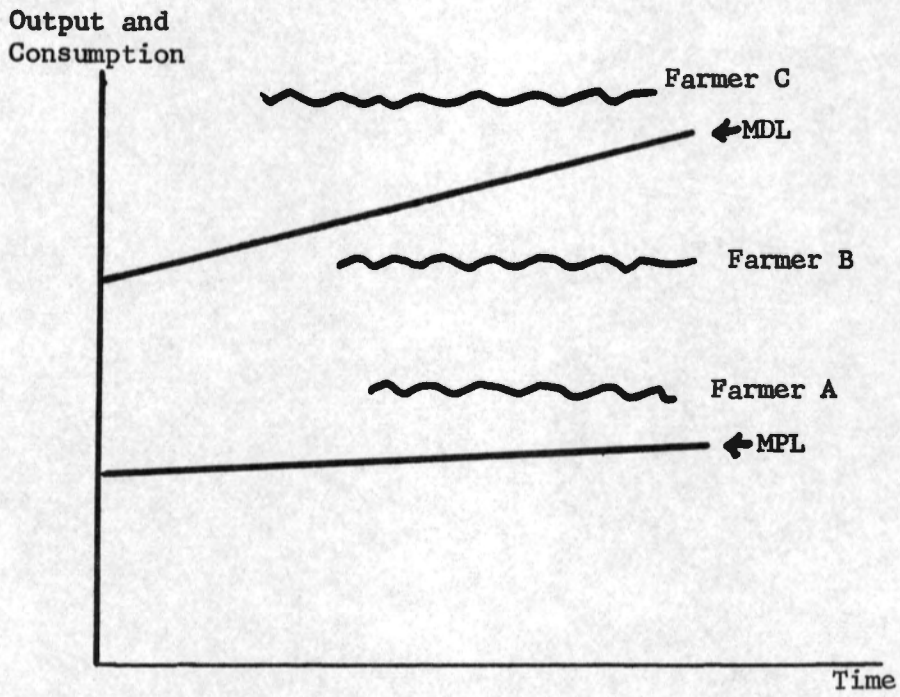


Figure 4. Minimum subsistence levels and acceptance of change.

such as most small farmers are, generally tend, in effect, to apply heavy discounts to results of improved technology to account for the risks they see in them.

2. Program results falling short of expectations. The farmers who respond to programs may obtain less results than the planners forecast. Programs may be based on production functions that are substantially different from those of the farmers. The production data used by program planners are, by and large, the averages of results obtained in experiments and trials, as mentioned earlier. These experiments and trials are conducted under conditions, especially with respect to managerial input, timely supplies of production requisites, technical knowledge and skills, etc., which do not exist on most small farms. Hence, the levels of returns used in decisions about programs may be considerably higher than the returns obtained by the farmers who respond to them.

A case in point is the study of Bisaliah and Taylor[6] in the Tungabhadra Irrigation Project of Mysore State. They observed that the yields obtained by farmers were, in the majority of cases, half or less of the expected yields indicated in the official booklet on the package of recommended practices.

This possibility that the program may be based on a production function that is superior (higher) to that of the farmers is illustrated

---

[6]S. Bisaliah and D. C. Taylor, "Input-Output and Cost-Return Data for Major Irrigated Crops in Selected Areas of the Tungabhadra Irrigation Project" (unpublished draft, University of Agricultural Sciences, Bangalore, 1971), pp. 22-23; and Donald C. Taylor, "Report for May-June 1971" (unpublished report to the Agricultural Development Council on his work as Visiting Professor with the University of Agricultural Sciences in Bangalore, New York, 1971), p. 1.

in Figure 5. At an input level OA (or less) the output OP_A is the same for the production function used by the program planners and that of the farmers. At an input level OB, however, the output of OP_{PB} that is expected under the program is considerably higher than the output OP_{FB} that is obtained by the farmers. If under the program an input level of OC were recommended, the difference would be even greater, i.e., P_{FC} P_{PC}. But even more significant is that at this level of input the farmers may be operating in the region of negative returns on their production function. As a result, they could be getting P_{FC} P_{FB} less of output than the maximum possible to them, and that while using BC less input.

3. Inflexibilities arising from top-down program planning. This procedure may also result in achievements falling short of expectations. When programs are designed for a state as a whole, the activities and targets tend to be rigid. What the farmer actually produces, as well as how much and how he produces it, depends not only upon factor-product relationships but also on product-product and factor-factor relationships. And all these differ among regions. The decisions that farmers make, even assuming that they all have identical goals, may rationally differ from farmer to farmer and locality to locality because of the following:

(a) The resource and institutional constraints may be different. Such would be differences in soil, equipment, available cash and tenure conditions.

(b) The technical relationships may be different, both in the absolute sense and the relative sense, because of climatological conditions.

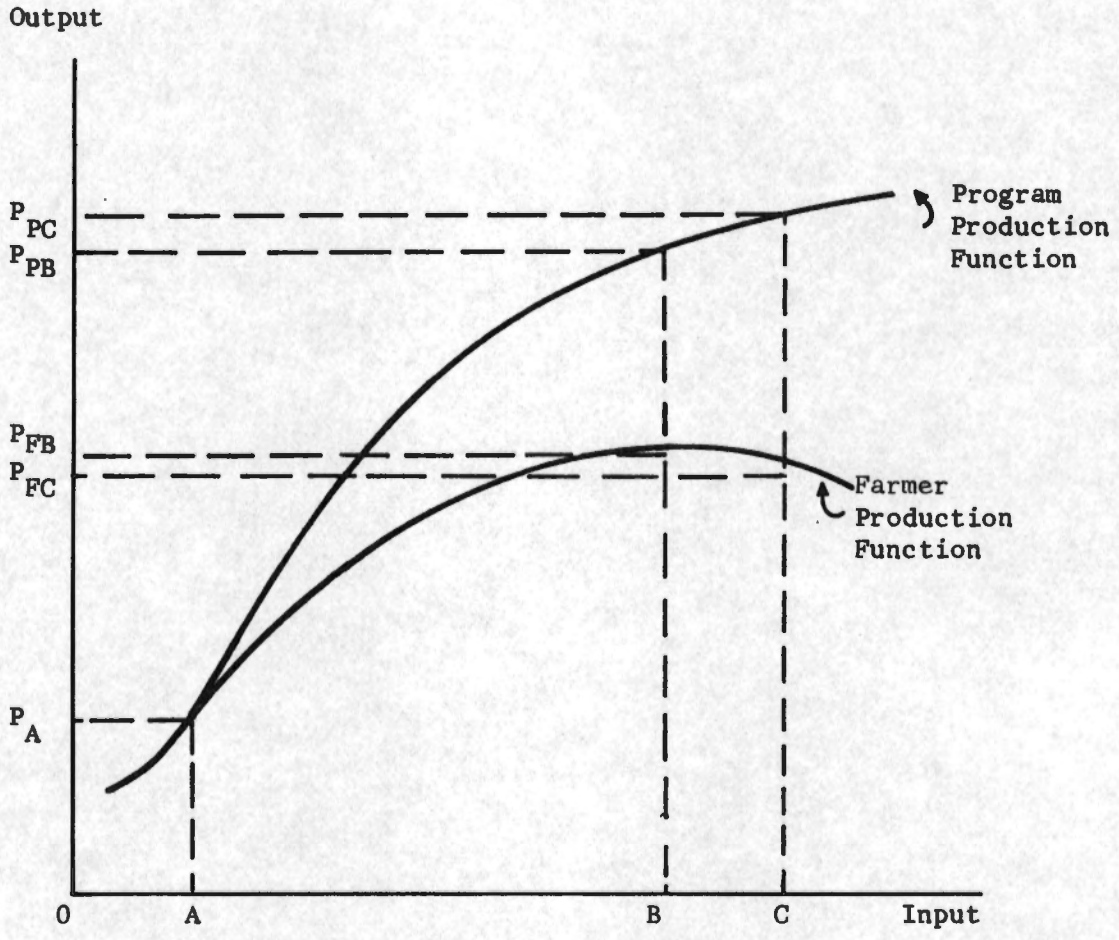


Figure 5. Problems in program design arising out of differences in production functions.

(c) The price ratios may differ, reflecting differences in consumption areas, transportation, bargaining power and the like.

There is clear need then to explore approaches to program planning that eliminate these problems. A method that uses micro-level decision-making tools to design programs could correct some of the plans. Hence, the thesis here is that:

(a) Farm management information (farm level production function) should be used in formulating development action programs.

(b) Farm level decision-making procedures should be adapted to program design so as to explicitly take into account the interests as well as capabilities of the farmers.

(c) Programs must be prepared for reasonably small and homogeneous areas. A district would be one such. Even a district may be heterogeneous, and administrative boundaries may not necessarily be the best basis for delineating areas for program planning purposes. So, it may be necessary to divide a district into smaller areas for the purpose of program design.

A Possible Approach to Program Design

Black[7] suggests that cost-benefit analysis is a subsystem analysis suitable for use in program formulation. But he points out that the

---

[7]Guy Black, The Application of Systems Analysis to Government Operations (New York: Frederic A. Praeger, 1968), p. 28.

the measurement of benefits poses major difficulties. Where a development program is concerned, there are many types of benefits, such as monetary, psychological, sociological and political. When response by the clientele such as small farmers is a major element, it is important to consider not only benefits to society as a whole but those pertinent to that particular group as well. Then, farm management analysis that focuses on the benefits to and response of particular groups should be useful in program planning.

Budgeting and linear programming are the procedures commonly used in farm planning. Budgeting is perhaps more appropriate in the context of the SFDA. These agencies have only a short period of time in which to plan programs and limited personnel and funds at their disposal for this purpose. However, they do operate in a complex milieu involving a variety of resource situations and production alternatives, as well as varying goals and interests of the farmers. Linear programming would be extremely useful in such situations, given the necessary technical capacity and facilities.

Figure 6 is an attempt to show how the analysis of farmer response and potentials can fit into the overall process of designing programs by development agencies such as the SFDA. The movement from A to C through B is the main concern in the program planning approach proposed here. However, the implications of D are recognized and procedures to take it into account suggested in Chapter V.

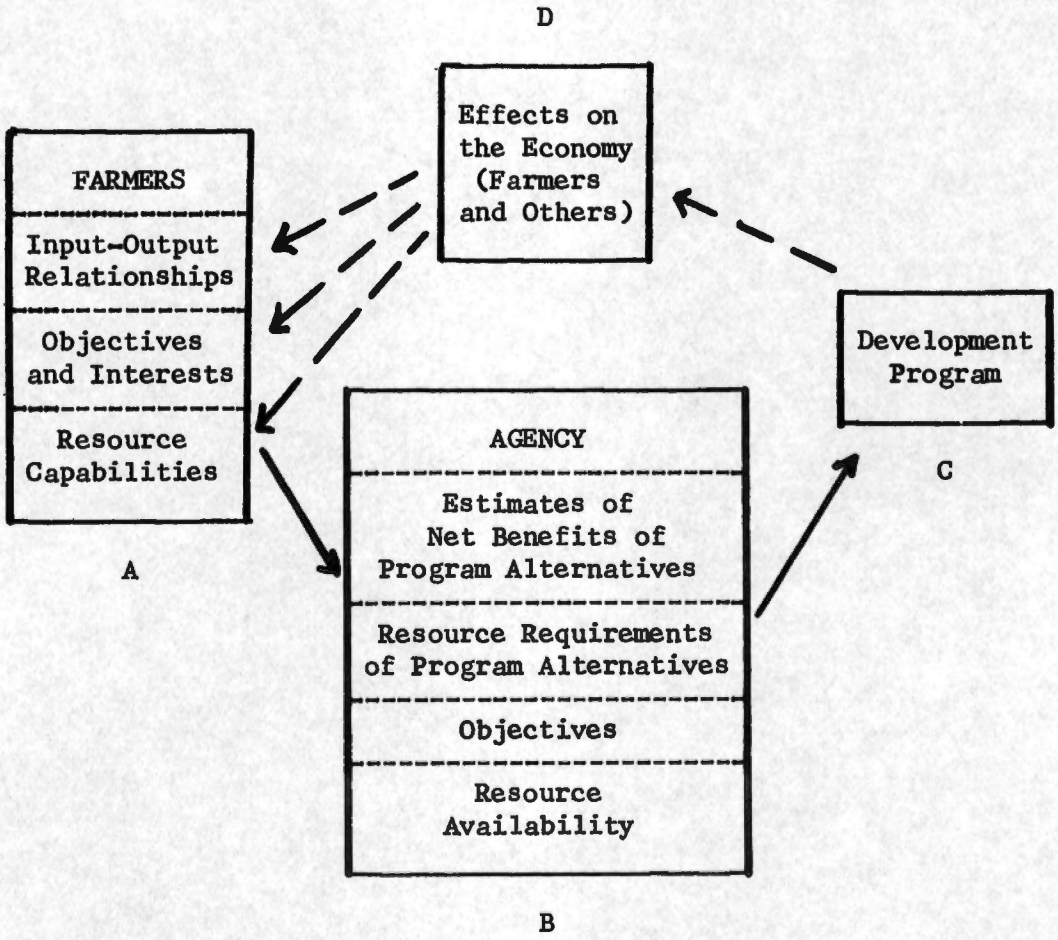


Figure 6. A path for program design.

The first stage in the approach to program planning suggested here is to estimate the possible benefits of program alternatives. Basic to the decision-making process are the farmers, represented by the input-output relationships or enterprise budgets they operate with, their resources, and their objectives and interests. The optimal plans for the farmers under different program alternatives can be obtained using budgeting or linear programming procedures.

The second stage in the approach is to estimate the net benefits from the program alternatives. The total benefit to the clientele from each such alternative can be estimated by the process of aggregation. The same procedure can also be used to estimate the involvement of or the assistance to be provided by the agency and, therefore, the direct program cost to the agency. The difference between the total benefit to the clientele and the total cost to the agency will yield an estimate of net benefit from each program alternative. These estimates of net benefit can be used to rank the alternatives initially, as well as to obtain the estimated sacrifice involved if a less than optimal alternative is adopted.

The third stage is to obtain the optimal program design for the agency. Each program alternative makes certain demands on agency resources such as time of technical personnel, services of facilities and machinery, production requisites, finances, etc. This represents the production coefficient matrix for the agency, while the net benefit estimates form the returns vector. The agency works with certain limited supplies of these resources, and these represent its constraint vector.

Finally, it has also certain objectives and goals. Budgeting or linear programming procedures can again be used using the above to ascertain the optimal program mix for the agency.

The general model suggested then is as below:

Stage I -

$$I_{gh} = \Sigma P_i E_i,\ g = 1, \ldots 1;\ i = 1, \ldots n,\ h = 1, \ldots r .$$

Max

$$S/t\ \Sigma A_{ij} E_i = R_j,\ i = 1, \ldots n;\ j = 1, \ldots m;\ \text{and } E_i \geq 0,$$
$$i = 1, \ldots n$$

where:

I_{gh} = the income of gth farmer under the optimal plan for the hth program alternative,

E_i = the units of ith activity or enterprise that a farmer can produce,

P_i = the profit that can be obtained from one unit of each of the ith activity,

A_{ij} = the requirement of the jth limited resource to produce one unit of the ith activity, and

R_{jg} = the quantities of the jth limited resource available to the gth farmer.

Stage II -

$$D_h = \Sigma I_g,\ h = 1, \ldots r;\ g = 1, \ldots s$$

$$C_h = \Sigma F_g,\ h = 1, \ldots r;\ g = 1, \ldots s$$

$$B_h = D_h - C_h,\ h = 1, \ldots r$$

where:

D_h = the total benefit to the clientele from the program alternative,

I_g = the optimal income of the gth (objective function above) farmer,

C_h = the total cost of the agency for the hth program alternative,

F_g = the cost incurred by the agency for the gth farm on the program alternative, and

B_h = the net benefit for the hth program alternative.

Stage III -

$$\phi_{Max} = \Sigma b_h N_h, \quad h = 1, \ldots r$$

S/t

$$\Sigma G_{hk} N_h \leq H_k, \quad h = 1, \ldots r; \quad k = 1, \ldots s$$

and

$$N_h \geq 0, \quad k = 1, \ldots r$$

where:

ϕ = the total net benefit (objective function for the agency),

N_h = the number of units of the hth program alternative,

b_h = the net benefit per unit of the hth program alternative,

G_{hk} = the requirements of each limited agency resource required for a unit of each program alternative, and

H_k = the quantity of the kth limited resource available to the agency.

The program mix that yields the maximum ϕ will be the optimal.

The first step in using this approach would be to ascertain the alternatives for action. For example, the SFDA could institute programs to provide irrigation, production credit, equipment and machinery, production requisites at subsidized prices, custom-services, technical advice, etc., as well as combinations of these. In gauging the impacts of such proposed action on the farmers in the district the agency could utilize:

1. The knowledge and experience of extension personnel.
2. Resource persons such as subject matter specialists.
3. Results of experiments, trials and demonstration.
4. Opinions of local leaders.

The next step would be to evaluate the alternatives. The benefits to the farmers can be estimated using budgeting or linear programming. Program alternatives can be approximated by suitably relaxing resource constraints. For example, the effect of an irrigation program can be investigated by relaxing the constraint on irrigable land on the farms, the effect of a credit program by relaxing the restriction on operating capital, the effect of a program combining irrigation and credit by relaxing both the constraints simultaneously and so on. It will, however, not be feasible to plan for every individual farm. The "Representative Farm" or "Typical Farm" approach is useful here, and the results can be aggregated to obtain estimates for the entire district or area.

Developing information about farmer resource constraints, input-output relationships and goal for budgeting or linear programming

purposes may entail a mixture of "statistical" and "subjective" approaches. As illustrated in Figure 7, there is in fact a continuum in between these two extremes that program analysts may choose from. Decisions on the matter of the best combination in a given situation are by and large a matter of judgment about how best to use available analytical time. What is "best" in a less developed country where data collection is beset with problems of availability and accuracy may be along the lines AB, CD or EF.

Once the net benefits that result from the direct returns to the clientele and the direct costs to the agency are evaluated, the stage is set for the second level of analysis. These estimates of net benefits for each action alternative can be taken as the returns vector for the agency. Each "unit" of agency activity places certain demands on the resources of the agency, such as time of the various technical personnel, machinery and facilities, logistical services and supplies, and operating funds. These need to be ascertained, along with the total availability of these resources. All these will constitute the input-output relationships (returns and technical coefficient matrix) and the constraint information for the agency. Budgeting or even linear programming procedures can then be used to maximize the objectives of the agency and thus obtain the optimal program content for the agency.

Most of the goals and interests of the farmers, as well as the objectives of the agency, can be accommodated by this approach. The limitations put on the general goal of farmers to maximize profits by the environmental, cultural and socioeconomic milieu can be considered

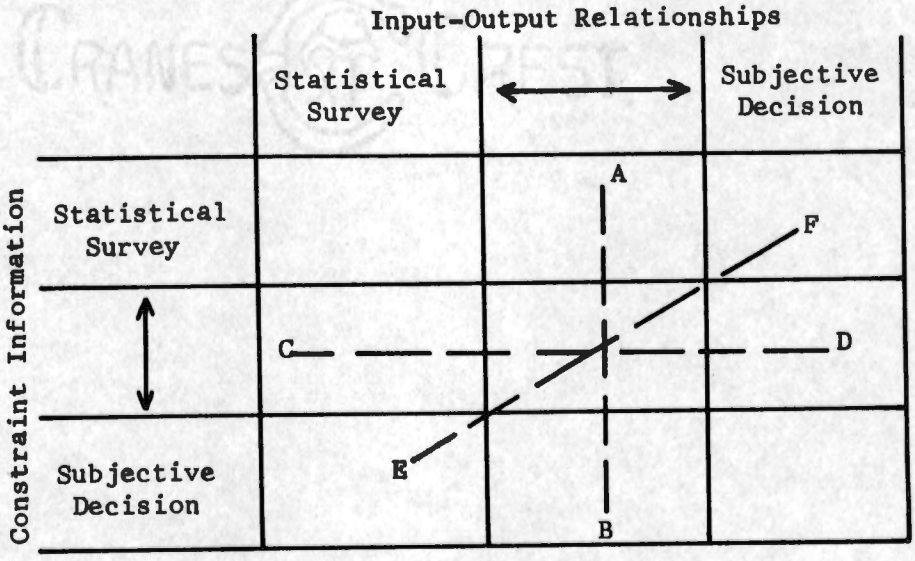


Figure 7. Possible combination of approaches to data gathering.

in some manner. Thus, when the farmer wants to keep cash expenses within a certain limit, an appropriate constrained maximum on operating capital can be set. Similarly limits or restrictions on the use of labor or other inputs whether in the matter of magnitude or time can be introduced in the constraints vector. If the farmers are unwilling to produce certain enterprises, these can be excluded from the matrix. Risk minimization can be ensured by suitably adjusting the returns vector. When the farmers have desires to grow their own food crops dictated by their desire for subsistence, or not to grow too much of some crop arising out of their desire for diversification, these can be built into the matrix through suitable constraint equations.

The agency objectives, on the other hand, may be of a different nature. Such may be the maximum production of a food crop. This would be incorporated the second part of the analysis. When the objectives of the farmers and the Agency do not agree, the analysis for the two could be done independently and the results compared to see what needs to be done to match up farmer response with Agency concerns. Thus, it is possible that the agency objective is to increase rice production, while the farmer's objective yields a solution that increases tobacco production. In such cases this analysis can make possible the estimation of the divergence between the two objectives and be helpful in deciding what type of action, such as price subsidies, is necessary to cause the objectives at the two levels to coincide. Basically, this calls for action that will compensate the farmer for the loss he incurs in following the Agency objective, or in other words, make it profitable for him to do so.

Pressures may and do build up for development agencies to implement programs that differ from the economic optimum. Special interest groups within or outside the clientele may be involved. For example, in an irrigation project persons in one locality that has been classified for light irrigation on the basis of maximum returns to water used in the entire project may demand heavy irrigation, as happened in the Tungabhadra Irrigation Project. In such circumstances estimates of monetary returns from various alternatives provides the decision-makers with concrete estimates of the economic sacrifice that has to be made to satisfy these groups. Or, hopefully, this information on the sacrifice that has to be made by society will be helpful in convincing the group that their demand is too costly to be satisfied. If a compromise involving subsidy to the affected individuals is developed, this analysis can be used to yield estimates of reasonable subsidy payments.

This approach, then, enables program planners to estimate the benefits that would accrue to the farmers from different action alternatives within the confines of their goals and capabilities, as well as decide on the program mix that will maximize the agency objectives subject to the constraints under which it operates. It is possible that the programs may not be adopted by the entire clientele within the time span for which plans are drawn up. In that case, it will be necessary to take this into account if the estimates of benefits are to be realistic. This is possible at the aggregation stage when the plans for representative farms can be aggregated for the number of farmers expected

to participate, rather than all the farmers. This does, however, increase the subjective element in the analysis.

Some side benefits can be obtained from this approach, such as:

1. The physical requirements of the program designed, both with respect to farmer resources, and the agency services, can be estimated. These estimates with respect to kind, quantity, sequence and timing of the demands can be very helpful in the successful implementation of these programs.

2. Similarly, the demands on agency supplies and services can be estimated. The agency can then plan its activity accurately and act in time to prevent bottlenecks. This is especially true when training of personnel, obtaining supplies or acquiring facilities require considerable time.

3. It is even possible to have in advance estimates of unutilized or surplus farmer and agency resources. This knowledge could make it possible to take other action to make fuller use of them. Thus, when surplus labor is available at certain times, it may be useful or necessary to plan part-time employment or subsidiary industries. This information could even be useful in suggesting directions for research to better utilize resources.

Problems of Aggregation

The second stage of the approach to program design proposed here involves essentially a process of aggregation to obtain macro-level estimates from micro-level data. While the SFDA is primarily concerned with

helping small farmers, alternative action possibilities need to be judged in terms of the total impacts in the district on the income, food production, and/or other relevant criteria. Also, the SFDA needs to have some gauging of the aggregate changes in the use of irrigation water, loan funds, labor, market facilities and other items that proposed programs could potentially bring about. Such macro-level estimates carry implications not only for allocation of the resources of the SFDA, but a broader range of private and government endeavors at the district, state and national levels as well.

Macro-level data have been used by agricultural economists in the analysis of the supply of farm products and the demand for factors. Many researchers have, however, pointed out that there are considerable dangers involved in the use of this procedure to obtain aggregate estimates of supply and demand. Many have also suggested ways and means of minimizing these problems.[8]

Aggregation bias is the most important source of error in the use of representative farms for aggregation.[9] The central idea in the Marshallian concept of the "typical firm" is that any one firm is similar to all the other firms in the group in every respect. Hence, it is essential to have a homogeneous group of farms. When the farms in the

---

[8]These problems have been extensively discussed by Schaller as well as by Barker and Stanton. Refer to: W. Neil Schaller, "Estimating Aggregate Product-Supply Relationships with Farm Level Observations," Production Economics in Agricultural Research (Urbana: University of Illinois, 1966), pp. 97-98; and Randolf Barker and Bernard F. Stanton, "Estimation and Aggregation of Farm Supply Functions," Journal of Farm Economics, Vol. 47, 1965, pp. 701-712.

[9]Schaller, op. cit., p. 104.

group have substantially different qualities or quantities of resources, the average reflected in the representative farm tends to change the picture. Taking an extreme example, a representative farm set up in place of two farms, one of which has 10 acres of land and Rs. 100 of operating capital and another which has one acre of land and Rs. 1,000 of operating capital, will have 5.5 acres of land and Rs. 550 of operating capital. Obviously this is quite different from both the farms it is supposed to represent. The same is true of different qualities of resources, such as dry land and irrigated land, 10 horsepower tractor and 40 horsepower tractor, technically trained and nontrained managers, etc., as well as of different technical coefficients. It is possible that the returns from the same enterprise may differ when the technology used differs. It is possible that the returns may differ with the same technology because of differences in soil and other resources. Consequently the results from a budget or linear programming analysis using representative farms may differ substantially from the average of the results of all the individual farms that went to make them up.[10] However, when the ratios between the resources on the different individual farms from which the representative farm is set up are more or less the same, errors due to aggregation are negligible.[11]

Steps that help to reduce resource aggregation bias include:

---

[10] H. O. Hartley, "Total Supply Functions Estimated from Farm Surveys" (a paper presented at the NCR-4 Conference on Problems in Estimating and Aggregating Regional Supply Response Estimate, 1962), pp. 7-8.

[11] Richard H. Day, "On Aggregating Linear Programming Models of Production," Journal of Farm Economics, Vol. 45, 1963, pp. 794-783.

1. Stratification of the region into areas based on type of soil, type of farming or other relevant characteristics so that yield potential, costs, prices, etc., are similar.
2. Sorting the farms within each area into groups that are homogeneous with respect to size or any other relevant factor.

The important decisions that need to be made in this context in any situation include:

1. The number of farms required to be set up.
2. The criteria to be used in grouping the farms.[12]

The most critical resource is a highly suitable criterion for grouping farms to reduce aggregation bias.[13] Often land is the most constraining resource, though not necessarily so, and farm size is used in grouping farms. Linear programming, relaxing the constraint on one resource at a time and observing the effects of the resource ratios on the output can be used to identify critical resources. Thus, capital could be relaxed and the effect of capital/land, capital/labor, etc., on output studied and the process repeated relaxing other resources.[14] If two or more resources, such as land and capital, effectively

---

[12]Barker and Stanton, op. cit., pp. 704, 705.

[13]For a detailed discussion, refer to: S. J. Sheehy and R. N. Alexander, "Selection of Representative Benchmark Farm for Supply Estimation," Journal of Farm Economics, Vol. 47, 1965, pp. 681-695; and G. E. Frick and R. A. Andrews, "Aggregation Bias and Four Methods of Summing Farm Supply Functions," Journal of Farm Economics, Vol. 47, 1965, pp. 646-700.

[14]Barker and Stanton, op. cit., p. 705.

constrain farm adjustment potentials and their ratios vary considerably from farm to farm, subsorting by more than one characteristic may be needed. However, this can give rise to a comparatively large number of representative farms for budgeting or linear programming purposes.

It should be noted that for analyzing optimum farm adjustments, differences in absolute amount of a resource may not be as relevant as differences in resource ratios from one farm to another, especially when linear programming is resorted to. For example, if land and labor are the key resources and there are no particular size economies, a farm of five acres and two laborers might appropriately be grouped together with another that has 25 acres and 10 laborers. The enterprise mix resulting from linear programming each would be the same. Here variable-resource programming would be useful to see how the ratios would vary without affecting the resulting activity mix. This, in turn, would suggest "boundaries" grouping farms for aggregation purposes. On the other hand, it has been demonstrated, using the duality theorem of linear programming, that when the resource ratios are the same among the farms, the results are the same and the aggregation error is a minimum.[15]

Homogeneity is important in defining representative farms. Should there not be one critical resource but wide variation in resource combinations, as when all farms in an area are considered instead of small farmers alone, other statistical procedures that can be used include:

---

[15]Richard H. Day, The Aggregation Problems and Linear Programming Models of Production Response (Washington, D.C.: Occasional Paper No. 4, Agricultural Adjustment Branch, Farm Production Economics Division, Economic Research Service, United States Department of Agriculture).

Alternative Methods for Grouping Farms

1. Principal Components Analysis. This approach consists essentially of fitting planes by orthogonal least squares.[16] It provides a procedure for using the variables that have large variances in classification, while ignoring those that have relatively small variances. There is no accent on the important or critical resources from an agronomic or economic viewpoint; the variables considered may have relatively less impact on the production but vary widely. Hence, the variables selected for the analysis must be chosen carefully. It is also to be noted that all the variables are not considered simultaneously. In fact, the farms are arrayed according to a number of components, each one representing a plane in the variable space, and therefore only some of the variables. The component that is to be used for classification is to be decided upon by the researcher. In fact, as many sets of groups as there are components developed can be made. The actual clusters are formed on the basis of suitable breaks in the value of the component.

2. Factor Analysis. This procedure reduces the variable to a relatively small number of independent factors by identifying and summarizing the structural relationships and combining interrelated

---

[16]Vernon Glenn Chappell, Jr., "The Identification and Evaluation of Factors Affecting Economic Growth in the Tennessee Valley Region, 1950-1960" (unpublished doctoral dissertation, The University of Tennessee, Knoxville, 1970), pp. 42-50. Two other useful references are: M. G. Kendall, A Course in Multivariate Statistical Analysis (New York: Hafner Publishing Co., Inc., 1961); and Donald F. Morrison, Multivariate Statistical Methods (New York: McGraw-Hill Book Co., 1967).

variables.[17] These factors become, in essence, proxies for the whole set of variables involved and are related in a manner to the correlation that exists between the variables. The actual clustering is done on the basis of cosign differences. This approach takes the variation in all the variables into account simultaneously, unlike the principal components analysis. It also yields a single set of groups.

Multiple discriminant analysis can be used to test the appropriateness of the groups formed by using either of the above approaches or groups formed by any other method. This procedure compares the members in each group with reference to the means of the variables for the groups.[18] It is essentially a type of analysis of variance. It also indicates appropriateness of each member with reference to the group in which it is placed as well as the other groups.

Representative farm linear programming models have a definite advantage over both aggregative linear programming models and regression models. Of course, there are two possible sources of errors, other than aggregation bias, which are:[19]

---

[17]Chappell, op. cit., pp. 50-57. Two other useful references are: Paul Horst, Factor Analysis and Data Matrices (New York: Holt, Rinehart and Winston, Inc., 1965); and Harvey H. Harman, Modern Factor Analysis (second edition, revised; Chicago: The University of Chicago Press, 1960).

[18]Chappell, op. cit., pp. 57-64. Two other useful references are: C. Radhakrishna Rao, Advanced Statistical Methods in Biometric Research (New York: John Wiley and Sons, Inc., 1952); and Kendall, loc. cit.

[19]Thomas Miller, "Aggregation Errors in Representative Farm Linear Programming Estimates" (unpublished doctoral dissertation, Iowa State University, Ames, 1967), pp. 4-8.

1. Specification errors. These arise because the model fails to accurately reflect the conditions actually faced by the farms.
2. Sampling errors. These are due to differences between the population parameters and the estimates of them.

Some General Observations on the Linear Programming and Aggregation Approach

A straightforward averaging procedure, together with estimates of variance and skewness of the distribution, with respect to the groups formed may be adequate when all that is desired is a description of the population in terms of the resources, cost and returns, etc. But when budgeting or linear programming is contemplated, more rigorous requirements need to be met.[20] Many researchers have questioned the reliability of the results when representative farms are used to obtain empirical estimates. But in situations where the objective of the analysis is to compare alternative farming systems or resource conditions, it may be suitable. It has been argued, for example, that for certain types of management problems, especially in the case of specific groups in an area, sufficient similarity may exist to justify their use.[21]

All the important factors other than managerial ability and risk aversion can be handled by suitable sampling procedures. Managerial

---

[20]Lee M. Day, "Use of Representative Farm Studies in Interregional Competition and Production Response," Journal of Farm Economics, Vol. 45, 1963, pp. 39-45.

[21]Harold O. Carter, "Representative Farms, Guides for Decision-Making," Journal of Farm Economics, Vol. 45, 1963, pp. 1448-1455.

ability and risk aversion, as well as soil and other physical characteristics, are relevant in setting up representative farms. Yet, these are hard to measure and therefore difficult to include in the analysis.[22]

Important considerations then in setting up representative farms, especially on a judgment basis, include:[23]

1. Whether nonphysical resources such as managerial skill, tenure, etc., are to be included.
2. Whether the analysis should be normative or predictive.
3. What degree of variability round the mean of the variables is to be accepted.
4. Whether the unit should be representative of the present or the future situation.

The number of representative farms required to reduce errors in aggregation increases geometrically with the complexity of the model.[24] Similarly, the number of representative farms that need to be set up increases with the variability in the variables or among the farms and the conditions within an area.

---

[22] I. G. Davis, Types of Farming and Type of Farming Areas in Connecticut (Storrs: Storrs Agricultural Experiment Station Bulletin 213, 1936), p. 131.

[23] James S. Plaxico and Luther G. Tweeten, "Representative Farms for Policy and Projection Research," Journal of Farm Economics, Vol. 45, 1963, p. 1459.

[24] Jerry A. Sharples, "The Representative Farm Approach to Estimation of Supply Response," American Economic Review, Vol. 59, 1969, p. 171.

Two general guidelines can be set up when a number of farms are to be substituted by a single "typical" farm.[25]

1. There should be proportional variation in the constraint vector, including the fixed and quasifixed behavioral and policy bounds.
2. There should also be proportional variation in the net returns expectations, which reflects a proportional variation in the input and output matrices, as well as proportionality in the prices.

In the context of the resource limitations under which the SFDA operates, it would be desirable to set up a single representative farm. This is possible only if the district is homogeneous in:

1. The physical features, such as soil, topography, climate, etc.
2. The farm characteristics, such as size and other resource ratios, etc.
3. The institutional characteristics, such as tenure, taxes, policy, etc.
4. Technical and managerial skills, risk awareness, etc. This is rarely possible in a district. In one way this reinforces the idea that the planning area be reasonably small.

---

[25]Richard H. Day, "On Aggregating Linear Programming Models of Production," op. cit., p. 811.

CHAPTER IV

AN EMPIRICAL APPLICATION OF THE SUGGESTED PROCEDURE FOR SFDA PLANNING TO A SITUATION IN TUNGABHADRA

It was not possible to visit India to collect data from a SFDA district in Mysore State necessary to illustrate the three-stage approach for program analysis and design proposed in Chapter III. Hence, it was decided to utilize the information collected by Cashdollar.[1] His study was designed to investigate possible changes in cropping patterns under irrigation. Consequently much of the information that was required for the application of this approach to program planning was not available.

Cashdollar surveyed the fortieth distributory of the Tungabhadra Irrigation Project in the northeastern part of the State of Mysore in late 1970 and early 1971. He and his associate collected farm management information by personal interviews from 116 farmers out of an estimated population of 14,443 farmers. Data pertaining to 40 of these sample farmers, who operated farms with land area between 2.5 acres and up to 10.0 acres, are used in the following empirical analysis on the assumption that these would be "small viable farmers" that would be defined as the clientele of a SFDA.

The resource constraints considered in this analysis are the following:

---

[1]Parker Cashdollar, "An Economic Analysis of Crop and Land Use Localization in Tungabhadra Irrigation Project of Mysore State, India" (unpublished doctoral dissertation, The University of Tennessee, Knoxville, 1971).

1. Total land operated by the farmer.
2. Land developed for irrigation currently.
3. Labor of the farmer and his family. Estimates are also made of the labor that he could hire.
4. Bullock pairs owned by the farmer. Again, estimates of bullock pairs he could hire are made.
5. Operating capital currently available with the farmer.

The resources available to the 40 farmers included in the analysis which follows are shown in Table 5.

The following are the possible enterprises or activities considered:

1. Irrigated rice.
2. Irrigated bajra.
3. Irrigated navane (kharif[2]).
4. Irrigated navane (rabi[2]).
5. Irrigated jowar (kharif).
6. Irrigated jowar (rabi).
7. Irrigated cotton.
8. Irrigated wheat.
9. Irrigated safflower.
10. Dry[3] cotton.

---

[2]There are two agricultural seasons that are associated with the monsoon rains. The "Kharif" season corresponds to the Southwest monsoon. Planting commences in June. The "Rabi" season corresponds to the North-east monsoon and planting commences in October.

[3]The term "dry" is used to indicate that it is unirrigated.

TABLE 5

INVENTORY OF RESOURCES OF FORTY SAMPLE FARMERS IN THE FORTIETH DISTRIBUTORY OF THE TUNGABHADRA IRRIGATION PROJECT, MYSORE STATE, 1971

Serial Number	Case Number	Total Land (Acres)	Developed Land (Acres)	Family Labor (Hours)	Bullock Pairs (Hours)	Operating Capital (Rupees)	Total Assets (Rupees)
1	5	3	0	3	0	100	100
2	45	3	3	0	0	300	100
3	73	3	3	3	1	1,750	900
4	81	3	1	2	1	1,040	700
5	94	3	3	4	1	400	1,300
6	100	3	0	4	0	600	400
7	31	4	2	2	0	200	450
8	32	4	0	2	0	500	1,600
9	49	4	4	3	0	100	100
10	63	4	2	0	1	1,300	300
11	65	4	0	1	1	2,000	400
12	90	4	1	3	1	300	800
13	23	5	0	2	1	400	600
14	44	5	2	3	0	1,200	100
15	60	5	2	3	1	800	700
16	22	6	3	3	1	1,250	800
17	33	6	0	2	1	1,000	750
18	35	6	2	6	1	750	800
19	50	6	3	3	1	1,100	500
20	74	6	6	2	1	500	5,600
21	102	6	1	2	0	750	100
22	105	6	1	4	1	750	1,400
23	8	7	2	5	1	750	500
24	28	8	0	2	0	750	100
25	34	8	3	3	1	1,400	1,100
26	36	8	0	1	1	1,000	600
27	43	8	8	8	2	2,500	3,100
28	53	8	1	7	1	300	1,200
29	55	8	8	4	1	750	3,800
30	92	8	2	3	1	4,000	2,350
31	103	8	0	2	0	500	100
32	119	8	4	0	1	500	500
33	1	9	6	2	1	3,750	400
34	25	9.5	0.5	1	0	500	100
35	3	10	3.5	2	1	200	500
36	21	10	0	1	0.5	700	300
37	64	10	10	2	2	1,700	2,500
38	78	10	2	2	1	500	1,800
39	95	10	3	0	0	1,000	1,800
40	104	10	8	3	1	2,000	1,400

11. Dry jowar.

12. Dry safflower.

13. Dry wheat.

14. Irrigated bajra followed by irrigated jowar.

15. Irrigated bajra followed by irrigated wheat.

16. Irrigated bajra followed by irrigated safflower.

17. Irrigated bajra followed by irrigated navane.

18. Irrigated bajra followed by dry jowar.

19. Irrigated bajra followed by dry safflower.

20. Irrigated bajra followed by dry wheat.

The enterprise budgets used for the above were those developed by Cashdollar, who supplemented research and extension information with personal interviews with technical experts, extension personnel and farmers.[4] These are presented in Table 6.

A scrutiny of the resources available on the farm shows the existence of considerable variation in the resources among the individual farmers. To ascertain whether there was any proportionality in the resource variations, correlation analysis was used and the correlation matrix is presented in Table 7. There is slight correlation between land developed currently for irrigation and the number of pairs of bullocks owned, and to a lesser extent between the operating capital available and the number of pairs of bullocks owned. Hence, it is inadvisable to set up a single representative farm.

---

[4]Cashdollar, loc. cit.

TABLE 6

THE TECHNICAL COEFFICIENTS MATRIX (UNITS PER ACRE)

Resource			Enterprises																		
			I. Rice	I. Bajra	I. Mavane (June planting)	I. Mavane (Oct. planting)	I. Jowar (June planting)	I. Jowar (Oct. planting)	I. Cotton	I. Wheat	I. Safflower	D. Cotton	D. Jowar	D. Safflower	D. Wheat	I. Bajra and I. Jowar	I. Bajra and I. Wheat	I. Bajra and I. Safflower	I. Bajra and I. Mavane	I. Bajra and D. Jowar	I. Bajra and D. Safflower	I. Bajra and D. Wheat
Total land		(Acres)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Irrigable land		"	1	1	1	1	1	1	1	1	1	-	-	-	-	1	1	1	1	1	1	1
Operating capital		(Rupees)	349.0	221.6	216.6	216.6	277.3	273.5	251.2	334.9	166.9	69.4	110.8	78.5	134.0	495.1	556.5	388.5	438.2	332.4	300.7	355.6
Labor during	April	(Hours)	36	32	18	—	26	—	—	—	—	—	—	—	—	32	32	32	32	32	32	32
	May	"	28	30	28	—	25	—	18	—	—	14	—	—	—	30	30	30	30	30	30	30
	June	"	95	60	48	18	42	—	28	—	18	14	14	14	—	60	60	60	60	60	60	60
	July	"	129	66	64	14	86	23	16	18	28	16	14	14	14	66	66	66	66	66	66	66
	Aug.	"	112	77	50	14	20	23	24	28	16	24	16	16	14	77	77	77	77	77	77	77
	Sep.	"	52	35	77	16	82	21	56	16	19	26	19	19	16	86	81	116	81	98	98	79
	Oct.	"	84	—	35	32	70	26	56	36	56	20	18	18	24	42	52	56	48	18	18	74
	Nov.	"	90	—	—	64	—	86	32	78	50	8	10	10	33	86	78	50	64	10	10	33
	Dec.	"	—	—	—	50	—	20	22	12	12	—	—	—	—	20	12	12	50	—	—	—
	Jan.	"	—	—	—	77	—	82	22	45	12	—	50	—	—	82	45	12	77	50	50	—
	Feb.	"	—	—	—	35	—	70	110	68	100	55	50	50	50	70	68	100	35	50	50	50
	Mar.	"	—	—	—	—	—	—	—	—	95	20	—	50	—	—	—	95	—	50	—	—
Bullock pairs during	April	"	12	20	6	—	14	—	—	—	—	—	—	—	—	20	20	20	20	20	20	20
	May	"	28	30	28	—	20	—	6	—	—	14	—	—	—	30	30	30	30	30	30	30
	June	"	38	21	29	6	25	—	28	—	6	14	14	14	—	21	21	21	21	21	21	21
	July	"	—	8	16	14	16	17	16	6	28	16	14	14	14	8	8	8	8	8	8	8
	Aug.	"	—	—	—	14	—	17	9	28	16	9	16	16	14	—	—	—	—	—	—	—
	Sep.	"	—	6	—	16	—	16	6	16	9	6	9	9	16	40	40	65	40	59	59	50
	Oct.	"	8	—	6	13	12	9	14	11	8	—	8	8	11	25	27	8	29	8	8	11
	Nov.	"	8	—	—	16	—	16	—	—	8	8	—	—	—	16	—	8	16	—	-	—
	Feb.	"	—	—	—	6	—	12	—	12	8	—	7	8	8	12	12	8	6	7	8	8
Net returns		(Rupees)	787.1	330.9	286.9	286.9	549.9	553.7	719.8	660.5	535.3	266.5	301.0	271.3	139.5	884.6	991.4	866.2	617.8	631.9	602.2	470.4

Note: I stands for Irrigated and D stands for Dry.

TABLE 7

CORRELATION MATRIX OF THE RESOURCES OF SMALL FARMERS, FORTY FARMS, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT

Variables*	1	2	3	4	5
1	1.00	.36	-.03	.25	.26
2	.36	1.00	.22	.53	.37
3	-.03	.22	1.00	.32	.12
4	.25	.53	.32	1.00	.43
5	.26	.37	.12	.43	1.00

*The variables considered are the resources available. They are:

1. Total land operated by the farmer.
2. Land developed for irrigation currently.
3. Labor of the farmer and his family.
4. Bullock pairs owned by the farmer.
5. Operating capital currently available with the farmer.

The approach utilizing the most critical resource is first used to group farmers to set up representative farms. Since the farmers who are included in this analysis are those operating small land areas, total land area or size is intuitively selected as the most critical resource. This is probably true since the size of the family and its assets are average, and especially since some labor and bullock power can be hired and additional irrigation potential and credit are to be provided. The following size groups are made on a subjective basis.

1. Group A--Total land operated more than 2.5 acres and up to 5.0 acres. There are 15 farms in this group.
2. Group B--Total land operated more than 5.0 acres and up to 7.5 acres. There are eight farms in this group.
3. Group C--Total land operated more than 7.5 acres and up to 10.0 acres. There are 17 farms in this group.

Representative farms are set up by averaging the resources. The resource picture for the three representative farms set up is given in Table 8. To ascertain whether the resources are proportional to the ratios of the other resources to total land operated are calculated and this information is shown in Table 9. There is appreciable difference in these ratios between Representative Farm C and the other two. The ratios of Representative Farms A and B are similar except in respect of operating capital available. There is a possibility that these two groups can be combined together. If only farmers operating from 2.5 acres to 7.5 acres are selected for the analysis, a single representative farm may suffice if land alone is a critical resource. Here, however, it was

TABLE 8

THE RESOURCE PICTURE OF REPRESENTATIVE FARMS A, B AND C, FORTY SMALL FARMERS, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT

Resource		Representative Farm A* (15 farms)	B* (8 farms)	C* (17 farms)
Total land	(Acres)	3.80	6.13	8.85
Land developed for irrigation	"	1.50	2.25	3.47
Operating capital	(Rupees)	734	865	1,297
Family labor per month	(Hours)	446	676	506
Owned bullock pairs per month	"	106	160	170
Hired labor per month	"	120	220	320
Hired bullock pairs per month	"	50	75	100

*A - over 2.5 and up to 5.0 acres.
B - over 5.0 and up to 7.5 acres
C - over 7.5 and up to 10.0 acres.

TABLE 9

THE RESOURCE RATIOS OF REPRESENTATIVE FARMS A, B AND C, FORTY SMALL FARMERS, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT

Resource Available per Acre of Total Land		Representative Farm		
		A*	B*	C*
Land developed for irrigation	(Acres)	0.40	0.37	0.39
Operating capital	(Rupees)	193	141	147
Family labor per month	(Hours)	117	110	57
Owned bullock pairs per month	"	28	26	19
Hired labor per month	"	32	36	36
Hired bullock pairs per month	"	13	12	11

*A - over 2.5 and up to 5.0 acres.
B - over 5.0 and up to 7.5 acres.
C - over 7.5 and up to 10.0 acres.

decided to go ahead using the three representative farms described above.

Linear programming procedure is used to obtain optimal plans for the three Representative Farms A, B, and C, under the constraint situations described below.

1. The existing constraints. This will yield the potentials if no programs are introduced. It could be useful if the returns to investments made in the program alternatives considered in the analysis are to be estimated. In other words, it would be a convenient "bench mark" or "control" situation.

2. The constraint on irrigable land alone relaxed. This is an approximation of the effects of a program alternative where additional irrigation potential is made available to the farmers, say by undertaking major or minor irrigation projects, digging wells, etc.

3. The constraint on operating capital alone relaxed. This approximates the conditions that would result when the program alternative is to provide credit.

4. The constraints on both irrigable land and operating capital relaxed. This would approximate the conditions under a program alternative that provides additional irrigation potential and credit simultaneously.

5. The constraints on all the resources other than total land relaxed. This is an attempt to approximate the effects of a possible program alternative that provides irrigation, credit and machinery or machine services. In a way it would help estimate the potentials for

mechanization. This alternative has not been actually evaluated later since it is a complicated situation where more than merely substitution of labor is involved. It is presented only to show the potentials of the approach to solve this kind of problem.

In all these cases hired labor is charged at Rs. 0.35 per hour and hired bullock pairs are charged at Rs. 0.65 per hour. (The other resources provided are not charged at this stage since the information on costs was not available, as explained later. The analysis is repeated using estimates of these to illustrate the possible importance and effects of these costs.)

Empirical Results When Water Rate and Interest Are Ignored

Optimal plans for Representative Farm A. The optimum plans under different program alternatives for Representative Farm A are presented in Table 10. Irrigation and credit programs tend to increase the income possibilities by about 18 and 15 percent, respectively. But the increase possibility when both are introduced simultaneously is about 96 percent. There is also a tendency to specialize as these facilities are provided. Mechanization does not appear to have much effect on the net incomes.

Optimum plans for Representative Farm B. The optimum plans are shown in Table 11. In this case the possibility for increasing income by irrigation is 6 percent, by credit is 27 percent and by both together is 122 percent. Mechanization again has little impact. A tendency to specialize does exist as before.

TABLE 10

OPTIMAL PLANS FOR REPRESENTATIVE FARM A, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Activities and Net Returns		Program Alternatives				
		Current Condition	Irrigation	Credit	Irrigation and Credit	Irrigation, Credit and Mechanization
Dry cotton	(Acres)	2.30	--	--	--	--
Dry jowar	"	--	--	2.30	--	--
Irrigated cotton	"	0.09	1.17	--	--	--
Irrigated safflower	"	--	2.63	--	--	--
Irrigated bajra and wheat	"	0.01	--	1.50	3.80	3.80
Irrigated bajra and safflower	"	1.40	--	--	--	--
Total net returns	(Rupees)	1,901	2,250	2,179	3,732	3,767

*Water rate and interest ignored.

TABLE 11

OPTIMAL PLANS FOR REPRESENTATIVE FARM B, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Activities and Net Returns		Program Alternatives				
		Current Condition	Irrigation	Credit	Irrigation and Credit	Irrigation, Credit and Mechanization
Dry cotton	(Acres)	3.88	--	--	--	--
Dry jowar	"	--	--	3.88	--	--
Irrigated rice	"	--	--	--	0.25	--
Irrigated cotton	"	2.03	4.51	--	--	--
Irrigated safflower	"	--	1.62	--	--	--
Irrigated bajra and wheat	"	--	--	2.25	5.88	6.13
Irrigated bajra and safflower	"	0.22	--	--	--	--
Total net returns	(Rupees)	2,686	2,846	3,399	5,961	6,077

*Water rate and interest ignored.

Optimal plans for Representative Farm C. The optimal plans for Representative Farm C are summarized in Table 12. Here the possible increase in net income under an irrigation program is less than 1 percent, under a credit program it is about 31 percent and under a combined irrigation and credit program it is about 104 percent. In this case, mechanization also has some possibilities since it can increase net income by about 24 percent.

Resources used up under the optimal plans. This information with respect of Representative Farms A, B and C is presented in Tables 13, 14 and 15, respectively. Farms A and B utilize their own labor under all alternatives and their own bullock power as well, except when irrigation and credit are both made available at the same time. Farm C, on the other hand, uses some hired labor when restricted to its own facilities and funds and considerably more of both hired labor, as well as bullock pairs when both irrigation and credit are provided. This farm then could use some machinery. However, it is interesting to note that when credit alone is provided, it does not need to hire labor as bullock pairs under the optimal plan.

Resources that need to be provided. The additional resources that are to be provided to the Representative Farms A, B and C, over and above what is owned by them, are shown in Tables 16, 17 and 18, respectively. Since hired labor and bullock power are available to the required extent, it is only the requirements of additional irrigable land and operating capital that are of real concern to the planning

TABLE 12

OPTIMAL PLANS FOR REPRESENTATIVE FARM C, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Activities and Net Returns		Program Alternatives				
		Current Condition	Irrigation	Credit	Irrigation and Credit	Irrigation, Credit and Mechanization
Dry cotton	(Acres)	5.38	4.39	--	--	--
Dry jowar	"	--	--	5.38	--	--
Irrigated rice	"	--	--	--	1.70	--
Irrigated cotton	"	3.37	2.10	--	0.47	--
Irrigated safflower	"	0.10	2.37	--	--	--
Irrigated bajra and wheat	"	--	--	3.47	6.68	8.85
Total net returns	(Rupees)	3,854	3,874	5,048	7,856	8,774

*Water rate and interest ignored.

TABLE 13

RESOURCE REQUIREMENTS OF THE OPTIMAL PLANS FOR REPRESENTATIVE FARM A, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Resources Required			Program Alternatives				
			Current Condition	Irrigation	Credit	Irrigation and Credit	Irrigation, Credit and Mechanization
Total land		(Acres)	3.80	3.80	3.80	3.80	3.80
Land developed for irrigation		"	1.50	3.80	1.50	3.80	3.80
Operating capital		(Rupees)	733	733	1,090	2,150	2,115
Family labor during	April	(Hours)	46	--	48	122	122
	May	"	77	22	45	114	114
	June	"	120	81	123	228	228
	July	"	132	93	132	251	251
	Aug.	"	167	71	153	293	293
	Sep.	"	229	116	166	308	308
	Oct.	"	130	213	120	198	198
	Nov.	"	93	169	140	297	297
	Dec.	"	19	58	18	46	46
	Jan.	"	20	58	183	171	171
	Feb.	"	277	392	217	259	259
	Mar.	"	180	251	--	--	--
Owned bullock pairs during	April	"	29	--	30	76	76
	May	"	76	8	45	106	114
	June	"	65	48	64	80	80
	July	"	50	93	45	31	31
	Aug.	"	22	53	37	--	--
	Sep.	"	106	31	81	106	152
	Oct.	"	13	38	58	103	103
	Nov.	"	30	22	--	--	--
	Feb.	"	12	22	35	46	46
Hired bullock pairs during	May	"	--	--	--	8	8
	Sep.	"	--	--	--	46	46

*Water rate and interest ignored.

TABLE 14

RESOURCE REQUIREMENTS OF THE OPTIMAL PLANS FOR REPRESENTATIVE FARM B, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Resources Required		Program Alternatives				
		Current Condition	Irrigation	Credit	Irrigation and Credit	Irrigation, Credit and Mechanization
Total land	(Acres)	6.13	6.13	6.13	6.13	6.13
Land developed for irrigation	"	2.25	4.51	2.25	6.13	6.13
Operating capital	(Rupees)	865	865	1,682	3,423	3,411
Family labor during	April (Hours)	8	--	72	198	197
	May "	98	23	68	184	184
	June "	125	104	190	377	368
	July "	110	153	203	421	404
	Aug. "	159	112	236	481	473
	Sep. "	241	128	256	481	497
	Oct. "	204	285	187	327	319
	Nov. "	108	239	215	482	479
	Dec. "	48	55	27	71	74
	Jan. "	48	55	296	265	276
	Feb. "	459	541	347	400	417
	Mar. "	99	461	--	--	--
Owned bullock pairs during	April "	5	--	45	121	123
	May "	74	23	68	160	160
	June "	116	50	102	134	129
	July "	97	153	73	47	50
	Aug. "	54	87	63	--	--
	Sep. "	50	51	125	160	160
	Oct. "	31	37	92	160	160
	Nov. "	33	50	--	3	--
	Feb. "	2	37	55	71	74
Hired bullock pairs during	May "	--	--	--	24	24
	Sep. "	--	--	--	75	86
	Oct. "	--	--	--	2	6

*Water rate and interest ignored.

TABLE 15

RESOURCE REQUIREMENTS OF THE OPTIMAL PLANS FOR REPRESENTATIVE FARM C, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Resources Required			Program Alternatives				
			Current Condition	Irrigation	Credit	Irrigation and Credit	Irrigation, Credit and Mechanization
Total land		(Acres)	8.85	8.85	8.85	8.85	8.85
Land developed for irrigation		"	3.47	4.46	3.47	8.85	8.85
Operating capital		(Rupees)	1,297	1,297	2,538	4,873	4,925
Family labor during	April	(Hours)	--	--	112	275	284
	May	"	137	100	105	257	266
	June	"	172	163	284	506	506
	July	"	143	170	305	506	506
	Aug.	"	212	194	354	506	506
	Sep.	"	331	277	384	506	506
	Oct.	"	301	338	278	506	461
	Nov.	"	156	221	325	506	506
	Dec.	"	76	75	42	91	107
	Jan.	"	76	75	426	311	399
	Feb.	"	506	506	505	506	506
	Mar.	"	117	313	--	--	--
Owned bullock pairs during	April	"	--	--	70	154	170
	May	"	96	74	105	170	170
	June	"	170	135	149	170	170
	July	"	143	170	104	61	71
	Aug.	"	81	97	87	5	--
	Sep.	"	54	61	170	170	170
	Oct.	"	49	49	137	170	170
	Nov.	"	44	55	--	14	--
	Feb.	"	1	19	80	81	107
Hired labor during	June	"	--	--	--	70	25
	July	"	--	--	--	162	79
	Aug.	"	--	--	---	210	176
	Sep.	"	--	--	--	150	211
	Oct.	"	--	--	--	11	--
	Nov.	"	--	--	--	184	185
	Feb.	"	171	203	--	--	96
Hired bullock pairs during	April	"	--	--	--	--	7
	May	"	--	--	--	81	96
	June	"	1	--	--	49	16
	Sep.	"	--	--	18	100	184
	Oct.	"	--	--	--	31	69

*Water rate and interest ignored.

TABLE 16

ADDITIONAL RESOURCES REQUIRED UNDER THE OPTIMAL PLANS FOR REPRESENTATIVE FARM A, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Additional Resources Required			Program Alternatives				
			Current Condition	Irrigation	Credit	Irrigation and Credit	Irrigation, Credit and Mechanization
Irrigable land		(Acres)	--	2.30	--	2.30	2.30
Operating capital		(Rupees)	--	--	3.57	1,417	1,382
Hired bullock pairs during	May	(Hours)	--	--	--	8	8
	June	"	--	--	--	46	46

*Water rate and interest ignored.

TABLE 17

ADDITIONAL RESOURCES REQUIRED UNDER THE OPTIMAL PLANS FOR REPRESENTATIVE FARM B, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Additional Resources Required		Program Alternatives				
		Current Condition	Irrigation	Credit	Irrigation and Credit	Irrigation, Credit and Mechanization
Irrigable land	(Acres)	--	2.26	--	3.88	3.88
Operating capital	(Rupees)	--	--	817	2,558	2,546
Hired bullock pairs during May	(Hours)	--	--	--	24	24
Hired bullock pairs during Sep.	"	--	--	--	75	86
Hired bullock pairs during Oct.	"	--	--	--	1	6

*Water rate and interest ignored.

TABLE 18

ADDITIONAL RESOURCES REQUIRED UNDER THE OPTIMAL PLANS FOR REPRESENTATIVE FARM C, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Additional Resources Required		Program Alternatives				
		Current Condition	Irrigation	Credit	Irrigation and Credit	Irrigation, Credit and Mechanization
Irrigable land	(Acres)	--	0.99	--	5.38	5.38
Operating capital	(Rupees)	--	--	1,241	3,576	3,628
Hired labor during June	(Hours)	--	--	--	70	25
Hired labor during July	"	--	--	--	162	79
Hired labor during Aug.	"	--	--	--	210	176
Hired labor during Sep.	"	--	--	--	150	211
Hired labor during Oct.	"	--	--	--	11	--
Hired labor during Nov.	"	--	--	--	184	185
Hired labor during Feb.	"	171	203	--	--	96
Hired bullock pairs during April	"	--	--	--	--	7
Hired bullock pairs during May	"	--	--	--	81	96
Hired bullock pairs during June	"	1	--	--	49	16
Hired bullock pairs during Sep.	"	--	--	18	100	184
Hired bullock pairs during Oct.	"	--	--	--	31	69

*Water rate and interest ignored.

agency. Credit requirements increase considerably when combined with irrigation for all the three farms. But the requirements of additional irrigable land are the same when irrigation is provided with and without credit for Farm A. But it increases somewhat for Farm B and considerably for Farm C when irrigation is combined with credit. Incidentally, in the case of Representative Farms A and B, when labor and bullock power are unlimited along with irrigation and operating capital, the requirement of additional credit is less than when only irrigation or credit is provided, while it is greater for Representative Farm C.

Unutilized resources. Family labor and bullock power that remain unutilized under the different optimal plans for the three farms are presented in Tables 19, 20 and 21. While a considerable quantity of these resources remain unutilized on Farm A and Farm B, they are unutilized only at certain times on Farm C when both irrigation and credit are made available. However, when only irrigation or credit is provided, there is surplus labor available even on Farm C, and hence there is considerable room for programs to utilize surplus labor in the small farm sector.

At this point it may be worthwhile noting that the optimal plans become more and more specialized in enterprises as irrigation and credit are provided. This may cause major changes and problems in the agricultural sector. However, this is to a large extent due to the lack of information on important resources, such as soil types and topography, availability of other production resources such as fertilizer, etc., as well as information on interests and constraints set by cultural,

TABLE 19

UNUTILIZED OWNED RESOURCES UNDER OPTIMAL PLANS FOR REPRESENTATIVE FARM A, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Unutilized Owned Resources			Program Alternatives				
			Current Condition	Irrigation	Credit	Irrigation and Credit	Irrigation, Credit and Mechanization
Family labor during	April	(Hours)	420	466	418	344	344
	May	"	389	444	421	352	352
	June	"	346	385	343	238	238
	July	"	334	373	334	215	215
	Aug.	"	299	395	313	173	173
	Sep.	"	237	350	300	158	158
	Oct.	"	336	253	346	268	268
	Nov.	"	373	297	326	169	169
	Dec.	"	447	408	448	420	420
	Jan.	"	446	408	283	295	295
	Feb.	"	189	74	249	207	207
	Mar.	"	286	215	466	466	466
Bullock pairs during	April	"	77	106	76	30	30
	May	"	30	98	61	--	--
	June	"	41	57	42	26	26
	July	"	56	13	61	75	75
	Aug.	"	84	53	69	106	106
	Sep.	"	--	75	25	--	--
	Oct.	"	93	68	47	3	3
	Nov.	"	76	84	106	106	106
	Dec.	"	106	106	106	106	106
	Jan.	"	106	106	106	106	106
	Feb.	"	94	84	71	60	60
	Mar.	"	106	106	106	106	106

*Water rate and interest ignored.

TABLE 20

UNUTILIZED OWNED RESOURCES UNDER OPTIMAL PLANS FOR REPRESENTATIVE FARM B, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Unutilized Owned Resources			Program Alternatives				
			Current Condition	Irrigation	Credit	Irrigation and Credit	Irrigation, Credit and Mechanization
Family labor during	April	(Hours)	668	676	604	478	479
	May	"	578	653	608	492	492
	June	"	551	572	486	299	308
	July	"	566	523	473	255	272
	Aug.	"	517	564	440	195	203
	Sep.	"	435	548	420	186	179
	Oct.	"	472	391	489	349	357
	Nov.	"	568	437	461	194	197
	Dec.	"	628	621	649	605	602
	Jan.	"	628	621	380	411	400
	Feb.	"	217	135	329	276	259
	Mar.	"	577	215	676	676	676
Bullock pairs during	April	"	155	160	115	39	37
	May	"	86	137	92	--	--
	June	"	44	110	58	26	31
	July	"	63	7	87	113	110
	Aug.	"	106	73	97	160	160
	Sep.	"	110	109	35	--	--
	Oct.	"	129	123	68	--	--
	Nov.	"	127	110	160	157	160
	Dec.	"	160	160	160	160	160
	Jan.	"	160	160	160	160	160
	Feb.	"	158	123	105	89	86
	Mar.	"	160	160	160	160	160

*Water rate and interest ignored.

TABLE 21

UNUTILIZED OWNED RESOURCES UNDER OPTIMAL PLANS FOR REPRESENTATIVE FARM C, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Unutilized Owned Resources			Program Alternatives				
			Current Condition	Irrigation	Credit	Irrigation and Credit	Irrigation, Credit and Mechanization
Family labor during	April	(Hours)	506	506	394	231	222
	May	"	369	406	401	249	240
	June	"	334	343	222	--	--
	July	"	363	336	201	--	--
	Aug.	"	294	312	152	--	--
	Sep.	"	175	229	122	--	--
	Oct.	"	204	168	228	--	45
	Nov.	"	350	258	181	--	--
	Dec.	"	430	431	464	415	399
	Jan.	"	430	431	80	195	107
	Feb.	"	--	--	1	--	--
	Mar.	"	389	193	506	506	506
Bullock pairs during	April	"	170	170	100	16	--
	May	"	74	96	65	--	--
	June	"	--	35	21	--	--
	July	"	27	--	66	109	99
	Aug.	"	89	73	83	165	170
	Sep.	"	116	109	--	--	--
	Oct.	"	121	121	33	--	--
	Nov.	"	126	115	170	156	170
	Dec.	"	170	170	170	170	170
	Jan.	"	170	170	170	170	170
	Feb.	"	169	151	90	89	63
	Mar.	"	170	170	170	170	170

*Water rate and interest ignored.

psychological and risk-based factors. For lack of the latter type of information, profit maximization has been taken as the sole objective. Hence, the analysis is not as refined as would be desirable.

Evaluation of program alternatives. Some data necessary for aggregation are not available. Such is the information on the number of farms of the different size groups in the population. So, a size distribution more or less similar to the general distribution has been assumed. The total number of farmers in the fortieth distributory is 14,443. Assuming that the farms of Groups A, B and C form 15 percent, 12 percent and 10 percent, respectively, of the total number of farms, the number of the three types of farms in the distributory are estimated to be 2,167, 1,733 and 1,444, respectively.

The cost to the agency of making irrigation available for one acre of land and developing the land for irrigation is not known. This cost is assumed to be Rs. 500 per acre, based on estimates of reported costs for such development by individuals. On the basis of this the financial implications to the agency for the three program alternatives, viz. irrigation alone, credit alone, and irrigation and credit simultaneously, have been worked out for 5,344 farmers operating farms over 2.5 acres and up to 10 acres. The total benefit to these farmers assuming that they will adopt the optimal programs developed is also estimated. The benefits are then compared with the direct cost to the agency to estimate the net benefit from each of the three program alternatives. This information is presented in Table 22. The credit program emerges as the best alternative with the irrigation program next best and the

TABLE 22

BENEFIT-COST ESTIMATES OF DIFFERENT PROGRAM ALTERNATIVES WHEN ALL FARMERS ADOPT, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Items		Program Alternatives		
		Irrigation	Credit	Irrigation and Credit
Total benefit to the clientele	(Rupees)	15,400,712	17,902,230	29,761,317
Additional irrigable land required	(Acres)	10,330	--	19,477
Additional capital required	(Rupees)	--	3,981,781	12,667,687
Total cost of the program	"	5,165,000	3,981,781	22,406,187
Net benefit from the program	"	10,235,712	13,920,449	7,355,130

*Water rate and interest ignored.

CRANES CREST

combined irrigation and credit program turns out a third. This is mostly due to the fact that the third alternative makes relatively high demands on additional irrigation facilities, which obviously have greater relative expense. Intuitively it appears that irrigation has a lower marginal return than credit. But if the cost of irrigation could be lowered, it is possible that the picture could be different. However, this cost will have to be less by at least Rs. 357 per acre or the cost should be no more than Rs. 143 per acre, which would not be probable. If it is so, the combined program would be the most advantageous in terms of net benefit. According to the analysis in Table 20, page 98, if for some reason, say political pressure, it were necessary to adopt the irrigation alternative instead of the credit alternative, the sacrifice in "net benefit" involved would be Rs. 4,102,297.

It is to be noted that only the direct costs, viz. the investment, have been considered. But often other costs may also be involved. Such would be an additional operational expenditure not included in the direct costs, say on personnel or equipment and facilities, that will have to be incurred by the administering body such as the SFDA. Thus a credit program would need special appraisers and machinery to provide and service loans. The cost estimates will have to be suitably adjusted to account for these.

Evaluation of program alternatives when only some farmers utilize the program. Often it may not be reasonable to assume that all farmers will utilize the program. This is especially true when the planning horizon covers a limited period, say one year. Thus an irrigation or

credit program could not be availed of by all the 14,443 farmers in the fortieth distributory within a year. However, if the same proportion of farmers in all the size groups responded to the program, the decision will not be different, though the total demand on funds and facilities of the agency and the total benefits to the farmers, and hence the net benefit from the alternatives, will be proportionally less. But if different proportions of farmers in the three groups are expected to avail themselves of the programs, this may have to be taken into account in evaluating the program alternatives.

Such a situation is analyzed. It is assumed that 10 percent of the farmers in Group A, 15 percent in Group B and 20 percent in Group C would utilize the programs within a year. The estimated benefit to the farmers, the cost to the agency and the net benefit are presented in Table 23. There is a substantial change in the comparative benefits from the three alternatives considered, even though the relative position does not change. But it does bring out the possibilities of a change in the decision had the proportions been more different. The really important difference is that if irrigation were preferred for some external reason the sacrifice of "net benefit" involved would be only Rs. 468,842.

The optimum program design. The above evaluation does not really answer the question: "What program combination maximizes benefit from the point of view of the agency?" The SFDA has limited funds, trained personnel, production requisites and facilities. It has also its objectives which may not be solely to increase the income of the small farmers.

TABLE 23

BENEFIT-COST ESTIMATES OF DIFFERENT PROGRAM ALTERNATIVES WHEN A LIMITED PROPORTION OF FARMERS ADOPT, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Items		Program Alternatives		
		Irrigation	Credit	Irrigation and Credit
Total benefit to the clientele	(Rupees)	2,347,679	2,815,521	4,629,977
Additional irrigable land required	(Acres)	1,373	--	3,063
Additional capital required	(Rupees)	--	648,612	2,006,060
Total cost of the program	"	685,500	648,500	3,537,560
Net benefit from the program	"	1,662,179	2,131,021	1,092,417

*Water rate and interest ignored.

The above analysis yields only the benefit vector as far as the agency decision is concerned. The resources required per unit of each of the program alternatives, the total resources available with the SFDA or its resource constraints and its specific goals and subgoals, as well as the limitations placed on it by social demands and state policy, also need to be considered. Once this information is collected, linear programming procedure can be used again to obtain the optimum program design that will maximize the net benefit subject to the objectives of and the constraints placed on the activities of the agency. This part of the analysis is omitted here as the required information is not available.

The Results When Water Rates and Interest Charges Are Considered

In evaluating program alternatives in the preceding analysis, a charge has been made for hiring labor and bullock pairs. But the charges associated with using additional irrigable land, such as water tax or charges and the interest on the capital invested in developing this land for irrigation, as well as the charges associated with borrowing capital, such as the interest and service charges on loans, have been ignored, mainly because this information is not available with respect to the farmers included in the analysis. This omission could obviously affect the optimal plans and hence result in a distortion of the entire evaluation. Hence estimates of these costs for the area of Rs. 48 per acre is made against additional irrigable land used and of 25 percent against operating capital borrowed are used in the subsequent analysis. These charges could not only reduce net incomes for the optimal plans but make heavier demands on the total amount of operating capital required under the optimal plans.

Optimal plans for the representative farms. The optimal plans when water rates and interest charges are included are presented in Tables 24, 25 and 26. The net incomes derived from the optimal plans under the three program alternatives are substantially different. It is not proposed to discuss these differences in detail here but only to bring out some salient points.

1. In the case of Representative Farm A the credit alternative shows a net income possibility that is slightly superior to that under the irrigation alternative, which is contrary to the results of the previous analysis. These two alternatives show, however, somewhat small and equal increases in net income--8 percent for irrigation and 9 percent for credit. When the two are combined together, the net income is substantially larger, i.e., 65 percent. When compared with the respective net income possibilities in the previous evaluation, there is a decrease in the order of 9 percent, 5 percent and 16 percent, respectively, for the three alternatives.

2. For Representative Farm B the net income possibilities are much lower than in the previous analysis, even though the ranking of the alternatives based on the net income remain the same. Thus, the alternatives of irrigation, credit and both together show net income increases of less than 1 percent, 17 percent and 83 percent over the net income possibilities if no program were introduced. Compared with the previous analysis, the net income possibilities are lower by 5 percent, 5 percent and 17 percent, respectively, for the three alternatives.

TABLE 24

OPTIMAL PLANS FOR REPRESENTATIVE FARM A, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Activities and Net Returns		Program Alternatives			
		Current Conditions	Irrigation	Credit	Irrigation and Credit
Dry cotton	(Acres)	2.30	1.45	--	--
Dry jowar	"	--	--	2.30	--
Irrigated cotton	"	0.09	2.35	--	--
Irrigated bajra and wheat	"	0.01	--	1.50	3.80
Irrigated bajra and safflower	"	1.40	--	--	--
Total net return	(Rupees)	1,901	2,039	2,068	3,145

*Water rate and interest charged.

TABLE 25

OPTIMAL PLANS FOR REPRESENTATIVE FARM B, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Activities and Net Returns		Program Alternatives			
		Current Conditions	Irrigation	Credit	Irrigation and Credit
Dry cotton	(Acres)	3.88	3.75	--	--
Dry jowar	"	--	--	3.88	--
Irrigated cotton	"	2.03	2.38	--	--
Irrigated paddy	"	--	--	--	0.26
Irrigated bajra and wheat	"	--	--	2.25	5.87
Irrigated bajra and safflower	"	0.22	--	--	--
Total net returns	(Rupees)	2,686	2,707	3,143	4,917

*Water rate and interest charged.

TABLE 26

OPTIMAL PLANS FOR REPRESENTATIVE FARM C, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Activities and Net Returns		Program Alternatives			
		Current Conditions	Irrigation	Credit	Irrigation and Credit
Dry cotton	(Acres)	5.38	5.38	--	--
Dry jowar	"	--	--	5.38	--
Irrigated cotton	"	3.37	3.37	--	2.03
Irrigated rice	"	--	--	--	0.37
Irrigated safflower	"	0.10	0.10	--	--
Irrigated bajra and wheat	"	--	--	3.47	6.45
Total net returns	(Rupees)	3,854	3,854	4,660	6,484

*Water rate and interest charged.

3. In the case of Representative Farm C, the picture is similar to that for Farm B, except that there is no increase in net income under irrigation, i.e., there is no possibility for irrigation alone. Credit alone shows a possible increase in net income of 21 percent and irrigation and credit together a possible increase in net income of 68 percent. There is a decrease in possible net income of less than 1 percent under the irrigation alternative, 8 percent under credit and 17 percent under irrigation and credit together, over the possibilities in the previous analysis.

Resources used up under the optimal plans. Tables 27, 28 and 29 show the resources utilized by Representative Farms A, B and C, respectively, in the optimal plans under the program alternatives. There is generally less use of labor and bullock pairs than in the previous analysis. The use of additional irrigable land is also less under the irrigation program, no irrigable land being used at all by Representative Farm C under this alternative. When both irrigation and capital are provided, the same amount of additional irrigable land as in the previous analysis is used. Considerably larger amounts of capital are borrowed by all the farms, both where credit alone is provided and when it is provided along with irrigation. The increase over the previous analysis is 25 percent for the credit program in the case of all the three representative farms. Under the combined irrigation and credit program alternative this increase is 36 percent for Representative Farm A, 34 percent for Farm B and 22 percent for Farm C.

TABLE 27

RESOURCE REQUIREMENTS OF THE OPTIMAL PLANS FOR REPRESENTATIVE FARM A, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Resources Required			Program Alternatives			
			Current Conditions	Irrigation	Credit	Irrigation and Credit
Total land		(Acres)	3.80	3.80	3.80	3.80
Land developed for irrigation		"	1.50	1.50	1.50	1.50
Additional irrigable land		"	--	0.86	--	2.30
Operating capital		(Rupees)	733	733	733	733
Borrowed capital		"	--	--	447	1,910
Family labor during	April	(Hours)	46	--	48	122
	May	"	77	63	45	114
	June	"	120	87	123	228
	July	"	132	61	132	250
	Aug.	"	167	92	153	293
	Sep.	"	229	170	166	308
	Oct.	"	130	161	120	198
	Nov.	"	93	87	140	296
	Dec.	"	19	52	18	46
	Jan.	"	20	52	183	171
	Feb.	"	277	339	217	259
	Mar.	"	180	29	--	--
Owned bullock pairs during	April	"	29	--	30	76
	May	"	76	35	45	106
	June	"	65	87	64	80
	July	"	50	61	44	31
	Aug.	"	22	35	37	--
	Sep.	"	106	23	81	106
	Oct.	"	13	33	59	103
	Nov.	"	30	12	--	--
	Feb.	"	12	--	35	46
Hired bullock pairs during	May.	"	--	--	--	8
	Sep.	"	--	--	--	46

*Water rate and interest charged.

TABLE 28

RESOURCE REQUIREMENTS OF THE OPTIMAL PLANS FOR REPRESENTATIVE FARM B, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Resources Required			Program Alternatives			
			Current Conditions	Irrigation	Credit	Irrigation and Credit
Total land		(Acres)	6.13	6.13	6.13	6.13
Land developed for irrigation		"	2.25	2.25	2.25	2.25
Additional irrigable land		"	--	0.14	--	3.88
Operating capital		(Rupees)	865	865	865	865
Borrowed capital		"	--	--	1,022	3,431
Family labor during	April	(Hours)	8	--	72	198
	May	"	98	96	68	184
	June	"	125	120	190	377
	July	"	110	99	203	421
	Aug.	"	159	148	236	481
	Sep.	"	241	231	256	490
	Oct.	"	204	209	187	327
	Nov.	"	108	107	215	482
	Dec.	"	48	53	27	71
	Jan.	"	48	53	296	265
	Feb.	"	459	469	347	400
	Mar.	"	99	75	--	--
Owned bullock pairs during	April	"	5	-	45	121
	May	"	74	67	68	160
	June	"	116	120	102	134
	July	"	97	99	73	47
	Aug.	"	54	56]	63	--
	Sep.	"	50	37	125	160
	Oct.	"	31	34	92	160
	Nov.	"	33	30	--	3
	Feb.	"	2	--	55	71
Hired bullock pairs during	May	"	--	--	--	24
	Sep.	"	--	--	--	75
	Oct.	"	--	--	--	1

*Water rate and interest charged.

TABLE 29

RESOURCE REQUIREMENTS OF THE OPTIMAL PLANS FOR REPRESENTATIVE FARM C, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Resources Required			Program Alternatives			
			Current Conditions	Irrigation	Credit	Irrigation and Credit
Total land		(Acres)	8.85	8.85	8.85	8.85
Land developed for irrigation		"	3.47	3.47	3.47	3.47
Additional irrigable land		"	--	--	--	5.38
Operating capital		(Rupees)	1,297	1,297	1,297	1,297
Borrowed capital		"	--	--	1,552	4,374
Family labor during	April	(Hours)	--	--	112	220
	May	"	137	137	105	241
	June	"	172	172	284	480
	July	"	143	143	305	506
	Aug.	"	212	212	354	506
	Sep.	"	331	331	384	506
	Oct.	"	302	302	278	481
	Nov.	"	156	156	325	506
	Dec.	"	76	76	42	123
	Jan.	"	76	76	426	335
	Feb.	"	506	506	505	506
	Mar.	"	117	117	--	--
Owned bullock pairs during	April	"	--	--	70	134
	May	"	96	96	105	170
	June	"	170	170	149	170
	July	"	143	143	104	85
	Aug.	"	81	81	87	19
	Sep.	"	54	54	170	170
	Oct.	"	49	49	137	170
	Nov.	"	44	44	--	3
	Feb.	"	1	1	80	74
Hired labor during	Aug.	"	--	--	--	81
	Sep.	"	--	--	--	150
	Nov.	"	--	--	--	96
	Feb.	"	171	171	--	156
Hired bullock pairs during	May	"	--	--	--	46
	June	"	1	1	--	37
	Sep.	"	--	--	18	100
	Oct.	"	--	--	--	36

*Water rate and interest charged.

Evaluation of program alternatives. The net benefit estimates with respect to the three program alternatives, assuming that all the farmers utilize the programs, are shown in Table 30. Unlike in the previous analysis where the credit program yielded the highest net benefit, in this case the irrigation program shows the highest possible net benefit possibilities. But the additional area to be irrigated under this program possibility is small, only 20 percent of that under the previous analysis. When irrigation and credit are provided together, the additional area to be irrigated is the same; but this program would result in costs to the agency that are higher than the net income to farmers by Rs. 1,440,177. The sacrifice involved when the credit program alternative is substituted for the irrigation alternative would be Rs. 1,945,568.

Evaluation of program alternatives when only some farmers utilize the program. Table 31 shows the net benefit estimates assuming that 10 percent of the farmers in Group A, 15 percent in Group B and 20 percent in Group C would utilize the program alternatives within the period planned for. The relative order of the program alternatives does not change in this case. But it could be different if the proportions of farmers responding were different.

Evaluation of program alternatives when different proportions of farmers respond to different alternatives. Another possibility that can arise is that different proportions of farmers from each of the three groups could respond to the different program alternatives. Thus, in

TABLE 30

BENEFIT-COST ESTIMATES OF DIFFERENT PROGRAM ALTERNATIVES WHEN ALL FARMERS ADOPT, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Items		Program Alternatives		
		Irrigation	Credit	Irrigation and Credit
Total benefit to the clientele	(Rupees)	14,674,920	16,657,215	24,899,272
Additional irrigable land required	(Acres)	2,106	--	19,477
Additional capital required	(Rupees)	--	4,980,863	16,400,949
Total cost of the program	"	1,053,000	4,980,863	26,139,449
Net benefit from the program	"	13,621,920	11,676,352	-1,440,177

*Water rate and interest charged.

TABLE 31

BENEFIT-COST ESTIMATES OF DIFFERENT PROGRAM ALTERNATIVES WHEN LIMITED PROPORTIONS OF FARMERS ADOPT, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Items		Program Alternatives		
		Irrigation	Credit	Irrigation and Credit
Total benefit to the clientele	(Rupees)	2,076,579	2,612,676	3,834,761
Additional irrigable land required	(Acres)	223	--	2,856
Additional capital required	(Rupees)	--	811,247	2,570,616
Total cost of the program	"	111,500	811,247	3,998,616
Net benefit from the program	"	1,965,079	1,801,429	-163,855

*Water rate and interest charged.

Group A 5 percent could utilize irrigation, 30 percent utilize credit and 10 percent both together, in Group B 10 percent utilize irrigation, 20 percent credit and 20 percent both together, and in Group C 10 percent utilize irrigation, 20 percent credit and 30 percent both together. The estimates of net benefits from the three program alternatives in that case are presented in Table 32. The credit program alternative yields the highest possible net benefit in this case. The sacrifice in net benefit if irrigation is substituted for credit is Rs. 1,494,379. Also, this alternative will involve only 117 acres to be additionally irrigated and does not benefit Type C farms. If irrigation and credit are combined, the costs exceed the net income to farmers by Rs. 389,064.

Optimal program design. Again for the optimal program design for the agency, it will be necessary to consider this net benefit vector, the resource requirement matrix for the program alternatives, the resources vector of the agency and its objectives. The only difference, as compared with the preceding analysis is the net benefit vector.

Relevance of costs considered. An important question that arises here is whether it is reasonable to charge the entire monetary requirements of the program alternatives in estimating their cost. Most of the investment in creating irrigation potential is recovered over a period of time, say 10 to 20 years, usually in the form of water charges and the like. Similarly, the production credit made available to farmers is recovered over comparatively short periods, say two or three years. So it can be contended that only the interest and service charges must be

TABLE 32

BENEFIT-COST ESTIMATES OF DIFFERENT PROGRAM ALTERNATIVES WHEN DIFFERENT PROPORTIONS OF FARMERS ADOPT, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT*

Items		Program Alternatives		
		Irrigation	Credit	Irrigation and Credit
Total benefit to the clientele	(Rupees)	1,243,499	3,769,622	5,181,690
Additional irrigable land required	(Acres)	117	--	4,163
Additional operating capital required	(Rupees)	--	1,090,244	3,489,254
Total cost of the program	"	58,500	1,090,244	5,570,754
Net benefit from the program	"	1,184,999	2,679,378	-389,064

*Water rate and interest charged.

considered when estimating costs of the program alternatives. This would be true over a long period of time. However, the agency has at its disposal a limited appropriation of funds over a short period, say one or five years, which appears in its vector of constraints, that it has to allocate among program alternatives in such a manner as to maximize its objectives. Under these circumstances it might be more reasonable to consider total costs rather than interest and service charges alone. Hence, the answer depends upon the circumstances or assumptions that are relevant to the situation under consideration.

The Use of Principal Components Analysis in Setting Up Representative Farms

Homogeneity is important when an aggregative procedure is involved. In some circumstances the use of the most critical resource may not be appropriate. This may be because there is not one most critical resource with respect to which all farms in the area could be classified. When more than one resource is involved, it may involve setting up too many representative farms. For these and possibly other reasons it might be advisable to use an approach to grouping farms that considers most of the variables involved. Principal components analysis is one approach that can be used for the purpose, as discussed in Chapter III.

Application of this approach using the five resources resulted in arrays based on three principal components. The farms have been divided into three groups--P, Q and R--based on the first principal component that explained 44 percent of the total variance. The appropriateness

of this grouping has been tested by discriminate analysis, also discussed in Chapter III. The F values obtained are the following:

1. Between Group P and Group Q, F = 22.96.
2. Between Group P and Group R, F = 37.81.
3. Between Group Q and Group R, F = 13.78.

The table F at 1 percent is 3.61 (degree of freedom 5 and 3). Hence, the differences are highly significant. But the analysis also indicates one member in Group P has greater probability of belonging to Group Q and two members in Group Q belong to Group R. After these changes are made, there are 12 farms in Group P, 22 farms in Group Q and six farms in Group R. It is interesting to note that each group contains farms of different sizes. Representative farms have been set up for these three groups and Table 33 shows the resources in respect to the three groups. The difference in area of total land is relatively little.

Another difference here, from the earlier analysis, is that an attempt has been made to make labor and bullock pairs available for hire more realistic. It is true that considerably more of them has been considered as available than in the earlier analysis. But this is not available at all times of the year and under pressure of development it is bound to be much less. Hence, the estimates included here may be more realistic. Also, since the groups are no longer based on size, the same quantities are assumed to be available to all the farmers. Therefore, the plans for the farms are no longer comparable with those of earlier analyses.

TABLE 33

THE RESOURCES OF REPRESENTATIVE FARMS P, Q AND R, FORTY FARMS, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT

Resource		Representative Farm P (12 farms)	Q (22 farms)	R (6 farms)
Total land	(Acres)	5.63	6.16	8.83
Land developed for irrigation	"	0.88	2.52	4.83
Operating capital	(Rupees)	716	1,055	1,417
Family labor per month	(Hours)	320	620	360
Owned bullock pairs per month	"	100	160	140
Hired labor per month	"	20	20	20
Hired bullock pairs per month	"	10	10	10

Results When Groups Are Based on Principal Component Analysis

Optimal plans and additional resource requirements for Representative Farm P. The optimum plans and additional resources needed for Farm P under different program alternatives are shown in Table 34. The main difference that is visible as compared to earlier analysis is that many more activities are involved and the tendency to specialize is absent. This is probably due to a large extent to the fact that labor and bullock pairs available for hiring are less here. The differences in the possible increase in net returns are appreciable.

Optimal plans and additional resource requirements for Representative Farm Q. Table 35 presents the optimum plans and additional resources needed for Farm Q. The number of activities that appear is not as large here as in the case of Farm P. But here too there is no tendency to specialize and again considerable differences in the net returns are also observed under different program alternatives.

Optimal plans and additional resource requirements for Representative Farm R. The optimal plans and additional resources needed for Farm R with respect to the different program alternatives are shown in Table 36. Here again there is diversity of crops. But a significant difference is that here irrigation alone does not come out as an alternative.

Evaluation of program alternatives. The number of farmers of the different types have been estimated using the proportions. The total number of farmers in the distributory is 14,443. Forty farmers out of

TABLE 34

OPTIMAL PLANS AND ADDITIONAL RESOURCE REQUIREMENTS FOR REPRESENTATIVE FARM P, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT

Activities, Net Returns and Additional Resources		Program Alternatives			
		Current Conditions	Irrigation	Credit	Irrigation and Credit
Dry cotton	(Acres)	3.46	4.29	--	--
Dry jowar	"	1.29	--	4.75	--
Irrigated paddy	"	0.23	0.58	--	0.50
Irrigated jowar (kharif)	"	--	--	--	0.75
Irrigated cotton	"	--	0.77	--	1.01
Irrigated wheat	"	--	--	--	1.28
Irrigated bajra and wheat	"	--	--	0.88	2.09
Irrigated bajra and safflower	"	0.65	--	--	--
Total net returns	(Rupees)	2,055	2,123	2,208	3,636
Additional irrigable land	(Acres)	--	0.46	--	4.75
Borrowed capital	(Rupees)	--	--	375	2,214
Hired labor during Sep.	(Hours)	--	--	--	14
Hired labor during Nov.	"	--	--	--	20
Hired labor during Feb.	"	--	--	--	20
Hired bullock pairs during June	"	--	4	--	10
Hired bullock pairs during Sep.	"	--	--	--	10

TABLE 35

OPTIMAL PLANS AND ADDITIONAL RESOURCE REQUIREMENTS FOR REPRESENTATIVE FARM Q, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT

Activities, Net Returns and Additional Resources		Program Alternatives			
		Current Conditions	Irrigation	Credit	Irrigation and Credit
Dry cotton	(Acres)	3.64	2.90	--	--
Dry jowar	"	--	--	3.64	--
Irrigated paddy	"	--	--	--	1.49
Irrigated cotton	"	1.29	3.26	--	0.49
Irrigated bajra and wheat	"	--	--	2.52	4.18
Irrigated bajra and safflower	"	1.23	--	--	--
Total net returns	(Rupees)	2,965	3,083	3,359	4,824
Additional irrigable land	(Acres)	--	0.74	--	3.64
Borrowed capital	(Rupees)	--	--	938	2,628
Hired bullock pairs during May	(Hours)	--	--	--	10
Hired bullock pairs during Sep.	"	--	--	--	10

TABLE 36

OPTIMAL PLANS AND ADDITIONAL RESOURCE REQUIREMENTS FOR REPRESENTATIVE FARM R, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT

Activities, Net Returns and Additional Resources		Program Alternatives			
		Current Conditions	Irrigation	Credit	Irrigation and Credit
Dry jowar	(Acres)	--	--	2.73	1.50
Dry safflower	"	2.15	2.15	--	--
Irrigated paddy	"	2.07	2.07	0.78	0.17
Irrigated jowar (kharif)	"	--	--	0.47	2.22
Irrigated cotton	"	0.89	0.89	--	--
Irrigated wheat	"	--	--	0.74	3.12
Irrigated safflower	"	1.74	1.74	--	--
Irrigated bajra and wheat	"	--	--	2.84	1.37
Total net returns	(Rupees)	3,777	3,777	4,600	4,661
Additional irrigable land	(Acres)	--	--	--	2.05
Borrowed capital	(Rupees)	--	--	1,444	1,703
Hired labor during July	(Hours)	--	--	20	20
Hired labor during Aug.	"	--	--	20	--
Hired labor during Sep.	"	--	--	13	20
Hired labor during Oct.	"	--	--	--	20
Hired labor during Nov.	"	--	--	17	20
Hired labor during Feb.	"	20	20	20	20
Hired bullock pairs during June	"	5	5	--	--
Hired bullock pairs during Sep.	"	--	--	10	--

Cashdollar's sample of 116 are small farmers. Hence, the number of small viable farmers in the area is estimated to be 4,903. These have been divided into the three groups on the basis of the number of members in each group. Thus, it is estimated that there are 1,471 farmers of type P, 2,967 farmers of type Q and 736 farmers of type R. The benefit-cost estimation of the program alternatives is presented in Table 37. Irrigation comes out as with higher net benefit possibilities than credit and the benefit when two are combined is low.

The Use of Factor Analysis in Setting Up Representative Farms

Another approach to grouping farms is that of factor analysis, which has also been discussed in Chapter III. Use of this approach to cluster the five resources themselves results in grouping total land, land developed for irrigation currently and operating capital available into one group and family labor and bullock pairs owned into another. In the case of farmers the use of this approach makes it possible to divide them into two groups, say X and Y. When this grouping is tested using discriminate analysis, the F value turns out to be 12.76, while the table value is 4.42 (degrees of freedom 5, 34) at the 1.1 level. However, it showed that one farmer in Group Y has greater probability of belonging to Group X. When this shift is made, Group X has 21 members and Group Y has 19 members. The representative farms set up for these groups are presented in Table 38. Here also there is little difference in the size of farms between the two groups.

TABLE 37

BENEFIT-COST ESTIMATES OF DIFFERENT PROGRAM ALTERNATIVES WHEN FARMERS ARE GROUPED BY PRINCIPAL COMPONENTS ANALYSIS, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT

Items		Program Alternatives		
		Irrigation	Credit	Irrigation and Credit
Total benefit to the clientele	(Rupees)	14,217,656	15,692,791	21,789,380
Additional irrigable land required	(Acres)	2,672	--	18,313
Additional operating capital required	(Rupees)	--	4,144,195	11,597,918
Total cost of the program	"	1,336,000	4,144,195	20,754,418
Net benefit from the program	"	12,881,656	11,548,596	1,034,962

TABLE 38

THE RESOURCE PICTURE OF REPRESENTATIVE FARMS X AND Y, FORTY FARMERS, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT

Resource		Representative Farm X (21 farms)	Representative Farm Y (19 farms)
Total land	(Acres)	6.45	6.37
Land developed for irrigation	"	2.38	3.21
Operating capital	(Rupees)	788	1,271
Family labor per month	(Hours)	540	460
Owned bullock pairs per month	"	140	160
Hired labor per month	"	20	20
Hired bullock pairs per month	"	10	10

Results When Groups Are Based on Factor Analysis

Optimal plans and additional resource requirements for Representative Farm X. Table 39 presents the optimum plans for the different program alternatives and the additional resources that are needed. The plans show diversity in activities and appreciable differences in net returns for different alternatives.

Optimal plans and additional resource requirements for Representative Farm Y. The optimal plans and requirements of additional resources for Representative Farm Y under the three program alternatives are shown in Table 40. The picture is similar to that for Farm X in respect to diversity of crops and differences in possible net returns.

Evaluation of program alternatives. The numbers of farmers of the two types are estimated, using the same procedure as in the evaluation based on principal components analysis, to be 2,574 for type X and 2,329 for type Y. The benefit-cost estimates for the three program alternatives are shown in Table 41. The net benefit estimates, as well as the ranking of the alternatives, are reasonably the same as when principal components analysis is used for grouping farms.

TABLE 39

OPTIMAL PLANS AND ADDITIONAL RESOURCE REQUIREMENTS FOR REPRESENTATIVE FARM X, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT

Activities, Net Returns and Additional Resources		Program Alternatives			
		Current Conditions	Irrigation	Credit	Irrigation and Credit
Dry cotton	(Acres)	4.07	4.07	--	--
Dry jowar	"	--	--	4.07	--
Irrigated paddy	"	--	--	--	1.68
Irrigated cotton	"	1.29	1.29	0.89	0.59
Irrigated wheat	"	--	--	--	0.86
Irrigated safflower	"	1.10	1.10	--	--
Irrigated bajra and wheat	"	--	--	1.49	3.32
Total net returns	(Rupees)	2,596	2,596	3,110	4,672
Additional irrigable land	(Acres)	--	--	--	4.07
Borrowed capital	(Rupees)	--	--	902	2,871
Hired bullock pairs during May	(Hours)	--	--	10	10
Hired bullock pairs during June	"	--	--	--	10
Hired bullock pairs during Sep.	"	--	--	--	10

TABLE 40

OPTIMAL PLANS AND ADDITIONAL RESOURCE REQUIREMENTS FOR REPRESENTATIVE FARM Y, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT

Activities, Net Returns and Additional Resources		Program Alternatives			
		Current Conditions	Irrigation	Credit	Irrigation and Credit
Dry cotton	(Acres)	3.16	--	--	--
Dry jowar	"	--	--	3.16	--
Irrigated paddy	"	0.48	0.94	--	1.10
Irrigated cotton	"	1.29	2.93	--	1.20
Irrigated bajra and wheat	"	--	--	3.21	4.07
Irrigated bajra and safflower	"	1.45	--	--	--
Total net returns	(Rupees)	3,396	3,485	3,863	5,029
Additional irrigable land	(Acres)	--	0.66	--	3.16
Borrowed capital	(Rupees)	--	--	1,082	2,300
Hired labor during Aug.	(Hours)	--	--	--	5
Hired bullock pairs during June	"	--	--	--	1
Hired bullock pairs during Sep.	"	--	--	--	10

TABLE 41

BENEFIT-COST ESTIMATES OF DIFFERENT PROGRAM ALTERNATIVES WHEN FARMS ARE GROUPED BY FACTOR ANALYSIS, FORTIETH DISTRIBUTORY, TUNGABHADRA PROJECT

Items		Program Alternatives		
		Irrigation	Credit	Irrigation and Credit
Total benefit to the clientele	(Rupees)	14,798,669	17,002,067	23,738,269
Additional irrigable land required	(Acres)	1,537	--	17,836
Additional capital required	(Rupees)	--	4,841,726	12,746,654
Total cost of the program	"	768,500	4,841,726	21,664,654
Net benefit from the program	"	14,030,169	12,160,341	2,073,615

CRANES CREST

CHAPTER V

IMPLICATIONS FOR THE SFDA AND SOME POSSIBLE REFINEMENTS

The purpose of this chapter is to diagnose the particular kinds of information, the approaches to their collection, and the institutional setup that are appropriate in the context of the SFDA. An essential part of the approach suggested in Chapter III is the use of farm level information in gauging potential and likely results of program alternatives during program design. This is equally applicable to (a) a "synoptic" evaluation approach where the program alternatives are all evaluated simultaneously or (b) an "incremental" evaluation approach, where the comparison of one program alternative or mix is made against another already evaluated.

The approach suggested can be divided into two essential components:

1. The mathematical and empirical procedures, such as budgeting or linear programming and aggregation, used for evaluation.
2. The information used in applying the procedure empirically.

The question of which of the two is more important has been raised again and again. There is always a procedure that is appropriate and one that is not. There is also a procedure that is more or less appropriate than another. But whether it is used will also depend upon the trained personnel, facilities and funds available. But in the situation in which

the SFDA will be operating the data will be the more critical.[1] For a sophisticated procedure will fail to yield reliable results unless the information used is relevant to the situation analyzed and sufficiently reliable. In this case, the relevance is to be judged with respect to the clientele, for in the final analysis a development program will fail unless it is acceptable to the clientele.[2]

Types of Information Needs

To utilize the procedure suggested here for program design the SFDA needs the following types of information:

1. Farm level input-output information or technical coefficients. This information with respect to all enterprises at present found in the area and those that would be possible needs to be obtained. This can then be divided into three groups:

(a) Enterprises and practices that already exist in the area to a substantial degree. With respect to these, the necessary information is available with the farmers and needs to be collected.

(b) New enterprises or technologies that are proposed to be introduced newly, but have been adopted in similar areas. The required information can then be collected from farmers

---

[1] This is a personal observation.

[2] It is not implied that the benefit to the clientele is the only criterion in selecting the program for development. National and agency objectives also need to be considered. However, an agency like the SFDA needs to emphasize the clientele in its program design.

in these other areas and used as a basis, along with professional judgment, for estimating likely local farmer results.

(c) New enterprises and technologies that are proposed to be introduced newly, but have not been adopted in similar conditions. These might have been adopted in other parts of the country, as in Hyderabad or Punjab with reference to the SFDA districts in Mysore, or in other counties. Localized information from experiment stations and field trials may be all that is available. In such cases the only alternative, beyond relying on professional judgment, is to obtain estimates from local farmers themselves about the input requirements and production results that they believe would be applicable to the conditions under which they operate. This, in part, involves ascertaining the subjective discounts that the farmers of the area would apply to untried changes. In other words, it is necessary to learn about the farmers' own expectations. This probably entails a survey of farmers to ascertain their reactions and opinions. One way to do this is to develop general estimates of the discounts that farmers apply to research information untried by them. Another would be to ascertain their expectations with respect to the specific enterprise or technology being proposed. If time and resources of the SFDA permit, some "cooperating farmers" could be persuaded to try the new practices and enterprises and information collected from them.

2. The resources available to the farmers. This is basically a matter of making the inventory of the farm resources. However, this inventory should include not only resources owned by the farmer or readily available with him but also those that the farmer can obtain under normal circumstances. The latter is somewhat more difficult to ascertain than the former.

3. The goals and interests of the farmers. It would be safe to assume that profit maximization is the basic goal of most farmers. However, they may have other objectives, such as minimizing cash expenses or maintaining high equity, which place limitations on the basic objective. Or desire to grow their own food and cattle feed requirements, and diversification to reduce risks, may modify the basic objective. They may have certain cultural or religious inhibitions that make some enterprises that maximize profit unacceptable. Information on goals and interests is difficult to obtain since at times it does not become apparent when direct questions are asked, but must be drawn out by indirect approaches.

4. The distribution of farms. Reliable information on the size distribution of farms is essential for aggregation, which is an important component of the approach. This information is also useful if the sample survey approach is used for data collection. This is the only type of information, among the five types listed here, that may be available currently on a widespread basis in the SFDA districts in Mysore State.

5. Agency resource requirement and constraints. Estimates of the demands that different program alternatives make on SFDA resources,

such as technical and trained personnel, services, material resources, machinery, time and funds, are essential for the third stage in the procedure. When some of these programs have already been tried in the district or in similar circumstances elsewhere, these estimates could be made with comparative ease. But when new alternatives are involved, the collection of this information may be difficult and time consuming, and may even require pilot studies if they are to be reasonably reliable. It is also necessary to make an inventory of the resource constraints within which the agency has to operate. This is especially a complicated situation when the SFDA has to operate through other development agencies and organizations that already exist, but does not have line authority over them.

Data Collection by SFDA

Possible methods for data collection depend upon the trained personnel available for the purpose, the periodicity of data collection, and the time and funds that are available for this purpose. Here again the approaches that can be adopted involve a continuum as discussed in Chapter III. Quantity and precision need to be balanced against facilities and expense necessary. Some possible points on the continuum are pointed out below:

1. Subjective methods. Estimates can be made by experienced personnel on the basis of information already available, such as experimental information and data published by existing agencies such as the Department of Economics and Statistics, marketing bodies and Revenue Department. It is possible that inquiries and opinions of strategically

placed people can be utilized to confirm and modify the information. This approach is especially suitable when data are required at one time or occasionally, and it is not feasible or economical to set up a separate machinery to generate it. This method is reasonably fast and cheap. However, it is fraught with dangers of being unrealistic or wrong, though not necessarily so.

2. Objective methods. These would utilize statistical procedures to make the collection of information objective to the extent possible. The first step would use randomized samples to obtain information, especially with respect to farmer production coefficients, resource information and objectives and interests. These samples could be stratified or not, depending upon the a priori knowledge of the clientele. If a stratified sample is to be used, it is necessary to decide whether to use an unweighted stratified sample or proportionate sample, etc. It is not proposed to go into the characteristics and advantages of these procedures at this point.

The collection of the information itself can be made by personal interviews or by the use of mailed questionnaires. From the point of view of the SFDA it might be more appropriate to use personal interviews since many farmers are illiterate and do not maintain records and may not be able to give the type of information required.[3]

Finally, there are two methods which can be used to collect information by personal interview. The first is to obtain information

---

[3]This observation is based on personal experience.

all at one time, usually by a single interview, at times called the "survey method". The second is to visit the farmers periodically and note operations as they are made, at times designated as the "cost-accounting method". The latter is more useful when the farmers do not maintain records and are unable to give reliable information regarding the past. It is also more time consuming and expensive. Hence, it might be useful only when it is proposed to collect information on a continuous basis. In general, "objective methods" make heavier demands on personnel, time and money. They would be indicated only when advantages over the "subjective methods" in accuracy are considerable.

3. Use of purposive samples. This is, in a manner of speaking, a compromise over the above two. While the sample is selected on the basis of experience and a priori knowledge of the farmers in the area and can be made to suit the convenience and resources available with the agency, the information is collected by direct approach to the farmers. This can be planned to yield reasonably representative information at considerably less cost than the objective method.

4. Use of farmer reporting panels. This method makes considerably less demands on personnel, time and funds than the use of the "objective" or "purposive samples" methods and yet can yield comparably reliable information. The panels can be set up either by random sampling or purposive selection. Usually, however, purposive sampling is more convenient since the willingness to report is important. From the point of view of the SFDA this approach may be expected to be relatively unfeasible considering that most of the farmers that it would be

expected to be concerned with may not be able to furnish information periodically by mail due to problems such as insufficient literacy.

Levels of Analysis and Personnel Requirements

The SFDA, or any development agency for that matter, is always faced with the problem of allocating its total resources between program analysis and the programs themselves. In other words, the less it spends on program design the more it has to spend on the programs and their implementation. On the other hand, if it spends too little on program analysis, it might come up with programs that are not very beneficial and therefore end up not making the best use of its resources. So, again, the decision has to be made in a continuum that lies between simplicity and cheapness at one end and complexity and high cost at the other. In the final analysis, this involves trade off between refinement and cost.

The idea of refinement has three dimensions:

1. Refinement in procedures used. This involves the use of budgeting or linear programming or more sophisticated procedures discussed in Chapter VI.

2. Refinement in collecting information collected at present. This involves the use of procedures that increase the accuracy and reliability of these data.

3. Collection of additional types of information. This involves data that will increase the reliability of the analytical procedures used.

To tie the preceding notions together and to bring out the demands that program analysis would make on SFDA personnel and funds, the following three illustrative levels of refinement are useful:

1. A Short-Cut Approach. Simple budgeting procedure can be used to evaluate program alternatives using the information already available from sources such as the University of Agricultural Sciences and the Department of Agriculture, the Department of Economics and Statistics, the Marketing Service, and the Department of Revenue, supplemented where necessary by estimates made in consultation with research and extension personnel as well as farmers selectively. Thus, farm size could be used to classify farms since it is generally available from existing sources. Enterprise budgets could be prepared by a judicious combination of research results and farmer experience. The resource information as well as the farmer goals and interests can be set up by consultation with a few selected farmers. This would involve essentially a few consultations with research and extension personnel as well as farmers. It might even be possible to treat the entire spectrum of small viable farmers as a single group in order to reduce computational work. It might even be possible to use partial budgeting to compare some of the alternatives once basic program alternatives have been evaluated using total budgeting technique. This procedure will no doubt give rise to bias and inaccuracy, but may be the best possible under some conditions.

This level of program analysis will make comparatively little demand on the SFDA in terms of personnel, funds and facilities. The services of a Farm Management Specialist, already included in the

staff plans for most SFDA districts, along with those of a Computational Assistant may suffice. There would be little demand on the other facilities and funds. Hence, the requirements of personnel and cost to the agency would be as below:

	Farm Management Specialist	Computational Assistant
Number of posts (no.)	1	1
Salary scale (Rupees)	300-700	110-220
Average monthly salary (Rupees)	500	150
Total annual salary (Rupees)	6,000	1,800
Dearness allowance per month (Rupees) (cost of living adjustment)	146	122
Dearness allowance per year (Rupees)	1,752	1,464
Other allowances per year (Rupees)	584	144
Travel expenses per year (Rupees)	300	---
Total expenses per year (Rupees)	8,636	3,408
Total annual cost on staff (Rupees)	12,044	

2. A Via-Media Approach. Budgeting procedures could be used here as well to evaluate program alternatives. However, more refined methods could be adopted in collecting information. The farmers could be stratified on the basis of information available on an area operated, assuming that land is the most critical resource to start with. The input-output information, data on resource constraints and the goals and interests of the farmers could then be collected from purposively selected samples of farmers from each of these strata. This information

may have to be collected annually so that changes that take place are incorporated. Personal interviews will be the only feasible approach to data collection from farmers under the present conditions that exist in the SFDA districts.[4] However, in the future the use of farmer reporting panels is conceivable.

This level of program analysis will naturally call for more SFDA personnel and funds than the short-cut approach. And it would probably take more time. But it does appear to be a reasonable level of refinement to strive toward in the present Mysore context. A possible staff pattern for this would be as below:

	Farm Management Specialist	Farm Management Assistants	Computational Assistants
Number of posts (no.)	1	3	1
Salary scale (Rupees)	300-700	275-500	110-220
Average monthly salary (Rupees)	500	400	150
Total annual salary (Rupees)	6,000	14,400	1,800
Dearness allowance per month (Rupees) (cost of living adjustment)	146	146	122
Dearness allowance per year (Rupees)	1,752	5,256	1,464
Other allowances per year (Rupees)	584	702	144
Travel expenses per year (Rupees)	300	600	---
Total expenses per year (Rupees)	8,636	20,958	3,408
Total annual cost on staff (Rupees)		33,002	

[4] A questionnaire that may be useful for collecting data is presented in the Appendix. Under some conditions it may be necessary to refine questions to obtain information on farmer discounts, goals and interests.

Here again there would not be too much of other expense. A calculator and an adding machine will be required. Some provision will also need to be made for incidental expenditure such as on paper and printing of questionnaires, forms and records.

3. A Sophisticated Approach. This would involve all the three types of refinement discussed earlier. The basic approach to data collection would be stratified random sampling using personal interviews. The stratification may be made on the basis of such factors as the most critical resource or family income. This may call for a pilot survey to gather basic information for this purpose. Once the data on the production relationships, farmer resources, goals, and interests are collected, representative farms may be set up using linear programming to select the most suitable resource as discussed in Chapter III, or using the grouping procedures such as principal component analysis or factor analysis and clustering dealt with in Chapters III and IV. The three-stage program evaluation approach proposed in Chapter III and partially applied in Chapter IV would be used to obtain the optimal program design. This process will have to be repeated, probably, every year and data collection will have to be done on a continuous basis. This approach will yield results that have a relatively high accuracy and precision. It has a comparatively high probability that the program decisions will be sound, but it does not necessarily ensure infallibility. In fact, its reliability will largely depend upon the competence and earnestness as well as the technical knowledge and skill of the personnel involved.

This level of analysis makes relatively heavy demands on the resources of the SFDA, demands which the agencies may not be in a position to meet under the current conditions. A suitable pattern is proposed below:

	Farm Management Specialist	Farm Management Assistants	Computational Assistants
Number of posts (no.)	1	9	2
Salary scale (Rupees)	300-700	275-500	110-220
Average monthly salary (Rupees)	500	400	150
Total annual salary (Rupees)	6,000	36,000	3,600
Dearness allowance per month (Rupees) (cost of living adjustment)	146	146	122
Dearness allowance per year (Rupees)	1,752	15,768	2,928
Other allowances per year (Rupees)	584	2,106	288
Travel expenses per year (Rupees)	300	1,800	---
Total expenses per year (Rupees)	8,636	55,674	6,816
Total annual cost on staff (Rupees)		71,126	

Besides the staff, considerable funds will have to be provided for such items as computer time, three calculators, two adding machines, printing of questionnaires forms and records and other supplies. It may also be necessary to provide a jeep for the use of the staff.

It is possible to consider levels of analysis that are in between those proposed above. And, as pointed out earlier, there is an even more refined level where simulation techniques can be used. This is discussed in greater detail in Chapter VI. But at all times there will

be pulls in opposite directions--demand for refinement on the one hand and the pressure of costs on the other. Decisions on this then involve a trade off between the two. However, it must be always kept in mind that to sacrifice reliability to save expense will at some stage end in total loss since the unreliability of the results may render the money spent on programs themselves a waste more or less. On the other hand, it may be possible that overinvestment in analytical machinery may fail to add appreciably to the reliability of programs designed, especially if data collection is not accurate.

CRANES CREST

CHAPTER VI

POSSIBILITIES FOR FURTHER REFINEMENTS

The analysis presented in the earlier chapter is essentially static. However, the milieu in which development takes place is dynamic. Development action programs affect not only the farmers who participate but also the agricultural industry and the entire economy. The more widely accepted the program the more drastic and far reaching these changes tend to be. The time span involved is also a relevant consideration. These effects enter into the SFDA planning picture mainly in the following ways:

1. The products supply situation. The supply of the commodities being promoted by the program tends to increase. At the same time, production of some commodities drops since the resources are limited. Thus, an increase in the production of bajra may tend to decrease the production of some other cereal crop, and an increase in the production of cotton may result in a reduction in the production of a food crop. This may affect the prices of these commodities. This in turn may cause a change in the demand since farmers and local people may change their consumption pattern. It may be useful here to distinguish between two types of commodities.

   a. The commodities that prices would be significantly affected by district level or regional level changes.

   b. The commodities that are tied in with national and international price formation forces.

The changes probably come about sooner in the case of the farmer and may also be of greater magnitude.

2. The factor demand situation. Agricultural development tends to increase both the absolute and the relative demand for production factors. This will be so in the case of most factors, all except those that are highly specialized to use in the production of substituted commodities. Those factors that are required in large quantities in the production of the important commodities involved in the programs tend to be demanded relatively more than others. This, initially at least, resulst in changes in the prices of the factors, increasing the price of most and the prices of some more than others.

Commodity and factor price changes make it necessary to alter the budgets used in farm level analysis. In the linear programming and aggregation it is usual to assume physical transformation rates, input cost, output prices and the like to be constant at all levels of aggregate production. But this is not true since aggregate production does affect costs and prices and finally the production of the firm.[1] They may even change the goals and interests of farmers over a period of time. Further, they may cause changes in the resource picture, especially capital and associated factors. This refers to the second and third levels of refinement in Figure 6, page 56, in Chapter III. It is obvious then that the evaluation of program alternatives made earlier may change as the program is implemented. If these changes are expected to

---

[1]Sharples, op. cit., p. 170.

be appreciable, the agency will need to take these into account while designing programs in the first place.

The problem arising from such aggregative effects may be reasonably handled by the SFDA if program design is reviewed and modified annually on the basis of budgets and other information collected or modified every year. However, it might result in a different program mix every year. For one thing, the farmers are forced to make decisions under conditions of relatively high uncertainty with respect to government policy and services. A certain amount of continuity in programs is essential to create an atmosphere conducive to response and acceptance. For another, it may not be feasible to summarily drop programs with projects that are essentially long term in character, such as major irrigation and other schemes which involve heavy permanent investment and training of specialized technicians. Thus, often it becomes imperative to evaluate program alternatives over relatively long periods of time.

A procedure that has some merit under these conditions is Sensitivity Analysis or Parametric Programming.[2] This is useful in estimating the possible effects on and the changes in the optimal plans that may result from changes in the profitability of enterprises, resource requirements and constraints. These estimates can be used to study how the expected changes will affect the evaluation of the program alternatives. This procedure is, however, subject to great limitations in its

---

[2]For information on the use of this procedure, refer to Richard H. Day, Linear Programming and Related Computation--A Guide to USDA LP/90 (Washington, D.C.: FPED/ERS, United States Department of Agriculture, 1964), pp. 24-44.

applicability to such situations. Only the effects of discrete predictable changes can be estimated. In other words, it is essential to forecast changes in advance, which may be difficult and cumbersome, not to say anything of the rather low probability of these estimates being realistic or appropriate in a rapidly changing agricultural setting.

A procedure that presents better possibilities in this situation is Recursive or Dynamic Programming.[3] Here the analysis is made over an extended period of time. The entire planning span is divided into a number of production periods, the output for each such period contributing to the input for the succeeding period. It is also possible to allow for time lags in the effects of the concerned variables. But this can account for the changes that come about internally, such as the changing resource situation, etc. It is difficult to accommodate changes that flow through the economy and back again. Thus, it would be difficult to account for changes in prices which arise not only from changes in supply of and demand for products caused by the response of the farmers to the program but also by the corresponding demand and supply of the consumers and producers in other places. Changes in prices and the like result not only out of the effects of agricultural development programs but also the effects of programs and actions in other sectors. They may even be the result of the laws and policies of government with respect to taxes, land ownership and the like. Education and sociocultural changes may also contribute to them. These changes cannot be easily brought into the recursive programming model suggested here.

---

[3] Ibid., pp. 51-71.

A related way to bring aggregative changes into account is to use recursive programming in combination with PERT-type network analysis. Such an approach has been applied by Goodwin et al.[4] to the assessment of regional farm adjustment prospects in the State of Andra Pradesh, India. They used it to obtain insights into the sporadic nature of economic development and marginal value productivities of limiting resources over time. But the programming component was treated at an aggregate level, the region as a whole and not individual farms. This approach considers the total resources of the region and therefore would be useful in studying the overall possibilities for development. But since it ignores the potentials of individual farms and the interfarm differences, it would be inappropriate for designing locally oriented programs, to say the least. The dangers of this type of approach to program planning have been discussed in detail in Chapter III.

A simpler form of the recursive programming model that would be meaningful in the context of the SFDA would be "repeated iterations". Briefly, this procedure would follow the line of analysis proposed for program design in Chapter III, forecasting the possible changes in farm budgets, resource constraints, etc., that are likely to take place. The first iteration would give an idea of the general magnitude of changes in area-wide production and input needs potentially forthcoming. This information, in turn, would form a basis for refined assumptions about prices and resource constraints at the representative farm level. The

---

[4]Joseph B. Goodwin, Melvin G. Blase and Dale Colyer, "A Development Planning Model for Technological Change in Agriculture," American Journal of Agricultural Economics, Vol. 52, 1970, pp. 81-90.

budgeting or linear programming and aggregation would then be repeated in the light of these refinements, and so on for perhaps several reiterations. Obviously this approach would be very cumbersome and time consuming and the results may or may not be realistic depending on whether the forecast of the likely changes were accurate or not.

Simulation is a procedure that has considerable application in a complex situation. It can take into account a variety of direct and indirect relationships permeating into the entire economy. The simulation model can incorporate various physical, biological, economic and sociocultural changes simultaneously. A simple application of this procedure will involve "thinking one's way through" a chain reaction by bringing in all the relevant influences. This could serve as a unifying "thread" to tie together bits and pieces of hard-core analysis and subjective judgment in the context of the SFDA. The essential elements of this approach are (a) it tries to incorporate all relevant variables and relationships and (b) it is attuned to predicting actual likely response rather than some highly abstract optimum. On the other hand,

> Computer simulation is a quantitative planning and decision-making tool which provides substantial capability for quick comprehensive policy analysis and program analysis.[5]

The major requirements of the use of the mathematical model include:

1. A large computer.
2. Trained personnel.

---

[5] M. L. Hayenga, T. J. Manetsch and A. N. Halter, "Computer Simulation as a Planning Tool in Developing Economies," Journal of Farm Economics, Vol. 50, 1968, pp. 1755-1759.

3. Information about the interrelationships within the economy.

The team at Michigan State University applied this procedure to evaluate broad policy alternatives in Nigeria (Africa).[6] Tyner and Tweeten[7] used it to study the possible effects of different farm policy alternatives on farm prices, labor use and cost of production. Shechter and Heady[8] used it to derive response surfaces for policy analysis.

The possibilities of the use of simulation in its mathematical form by the SFDA's are slim when the requirements listed above are taken into account. Not only are a computer and highly trained personnel required but a mass of information on a variety of relationships are necessary. In a developing economy, especially the last is very limited. And where objectively collected data are lacking, the alternative is to make use of subjective judgments. It goes without saying that the more the subjective pieces of information are used the less will be the probability of obtaining reasonably accurate results. Most SFDA's have at present lack of all the three requirements listed above. However, it might be useful to keep the data requirements of this model in mind

---

[6] A. N. Halter, M. L. Hayenga and T. J. Manetsch, "Simulating a Developing Agricultural Economy: Methodology and Planning Capability," American Journal of Agricultural Economics, Vol. 52, 1970, pp. 272-284.

[7] Fred H. Tyner and Luther G. Tweeten, "Simulation as a Method of Appraising Farm Programs," Journal of Farm Economics, Vol. 50, 1968, pp. 66-81.

[8] Mordechai Shechter and Earl O. Heady, "Response Surface Analysis and Simulation Models in Policy," American Journal of Agricultural Economics, Vol. 52, 1970, pp. 41-50.

while planning data collection while using currently the rather simpler "think through" approach discussed earlier.

CHAPTER VII

SUMMARY AND CONCLUSIONS

The concern of this dissertation was with the weaknesses in program design that might potentially result from the failure to take the input-output relationships, resource constraints and goals of small farmers into account adequately. It examined possible approaches and techniques for analyzing such farm situations and incorporating such analysis into the overall SFDA program planning process. The various components of the suggested approach were illustrated using data from a sample of small farms in the Tungabhadra Irrigation Project in Mysore State.

The main thesis was that the use of farm management information in program analysis can play a major role in eliminating some of the possible reasons why small farmers do not respond to development programs to an appreciable extent. These were diagnosed to include:

1. The absence of sufficient incentives oriented to the goals of small farmers.
2. The failure of program content and farmer interest meshing together to a sufficient degree.
3. The program expectations being unrealistic to the farmers because they are not based on farmer experience.
4. The differences between the risk estimates of the farmers and those implicit in the data used by program planners.

5. The rigidities that arise out of planning at the state or regional level which results in ignoring differences that exist between areas and farms with respect to factor-product, product-product and factor-factor relationships as well as prices and institutional factors.

The suggested approach to program analysis made use of not only farm survey information but also micro-level analytical procedures--budgeting or linear programming. The approach proposed and illustrated in this study included:

Stage I. The application of budgeting or linear programming to representative farms to obtain plans, considering technical coefficients, resources and objectives of the farmers, under program alternatives approximated by relaxing constraints suitably.

Stage II. Aggregation of the results of the optimal plans to estimate the total benefit to the clientele and the cost to the agency of the program alternatives, from which the possible net benefit from each alternative can be evaluated.

Stage III. The application of budgeting or linear programming to the agency situation, considering the net benefits and resource requirements of the program alternatives and the resource constraints and objectives of the agency, to obtain an optimal program plan.

Data collected by Cashdollar in the fortieth distributory of the Tungabhadra Irrigation Project in Mysore State were used. From his sample of 116 farmers, 40 who operated over 2.5 acres and up to 10 acres were selected for the empirical application of the above approach.

These were initially divided into three size groups and representative farms set up. For each of these farms linear programming procedure was used to estimate the most profitable product mixes, and input needs pertaining to them, likely to result from additional credit and/or irrigation made available through the SFDA. These results were then aggregated to provide estimates of the potential net benefit and resource use at the area level for each of the program alternatives.

The empirical application of the approach to the Tungabhadra situation brought out several useful insights:

1. The linear programming procedure in Stage I showed that the farmer constraints are irrigated land and operating capital. Each comes to the forefront as the other is augmented. Labor, on the other hand, is not much of a constraining resource, except where considerable land area is available and irrigation and credit are provided simultaneously.

2. The analysis also demonstrated that it can be important to identify and measure constraints carefully. Otherwise a simplistic plan that specializes in a single crop results when irrigation and/or credit are augmented. Such constraints would include, among others, fertilizer availability, limitations on labor at certain times, limits on hired labor, minimum or maximum limits on certain crops like food grains.

3. The aggregation in Stage II emphasized the possibility that the comparative program payoffs could be different when the proportion of farmers adopting each program alternative differ in different groups. Hence, a careful assessment of this aspect is important while applying this procedure.

Homogeneity is important in setting up representative farms for purposes of aggregation. The use of two additional approaches, other than the basis of the most critical resource, was investigated and illustrated. They were:

1. Principal component analysis which resulted in grouping the farmers into three groups.
2. Factor analysis which resulted in grouping the farmers into two groups.

The main point brought out was that the approach used to classify farms makes considerable difference even in the case of small farmers, who would be generally considered fairly homogeneous. The different procedures resulted in not only different groups but also differences in the evaluation of the farms.

The empirical application of the proposed approach to program planning also showed capabilities of yielding such information as estimates of unutilized resources (which may be useful in planning programs for small industries and the like) and estimates of sacrifices involved in yielding to political expediency.

The implications of this approach to program design that were brought out pertained mainly to data requirements. These included:

1. Input-output information that is applicable to the conditions under which farmers operate. This needs to be based on farmer experience rather than research results. In the case of technology or enterprises that are new to the area, where the use of research data is inevitable, it is necessary to consider the "discounts" that farmers

apply to such information because of their response to risks and similar considerations.

2. Information on the goals and interests of the farmers. This would include not only the objectives of the farmers, but also the constraints placed on them by socioeconomic, cultural, psychological and other factors.

3. Information on the resources available to the farmers. This should cover not only resources owned by the farmers, but also those that they can borrow, hire or exchange.

4. Information on the distribution of farms which is essential for purposes of sampling and aggregation.

5. Information on the resource requirements of programs and those available with the agency. The costs of program services need to be assessed carefully.

A general observation that can be made is that the data available are skimpy and not always reliable. There is then need to move toward:

1. Improvement in the present procedures of data collection to make information gathered more reliable. Proper survey methods, sampling procedures and even the use of better trained personnel may be indicated.

2. Increase in the quantity of information gathered. Such would be the need to gather information on resources in more detail, rather than broad categories of land, labor and capital.

3. Collection of new information, such as on more enterprises, technological levels and goals and interests.

Three alternative levels of analysis were suggested for SFDA use, depending on considerations of precision and cost.

1. A short-cut approach, where most information is prepared on a subjective basis, with experience and judgment playing a major part, and budgeting is used.

2. A midway approach, where subjective judgment and objective or survey type procedures are used in collecting data and budgeting is used for analysis.

3. A sophisticated approach, where statistically refined tools such as randomized sampling are used in the collection of information and linear programming is used for program analysis. Suitable staff patterns for these three approaches were suggested and their monetary requirements investigated.

Many researchers have questioned, on one ground or another, the appropriateness of the aggregative procedure to obtain macro-level estimates. This is probably more or less valid when the analysis is used for predictive purposes, as in commodity supply analysis, and the results used for policy decisions. This is to be borne in mind when the estimates of agency service requirements, unutilized resources, etc., are to be used directly. However, the essential use of aggregation in this approach is more ordinal than cardinal in nature. It is similar to indifference curve analysis. It attempts to compare and rank program mixes. Hence, the arguments used in favor of utility analysis are applicable to a considerable extent. Further, the dangers are even less when the analysis is done for relatively small and homogeneous areas, as

stressed elsewhere in this dissertation. Even a district may not be always homogeneous with respect to agroclimatic and socioeconomic conditions and the like. In that case, it may be necessary to divide it into more than one division for the purpose of this analysis.

The discussion, as well as the empirical application of this approach, has been made in the context of the SFDA. But the approach may be useful, with suitable adaptations, to other development agencies, such as the Department of Agriculture at the regional level.

The effects of programs, if they are widely adopted, as well as the changes in other sectors of the economy, affect the validity of the findings of program analysis over time, mainly because of changes in the basic data themselves. Such are changes in prices, technology, supply and demand conditions, resource base and the like. When the area planned for is large, as in the case of a state or a region, the situation is further complicated. Under such circumstances simulation is a useful procedure to account for variables and relationships that are beyond the realm of this approach.

Finally, a word of caution may be in order with respect to the use of the empirical findings of this dissertation. Some information necessary for the analysis was not available and has been substituted by subjective estimates. Hence, it would be dangerous to assume that the results are directly applicable to the Tungabhadra area, though the procedures suggested are.

BIBLIOGRAPHY

BIBLIOGRAPHY

Barker, Randolf, and Bernard F. Stanton. "Estimation and Aggregation of Farm Supply Functions," Journal of Farm Economics, Vol. 47, 1965.

Bisaliah, S., and Taylor, D. C. "Input-Output and Cost-Return Data for Major Irrigated Crops in Selected Areas of the Tungabhadra Irrigation Project." Unpublished Draft, University of Agricultural Sciences, Bangalore, 1971.

Black, Guy. The Application of Systems Analysis to Government Operations. New York: Fredric A. Praeger, 1968.

Brynes, Francis C. "Farmers' Resistance--To What?" Development Digest, Vol. 7, No. 2, April 1969.

Cano, Jairo, and Delbert T. Myren. "Benefit-Cost Analysis of the Puebla Project," Strategies for Increasing Agricultural Production in Small Holdings. Londres, Mexico: International Maize and Wheat Improvement Center, 1970.

Carter, Harold O. "Representative Farms, Guides for Decision Making," Journal of Farm Economics, Vol. 45, 1963.

Cashdollar, Parker. "An Economic Analysis of Crop and Land Use Localization in Tungabhadra Irrigation Project of Mysore State, India." Unpublished doctoral dissertation, The University of Tennessee, Knoxville, 1971.

Chappell, Vernon Glenn, Jr. "The Identification and Evaluation of Factors Affecting Economic Growth in the Tennessee Valley Region, 1950-1960." Unpublished doctoral dissertation, The University of Tennessee, Knoxville, 1970.

Clawson, Marion. "Development Planning in Agriculture," Selected Readings to Accompany Getting Agriculture Moving, Vol. II. Raymond E. Borton, ed. New York: The Agricultural Development Council, 1966.

Cocks, K. D., and H. O. Carter. "Micro Goal Functions and Economic Planning," Journal of Farm Economics, Vol. 50, 1968.

Davis, I. G. Types of Farming and Type of Farming Areas in Connecticut. Storrs: Storrs Agricultural Experiment Station Bulletin, No. 213.

Day, Lee M. "Use of Representative Farm Studies in Interregional Competition and Production Response," Journal of Farm Economics, Vol. 45, 1963.

Day, Richard H. Linear Programming and Related Computations--A Guide to USDA LP/90. Washington, D.C.: Farm Production Economics Division, Economic Research Service, United States Department of Agriculture, 1964.

Day, Richard H. "On Aggregative Linear Programming Models of Production," Journal of Farm Economics, Vol. 45, 1963.

Day, Richard H. The Aggregative Problem and Linear Programming Models of Production Response. Washington, D.C.: Occasional Paper No. 4, Agricultural Adjustment Branch, Farm Production Economics Division, Economic Research Service, United States Department of Agriculture.

Dias, C., Heliadora, and Juan Manual Rangel. "Methodology and Results of Evaluation in the Puebla Project," Strategies for Increasing Agricultural Production in Small Holdings. Londres, Mexico: International Maize and Wheat Improvement Center, 1970.

Epstein, Scarlett T. "A Customary System of Reward and Improved Production Techniques," Case Studies to Accompany Getting Agriculture Moving. Raymond E. Borton, ed. New York: The Agricultural Development Council, 1967; also The Economic Weekly (Bombay), Vol. XV, No. 11, March 1963.

Etienne, Gilbert. Studies in Indian Agriculture: The Art of the Possible. Berkeley: University of California Press, 1968.

Farouky, S. T. "The Role of the Extension Service in the Formulation of Agricultural Plans," Selected Readings to Accompany Getting Agriculture Moving. Vol. II. Raymond E. Borton, ed. New York: The Agricultural Development Council, 1966.

Freck, G. E., and R. A. Andrews. "Aggregation Bias and Four Methods of Summing Farm Supply Functions," Journal of Farm Economics, Vol. 47, 1965.

Goodwin, Joseph B., Melvin G. Blase and Dale Colyer. "A Development Planning Model for Technological Change in Agriculture," American Journal of Agricultural Economics, Vol. 53, 1970.

Government of India, Planning Commission. Fourth Five Year Plan, 1969-74, Draft. New Delhi: Manager of Publications, Government of India, 1969.

Government of India, Planning Commission. Second Five Year Plan. New Delhi: Manager of Publications, Government of India, 1956.

Government of Mysore, Bureau of Economics and Statistics. Economic Development of Mysore 1956-69. Bangalore: Manager, Government Press, 1970.

Government of Mysore. The Small Farmers Development Agency, Bangalore. Bangalore: Manager, Government Press, 1971.

Government of Mysore, Planning Department. Fourth Five Year Plan 1969-74, Policy and Programme. Bangalore: Manager, Government Press, 1970.

Halter, A. N., M. L. Hayenga and T. J. Manetsch. Simulating A Developing Agricultural Economy: Methodology and Planning Capability. Washington: A Paper prepared for the USAID, Washington, 1970.

Harman, Harvey H. Modern Factor Analysis. Second edition, Revised. Chicago: The University of Chicago Press, 1960.

Hartley, H. D, "Total Supply Functions Estimated from Farm Surveys." A paper presented at the NCR-4 conference on Problems in Estimating and Aggregative Regional Supply Response Estimates, 1962.

Hayenga, M. L., T. J. Manetsch and A. N. Halter. "Computer Simulation As A Planning Tool in Developing Economies," Journal of Farm Economics, Vol. 50, 1968.

Heady, E. O. "Criteria for Policy." A paper presented at the U.S.-Canadian Conference on Agricultural Policy, Edmontin, 1967.

Higginbotham, S. J. "Patterns and Sources of Indian Bureaucratic Behavior--Organizational Pressures and Ethic of Duty in Tamil Nadu Development Program." Unpublished Master's thesis, Massachusetts Institute of Technology, Cambridge, 1970.

Hirsh, G. P. "Incentives for Rural Development," Selected Readings to Accompany Getting Agriculture Moving, Vol. I. Raymond E. Borton, ed. New York: The Agricultural Development Council, 1966.

Holmes, C. L. Type of Farming in Iowa. Ames: April Experiment Station Bulletin 256, 1923.

Horst, Paul. Factor Analysis and Data Matrices. New York: Holt, Rinehart and Winston, Inc., 1965.

Hunter, Guy. The Administration of Agricultural Development--Lessons from India. New York: Oxford University Press, 1970.

Kendall, M. A. A Course in Multivariate Statistical Analysis. New York: Hafner Publishing Company, Inc., 1961.

Kulp, Earl M. Rural Development Planning--Systems Analysis and Working Methods. New York: Praegar Publishers, 1970.

Lee, John E. "Improving Aggregation Validity," Implications of Changes on Farm Management and Marketing Research. CAED Report 29, 1967.

Lipton, Michael. "A Game Against Nature: Strategies of Security," Development Digest, Vol. 7, No. 2, April 1969.

Mann, K. S., D. V. Moore and S. S. Tohl. "Estimate of the Potential Effects of New Technology in Agriculture in Punjab, India," Journal of Farm Economics, Vol. 50, 1968.

Mighell, R. L., and Black, J. D. Interregional Competition in Agriculture. Cambridge: Harvard University Press, 1951.

Miller, Thomas. "Aggregation Errors in Representative Farm Linear Programming Estimates." Unpublished doctoral dissertation, Iowa State University, Ames, 1967.

Miracle, Marvin P. "Subsistence Agriculture: Analytical Problems and Alternative Concepts," American Journal of Agricultural Economics, Vol. 50, 1968.

Morrison, Donald F. Multivariate Statistical Methods. New York: McGraw-Hill Book Company, 1967.

Mosher, Arthur T. "Administrative Experimentation as a 'Way of Life' for Development Projects," International Development Review, Vol. 9, No. 2, June 1967.

Mosher, A. T. Creating a Progressive Rural Structure, To Serve a Modern Agriculture. New York: Agricultural Development Council, Inc., 1969.

Mosher, Arthur T. Getting Agriculture Moving: Essentials for Development and Modernization. New York: Fredric A. Praeger, 1966.

Nayar, P. K. B. Leadership Bureaucracy and Planning in India. New Delhi: Associated Publishing House, 1969.

Parthasarathy, G. Agricultural Development and Small Farmers--A Study in Andra Pradesh. Bombay: Vikar Publications, 1971.

Plexico, James S., and Luther G. Tweeten. "Representative Farms for Policy and Projection Research," Journal of Farm Economics, Vol. 45, 1963.

Ramesh, D. "Measurement of Size of Farm and Efficiency--Some Alternative Approaches," Indian Journal of Agricultural Economics, Vol. 23, January-March 1968.

Randharva, Narindar S., and Earl O. Heady. "An Interregional Programming Model for Agricultural Planning in India," Journal of Farm Economics, Vol. 46, 1964.

Rao, C. Radhakrishna. Advanced Statistical Methods in Biometric Research. New York: John Wiley and Sons, Inc., 1952.

Rebello, Noel S. P. "Adoption of Hybrid Corn in Tungabhadra Region of Mysore State." Unpublished paper for the Department of Agricultural Economics and Rural Sociology, The University of Tennessee, Knoxville, 1970.

Rogers, Everett M., and F. Floyd Shoemaker. Communication of Innovations. New York: The Free Press, 1971.

Schaller, W. Neil. "Estimating Aggregate Product-Supply Relations with Farm Level Observations," Production Economics in Agricultural Research. Urbana: University of Illinois, 1966.

Schlurer, Michael. Differential Rates of Adoption of the New Seed Varieties in India: The Problem of the Small Farmer. Ithaca: Cornell University, Occasional Paper No. 47, 1971.

Sen, S. R. "Planning Machinery in India," Indian Journal of Public Administration, Vol. 8, No. 3, August 1961.

Sen, S. R. The Strategy for Agricultural Development and Other Essays on Economic Policy and Planning. Second edition. New York: Asia Publishing House, 1966.

Sharples, Jerry A. "The Representative Farm Approach to Estimation of Supply Response," American Economic Review, Vol. 59, 1969.

Sharples, Jerry A., Thomas A. Miller, and Lee M. Day. Evaluation of a Firm Model in Estimating Aggregate Supply Response. Iowa Agricultural Experiment Station Research Bulletin 558, 1968.

Shechter, Mordechai, and Earl O. Heady. "Response Surface Analysis and Simulation Models in Policy Choices," American Journal of Agricultural Economics, Vol. 52, 1970.

Sheehy, S. J., and R. H. McAlexander. "Selection of Representative Benchmark Farms for Supply Estimation," Journal of Farm Economics, Vol. 47, 1965.

Shetty, N. S. "Agricultural Innovation: Leaders and Laggards," Development Digest, Vol. 7. Washington: Agency for International Development, 1969.

Shukla, V. N. The Constitution of India. Fifth edition. New Delhi: Eastern Book Company, 1969.

Small Farmers Development Agency, Bedar District. Project Report 1970-74. Bedar: Project Officer, Small Farmers Development Agency, 1971.

Small Farmers Development Agency, Mysore District. A Pilot Project on the Agricultural Development of the Small Farmers of Mysore District, 1970. Mysore: Project-Officer, Small Farmers Development Agency, 1971.

Small Farmers Development Agency, North Kanara District. Project Report for the Economic Development of Small Farmers in North Kanara District, Mysore State. Karnar: Project Officer, Small Farmers Development Agency, 1971.

Tax, Sol. "Motivations," Selected Readings to Accompany Getting Agriculture Moving, Volume I. Raymond E. Borton, ed. New York: Agricultural Development Council, 1966.

Taylor, Donald C. "Report for May-June, 1971." Unpublished report to the ADC on his work as visiting professor with the University of Agricultural Sciences in Bangalore, New York, 1971.

Tennessee Test-Demonstration Program Evaluation Committee, C. L. Cleland, Chairman. "Report for 1958-59." Unpublished report, The University of Tennessee, Knoxville, 1959.

Tyner, Fred H., and Luther G. Tweeten. "Simulation as a Method of Appraising Farm Programs," Journal of Farm Economics, Vol. 50, 1968.

Vasudevan, A. The Strategy of Planning in India. Meereet: Meenakshi Prakashan, 1970.

Wharton, Clifton R., Jr. "Risk, Uncertainty and the Subsistance Farmer," War on Hunger, Vol. 3, No. 5, May 1969.

Yang, W. Y. "Farm Planning and Agricultural Development," Selected Reading to Accompany Getting Agriculture Moving, Volume II. Raymond E. Borton, ed. New York: The Agricultural Development Council, 1966.

APPENDIX

QUESTIONNAIRE

A. GOALS AND RESOURCES OF FARMERS

Farmer

Name _____

Address _____

Village _____

Taluka _____

Age _____

Education level _____

Land Resources

Area operated	Owned	Rented	Total
All land	_____	_____	_____
Irrigated land	_____	_____	_____

Source of irrigation _____

Dryland that could be converted to irrigated with well, etc. _____

Cost of such conversion per acre _____

Annual water charge or interest on investment payable per acre _____

Capital Resources

How much cash is available for next year's operation?

Owned _____ Credit _____

Source of credit _____

Interest payable _____

How much more will you be willing to borrow for next year, if available? _____

At what rate of interest _____

Labor Resources

Worker days available	Month	Men	Women
Family	January	_____	_____
	February	_____	_____
	March	_____	_____
	April	_____	_____
	May	_____	_____
	June	_____	_____
	July	_____	_____
	August	_____	_____
	September	_____	_____
	October	_____	_____
	November	_____	_____
	December	_____	_____
Hired	January	_____	_____
	February	_____	_____
	March	_____	_____
	April	_____	_____
	May	_____	_____
	June	_____	_____
	July	_____	_____
	August	_____	_____

Month	Men	Women
September	_____	_____
October	_____	_____
November	_____	_____
December	_____	_____
Daily wages	_____	_____

Bullock Power

Number of days available	Owned	Hired
January	_____	_____
February	_____	_____
March	_____	_____
April	_____	_____
May	_____	_____
June	_____	_____
July	_____	_____
August	_____	_____
September	_____	_____
October	_____	_____
November	_____	_____
December	_____	_____
Rate of hire per day		_____

Other Limiting Resources

Implements _____

Fertilizer _____

Pesticides _____

Others _____

Goals

Is profit maximization important to you? _____

Have you any limitations on this? _____

What enterprises will you not produce? _____

What enterprises do you insist on producing?

Kind	Area or Quantity
_____	_____
_____	_____
_____	_____

What maximum limits do you have on enterprises?

Kind	Area or Quantity
_____	_____
_____	_____
_____	_____

Have you any special interests? _____

_____

Have you any other conditions (such as diversification equity ratio, etc.) in planning farm operation? _____

_____

Any other observations _____

_____

_____

B. PRODUCTION INFORMATION

Enterprise _____ Variety _____

Area or size _____

Materials Used (per acre or unit)

Kind	Variety	Month	Quantity	Price	Value
Seed					
Fertilizer					
Plant Protection Chemical					
Water					
Others					

Labor and Bullock Power Used (per acre or unit)

Month	Operation	Bullock pairs	Men	Women	Remarks

Month	Operation	Bullock pairs	Men	Women	Remarks

Yields Obtained (per acre or unit)

Kind	Variety	Quantity	Price	Value
Grain or meat				
Fodder				
Other				

Size of unit (if not acre) _____

C. MISCELLANEOUS

Other Assets

Machinery	Number of units	Total Present values

Implements

Other Livestock

Other Occupations

Kind	Time spent	Income obtained

VITA

Noel Salvedore Paul Rebello was born on the 25th of December, 1927, at Mangalore, a coastal city on the west coast of India. He spent his early years on his father's farm in Kallianpur and graduated from The Milagres High School in that town in 1944. He did his junior college in St. Aloysius College, Mangalore, and passed the Intermediate Exam in Arts and Sciences of the University of Madras in 1946 with distinction in mathematics, physics and chemistry. He then studied physics for one year in St. Joseph's College, Tiruchirapally. He joined the Agricultural College at Coimbatore in 1947 and was awarded the degree of Bachelor of Science in Agriculture at the University of Madras in 1950, winning the gold medal in Agricultural Economics and prize in Agricultural Engineering.

He joined the Department of Agriculture in July 1950 and worked for three years as Research Assistant in Agricultural Research Stations. Thereafter he worked as Extension Agent and later as Assistant to the District Agricultural Officer as well as District Agricultural Officer until 1961.

About this time his interest in Agricultural Economics was rekindled by his contact with Dr. Erven J. Long and Dr. Merton B. Badenhop of the Tennessee University advisory team in Bangalore. He commenced studies at the Indian Agricultural Research Institute, New Delhi, and was awarded the Master's degree in agricultural economics in 1963, majoring in farm management. He worked thereafter in economic research for

one year at the end of which he was appointed the Professor of Agricultural Economics at the Agricultural College, Dharwar, and later transferred to the Agricultural College, Hebbal, at Bangalore. He was awarded a US/AID Participantship and commenced studies at the University of Tennessee for a Ph.D. degree in the Fall Quarter, 1968.