February, 1975

# Relationship of Consumption and Production in Changing Agriculture

## — A Study in Surat District, India —

By

B. M. Desai

Occasional Paper No. 80
Technological Change in Agriculture Project
Department of Agricultural Economics
Cornell University

Research supported by Contract No. AID/ta-c-1131
"Analysis of Direct and Indirect Effects of Technological Change in Agriculture"
Cornell University and the United States Agency for International Development

February, 1975

# Relationship of Consumption and Production in Changing Agriculture

## — A Study in Surat District, India —

By

B. M. Desai

Occasional Paper No. 80
Technological Change in Agriculture Project
Department of Agricultural Economics
Cornell University

Research supported by Contract No. AID/ta-c-1131
"Analysis of Direct and Indirect Effects of Technological Change in Agriculture"
Cornell University and the United States Agency for International Development

# ACKNOWLEDGEMENTS

I am grateful to Professor John W. Mellor who guided me in researching the problem studied, and whose pertinent criticism was valuable in analyzing the results. I am indebted to Professor Timothy D. Mount whose perceptive assistance on conceptualization of the model research was invaluable, and to Professor Henry Wan, Jr. whose emphasis on the importance of assumptions of economic theory I hope is reflected in my research.

I am indebted to the Directorate of Economics and Statistics, Ministry of Food and Agriculture, Government of India, and to the Director of Agro-Economic Research Centre, Vallabh Vidyanagar, for making data available for this study. I would particularly like to express my gratitude to Mr. Ram Saran, Professor V. M. Dandekar, Dr. Dharm Narain, Dr. V. S. Vyas, Dr. Roshan Singh, Dr. Sarveshwar Rao, Dr. M. T. Pathak, and Dr. G. M. Desai for their assistance. To Mr. M. D. Desai, and Mr. Indu of Agro-Economic Research Centre, Vallabh Vidyanagar, I am deeply indebted, for their help in organizing and in making me understand the data on which this dissertation is based. I am also grateful to the other members of the staff at the Centre for their help.

The financial support of the United States Agency for International Development which made this study possible is gratefully acknowledged, and also the support and help of the Department of Agricultural Economics at Cornell University, who sponsored the study. To the Indian Institute of Management, Ahmedabad, I am grateful for the study leave and travel grant which made it possible for me to avail of this opportunity.

For John Broderick's patient help with the computer program on which the analysis in Chapter IV is based, I am especially thankful. To Chandrashekhar Ranade, Anjana Desai, Neville Edirisinghe, and Gillian Hart, who made important contributions at various stages of this study I am also grateful.

I am grateful to Alice Wells for her careful assistance with so many administrative details of my research. Gerry Serrote and Hector Coward helped with the transcription and tabulation of data. I thank Rebecca Lacey, Joseph Baldwin, Debra Biamonte, and Jean Swartwood for help in preparing the final draft of the study.

Finally, I am grateful to my wife, Urmi, for her support and encouragement in completing this research.

# PREFACE

The concern of development economists has in the past few years turned substantially to problems of fostering growth in employment and broadening the participation in processes of growth. However, the analysis and policy prescriptions have tended to be naive – with little emphasis on the productivity implications of alternative programs for increasing employment. It has become increasingly clear, in part from earlier work in this program by Graeme Donovan and Michael Schluter, that change in cropping pattern has potential for major increases in productive rural employment.

In this study, Bhupat Desai makes note of the key role of cropping pattern in determining farmer's per acre input requirements and per acre revenue and proceeds to examine determinants of cropping patterns. Particular emphasis is given to constraints on intensive cropping provided by shortage of capital and related risk and uncertainty and hence on the interaction between allocation of income between expenditure for consumption and for investment. The study also notes the special importance of dairy production as a means of intensifying agricultural production and examines interactions determinant of the intensity of the dairy enterprise. The analysis is of special interest because it describes actual relationships among farms through a recursive model consisting of four main parts and thereby identifies various behavioral relationships. The data for the study comes from detailed farm surveys for the use of which we are grateful to the Agro-Economic Research Centre. Vallabh Vidyanagar.

This work is part of a larger effort supported by USAID at Cornell University, dealing with the relation between technological change in agriculture and employment and income distribution. The basic thrust of the research undertaken in this program is positive – based on the assumption that technological change which increases the supply of food grains, the basic wages good and item of expenditure of the poor, is basically desirable for the poor; and the recognition that many economic and institutional aspects of poverty may reduce the extent to which the poor obtain the innate benefits of such change. In diagnosing the policy needs for broadening participation in the increased income from new agricultural technologies it is necessary to consider the direct and indirect effects of increased income – a consideration which has carried our analysis over a broad range of studies of expenditure patterns, labor supply relations, analysis of labor absorption in industry generally and small scale industry specifically, and the relation between labor absorption in agriculture and various demand and policy variables; and, as in this study, the determinants of alternative patterns of cropping with their differing employment potentials.

This study is another effort in a continuing, informal interchange and cooperative research effort between researchers at various institutions in India and Cornell University. I continue to be grateful, in particular, for the opportunity provided at various times by the Indian Institute of Management, Ahmedabad. In this case, Bhupat Desai is on leave from I.I.M. and has worked closely with his colleagues there on both substantive and administrative aspects of the project. This, as previous studies, reflects their generous contributions.

JOHN W. MELLOR

*Ithaca, New York*
*March 30, 1975*

# TABLE OF CONTENTS

# CHAPTER I

# INTRODUCTION

## Objectives

Consumption and production decisions are innately interwoven in the economy of farm-families as they are not in the economy of industrial firms. This study examines short-run interrelation of the aggregate consumption and working capital investment decisions of farmers. It also examines expenditure patterns that are related to the aggregate consumption of farmers. Recursive instead of simultaneous relation between current consumption and current production decisions of farm-families is assumed in specifying a descriptive economic framework for analysis.

The detailed objectives of the study are to explain and predict changes in farmers':

1. input requirements for and revenue from dairying;
2. crop pattern and hence changes in use of inputs and revenue;
3. aggregate consumption expenditure; and
4. allocation of this expenditure between various goods and services.

Analysis of factors constraining increases in use of inputs for and revenue from dairy enterprise is important in view of the macroeconomic objectives of growth in incomes and employment. Moreover, dairy income being characterized by continuity of flow of funds may help farmers by providing minimum assured income. Such characteristics of dairy income can also be considered indicative of relaxing capital as well as risk-bearing constraints of farmers in growing various crops. Technological change as embodied in the breed of buffaloes can play an important role in determining these functions of dairying.

Farmers' choice of crops is the most crucial aspect of their working capital investment and revenue decisions. This is so because crops vary in their per acre use of working capital as well as in net returns. Therefore, the single most important determinant of multi-crop producing farmers' per acre input requirements and per acre revenue is crop pattern.[1]

The crop pattern can be considered as a function of farm size, availability of net irrigable land, wealth, family labor, per acre expected net returns, and net flow of family finance. From the viewpoint of a farm-family, the net flow of funds can be considered as being formed of past saving and current dairy plus non-farm incomes minus current aggregate consumption expenditure. Family finance could have decisive influence on crop pattern because credit may not be perfectly substitutable for internal finance under conditions of imperfection in capital market and risks in farming.

After analyzing the relationship of crop pattern with the above mentioned variables this study predicts the shifts in crop pattern from low-return low-working-capital-intensive crops to high-return crops, due to change in the availability of net irrigable land, and internal capital through dairy income.[2] The effect of prices of crops, and credit on crop pattern could not be examined because the econometric model in this study is based on data in which these factors do not vary.

Increases in the availability of net irrigable land are important for they encourage the adoption of such high-return crops as HYV paddy, and sugarcane. Similarly, increases in the availability of internal capital through dairy income, by relaxing capital and risk-bearing constraints, could also lead to the adoption of new technologies including new crops.

Such shifts in crop pattern are important for increases in the use of inputs including labor, and in incomes of farmers. These increases provide potentialities for employment-oriented intersectoral and interregional growth linkages.[3] These linkages may differ in two broad respects. First, they may differ in the magnitude of employment and capital use that may be created due to increases in production of goods in other sectors of the economy. Second, they may also differ in the type of industries that may get encouraged, whether small or large, regionally dispersed or concentrated. Similar potentialities for growth linkages are also provided by changes in expenditure on various consumption goods and services. Hence, it is important to analyze the consumption patterns of farm-families.

Thus, it is important to consider both the production and consumption aspects of farm-families inasmuch as the agricultural sector provides markets for various production, investment, and consumption goods. This role of agriculture is crucial in determining the pace, and the pattern of economic development in low income countries.[4]

---

[1]This is consistent with the sample data under study. For results, see Tables 3 and 4 in Chapter III. Also see Appendix Tables 2 and 3 which show that the differences in per acre inputs for and per acre revenue from each crop of small versus large farmers are statistically insignificant.

[2]In the sample for this study, the high-return crops are sugarcane, banana, HYV paddy and wheat, whereas low-return crops are jowar, tur, val, cotton, and groundnut.

[3]See, for example, Nurul Islam, "Employment and Output as Objectives of Development Policy," in Theme Papers for 15th International Congress of Agricultural Economists (Oxford: 1973). John W. Mellor and Uma Lele, "Growth Linkages of the New Foodgrain Technologies," *Indian Journal of Agricultural Economics*, Vol. 28, No. 1 (January/March, 1973), p. 35. Also, Uma Lele and John W. Mellor, "Jobs, Poverty and the Green Revolution," *International Affairs*, Vol. 48, No. 1 (January, 1972), p. 20.

[4]For a survey of literature on role of agriculture in economic development see Bruce F. Johnston, "Agriculture and Structural Transformation in Developing Countries: A Survey of Research," *Journal of Economic Literature*, Vol. 8, No. 2 (June, 1970), p. 369. Also, see John W. Mellor, *India and the New Economics of Growth*, (New York: Twentieth Century Fund, Forthcoming, 1975). With his characteristically wide-sweeping economic analysis, Mellor suggests an employment-oriented strategy of economic growth which uses technological change in agriculture as a major stimulus to overall growth.

An ideal set of data for this study would be a cross-section cum time-series data from the same group of farmers on their *cash flows* of input costs, dairy production, output of each crop, non-farm incomes, consumption expenditure, lending and borrowing. In addition, these data should cover prices of various crops, crop pattern, availability of net irrigable land, credit, *past saving,* hired labor, wealth, size of family, and size and composition of dairy herd. Such data would be ideal for examining the influence of interrelation of consumption and production, prices, risk, and other factors on crop pattern. In particular, data on cash flow would enable the analysis of relative importance of family finance, including dairy income and non-farm income, and past saving, and external finance in determining crop pattern. In the absence of such data, an attempt is made in this study to present an analytical and methodological approach suitable to the available data.

### Analytical and Methodological Approach

The study utilizes a recursive descriptive economic framework that consists of four parts, namely, dairy-farming, crop-farming, level, and pattern of aggregate consumption expenditure. This framework identifies various behavioral relationships to explain the changes in these four economic activities of farmers. The analysis begins with the following simplifying assumptions:

1. That it is more important to explain inter-crop rather than intra-crop input and revenue differences for the study of incomes and input requirements of farmers. The per acre output and also per acre use of each input for every crop are therefore considered as fixed.[5]
2. That at the beginning of a crop-year, the farm-families make recursive decisions about consumption and production. This is justified because farmers' income from crops accrues to them only at the end of a crop-cycle, whereas their consumption is continuous. For the same reason, it is assumed that farmers' current aggregate consumption is influenced by their expected rather than current income.
3. That in the sequential decision-making process at the beginning of a crop-year farmers take their aggregate consumption and dairy-farming decisions followed by crop-farming activity. This is justified because aggregate consumption and dairy-farming activities being characterized by a continuity of flow of funds can form internal funds that would influence, among other factors, the choice of crop pattern.
4. That the integration of internal finance and crop pattern decisions of farm-families is important. This is justified under the conditions of imperfection in capital market as well as under situations of risk.
5. That the decision to expend on individual items of consumption follows after the aggregate consumption expenditure decisions. Restricting expenditure to that on non-durable and regular items of consumption can justify this assumption.

Considering the above assumptions, various factors are identified to explain changes in (1) investment in variable inputs for dairy-farming of year t, (2) gross revenue from dairying activity of year t, (3) allocation of land to alternative crops and hence use of inputs and level of crop income of year t, (4) aggregate consumption expenditure of year t + 1, and (5) allocation of this expenditure between various goods and services.

The relationship of these factors with the relevant explanatory variables is estimated using econometric methods. A single equation technique of estimation, namely, Ordinary Least Squares, is used because the study assumes recursive relation between aggregate consumption and production.

### Data Source, Sampling Design, and Salient Features of Sample Farmers

#### Data Source

The study utilizes input-output data of dairy and crop enterprises, in addition to data on family budget, non-farm incomes, wealth of a group of farm-families in Surat district, India. These data were obtained from the Agro-Economic Research Centre, Vallabh Vidyanagar, Gujarat, sponsored by the Directorate of Economics and Statistics in Ministry of Food and Agriculture.[6]

These data are unique in the sense that the survey covered both the production and consumption aspects of the *same* group of farm-families. Hence, this research on inter-relation of these two aspects which are intertwined in the economy of farm-families is made possible. Such data are not available in published form. Collection of such data by undertaking a survey of farmers is time consuming and expensive.

#### Sampling Design

The Agro-Economic Research Centre collected detailed data on land holding and its use, input pattern, farm and non-farm incomes, and consumption patterns from 99 farmers of Surat district in Gujarat. These farmers were selected from two adjoining talukas, Bardoli and Palsana, which have common characteristics such as crop pattern, irrigation facilities, and institutional and marketing facilities.[7] Figure 1 at the end of this chapter presents the map showing the location of the selected talukas in Surat district.

---

[5]This implies a Leontief production function for each product as is used in input-output and linear programming analyses.

[6]M. D. Desai, "Saving and Investment in an Agriculturally Prosperous Area," Research Study No. 30, (Vallabh Vidyanagar: Agro-Economic Research Centre, Sardar Patel University, 1973).

[7]For data on some features of institutional facilities in Surat district, two sample talukas and Bardoli town, see B. M. Desai, "Relationship of Consumption and Production in Changing Agriculture, A Study in Surat District, India," (Unpublished Ph.D. Thesis, Cornell University, 1975), Appendix Table 1.

From each of the two talukas, five villages were randomly selected using a sampling method of probability proportional to size, the size being the percentage of irrigated area to gross cropped area of the villages. Ten farmers were selected from each sample village, using stratified random sampling design, the basis of stratification being operational land holding. Moreover, the sample was drawn from a universe that excluded those farm households which operated less than three acres.[8] This was done because the study undertaken by the Centre was mainly concerned with those farmers whose primary occupation was cultivation. The data refer to the agricultural years July to June 1969-70, and 1970-71. For the collection of required data, a recall instead of cost accounting method of survey was conducted. Each farm household was interviewed twice a year.[9]

### Salient Features of Crop Pattern, Dairy Enterprise, and Consumption Patterns of Sample Farmers

An average farmer allocated about the same proportion of his land to the high-return-high-input-use crops namely, sugarcane, banana, HYV paddy, and wheat (52%) as to the low-return-low-input-use crops such as jowar, tur, val, and cotton (48%). However, the former group of crops contributed about 86 percent to the total net crop-income of an average farmer. These crops also shared between 86 and 93 percent in the total requirement of labor and other cash purchased inputs.

Net income from dairying formed about 12 percent of the family net income in 1969-70. The average size of herd including young calves was five. Only nine percent of the herd was of improved breed. About 27 percent of the owned land was kept by farmers as grass or fodder land.

The consumption patterns of 1970-71 revealed about an equal importance of three groups of commodities:

a. milk, ghee, vegetables, and fruits (19%);

b. manufactured nonfood items such as tobacco and its products, washing soap, toiletry goods, footwear, and clothing (19%); and

c. services such as domestic and medical services, education, and travel and recreation (19%).

The remaining 43 percent of total expenditures was claimed by foodgrains (26%), and processed foods (17%). Sugar, gur, and edible oil claimed 64 percent share in the expenditure on processed foods.[10]

[8] The results of this study may, therefore, be evaluated after considering this feature of the sampling design.

[9] For details on this and sampling design, see Desai, *op. cit.*, pp. 5-13.

[10] Appendix Table 1 gives data on some other features of these farmers.

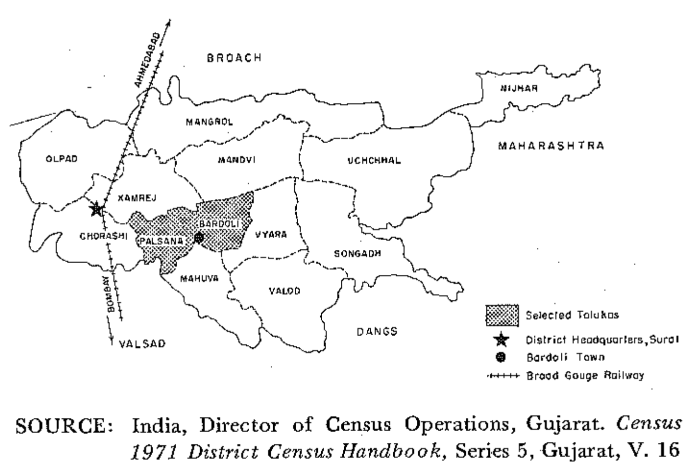
### Sequence of Presentation

A conceptual framework on interrelation of consumption and production decisions of farmers by utilizing the differing characteristics of the sources of their incomes, the importance of crop pattern, and also the importance of conditions in the capital market and risks in farming is developed in Chapter II. Chapter III estimates the relationship of various factors influencing the four economic activities, namely, dairy-enterprise, and crop-farming of 1969-70 level, and pattern of aggregate consumption expenditure of 1970-71. This chapter is divided into four sections, one each for the four economic activities of farmers.

Each section first examines the results of the estimated relationships and then reports the findings of Theil's method of Residual Analysis to evaluate the forecasting ability of different equations. Chapter III is followed by Chapter IV on policy appraisal of alternative changes in crop pattern, use of inputs, level of income and in turn in consumption pattern of sample farm-families. For such appraisal the availability of two resources, namely, net irrigable land, and size and composition of dairy herd of sample farmers are altered by assuming two different types of changes in these resources. One of these is identical change in these resources of small and large farmers alike. The second is differential change in these resources of small versus large farmers.

In Chapter V the main conclusions of the study are recapitulated. This chapter goes on to discuss the relevance of some specific policies to manipulate changes in the two resources for intensifying agriculture and thereby inducing economic growth.

*Figure 1. Map of Surat District showing the Sample Talukas where the study was conducted.*




SOURCE: India, Director of Census Operations, Gujarat. *Census 1971 District Census Handbook,* Series 5, Gujarat, V. 16 Parts X A-B.

*CHAPTER II*

# INTERRELATION OF CONSUMPTION AND PRODUCTION IN CHANGING AGRICULTURE – A CONCEPTUAL FRAMEWORK

## Introduction

One of the distinguishing features of farm-households is the integration of two decision units into one; a family acts both as an entrepreneur and as a consumer. This results in interrelation of consumption and investment decisions. This is because the former, through marketed surplus and cash expenses, influences cash flows and determines the latter. And investment, through expected profitability, would determine the size of expected incomes and influence consumption. Therefore, farmers take these decisions either simultaneously or recursively. Yet another distinguishing feature of farm-families is that their income from different sources accrues to them differently. The dairy and non-farm incomes like aggregate consumption expenditure are characterized by a continuity of flow. In contrast, the income from crops accrues to the farm-households only at the end of a crop-cycle. Hence, as the farm-families earn a large proportion of their income from crops, their decisions to consume and produce at the beginning of a crop year may legitimately be assumed to be recursive. Also, because of these very features, the farmers' current aggregate consumption expenditure may be assumed to be influenced by expected rather than current income. In this chapter, the assumptions, behavioral sequence, and factors influencing the decisions to consume and produce are discussed.

## Assumptions

At the beginning of a crop-year, the farmers are assumed to take their decisions about consumption and production recursively. It is also assumed that the farm-families undertake four economic activities, namely, dairy-farming, aggregate consumption expenditure, allocation of this expenditure, and crop-farming. In the sequential decision-making process the farmers are further assumed first to take their dairy-farming and consumption decisions followed by crop-farming activity. This is because the former two are characterized by a continuity of flow of receipts and expenses, whereas input needs for the latter recur at intervals and the income from it accrues in a lump sum. These assumptions imply that there is no causal influence of crop-farming on dairy-farming at the same point in time. Similarly, they imply that current dairy and non-farm incomes do not influence current aggregate consumption. The former implication may be justified under two circumstances. One, when a given amount of owned land, as is the case with the sample studied, is kept as fodder or grass land.[1] Two, when dairy-farming is pursued as a supplementary rather than a competitive enterprise.

Furthermore, income from dairy plus that from non-farm jobs together with past saving *minus* consumption expenditure can form internal finance that would influence, among other factors, the crop pattern. This linkage of family capital and crop-production decisions of farmers is justified under inadequacies of capital market and risks in crop-farming. Under such conditions, farmers may not consider credit as perfectly substitutable for family capital. The use of credit entails cost which is likely to be greater than the opportunity cost of family capital. Also, a large number of studies of farm management in India show that owned funds constitute a very important source of finance for farming.[2] This could be due largely to inadequacy of capital market for borrowing and lending, and risks associated with farming. Under conditions of risks, farmers may maximize their minimum income, in which event the importance of internal finance is reinforced because farmers would avert undertaking the uncertainties of repayment of loans.

Another important assumption is that in the short run the inter-crop input differences may dominate the intra-crop input differences. Hence, farmers' choice of crops is considered to be the most crucial aspect of their working capital investment and income decisions. Thus, 96 percent of variation in per acre use of hired human labor is associated with the crop pattern of the sample farmers. The corresponding figures for other major variable inputs are 95 percent for fertilizers, 96 percent for irrigation, and 85 percent for oil cakes (Table 3, Chapter III). The percentages of variation in per acre use of all variable inputs and gross revenue are 98 and 97, respectively (Table 4, Chapter III). Furthermore, the differences in per acre input use and gross return on various crops of sample farmers of small and large farm sizes are statistically insignificant (Appendix Tables 2 and 3).[3] Also, the percentage of variation in per acre net returns of each crop explained by such factors as farm size, irrigable land, supplementary incomes, and family size exceeds ten percent only for two out of six crops (Table 4, Chapter III).[4]

The preceding discussion illustrates that it is more important to explain the farmers' decision to allocate land

---

[1]About 27 percent of owned land was kept as fodder land by the sample farmers. In some regions in India farmers grow crops such as jowar, methi, and chari as fodder crops for a period of about a month or two before carrying out the sowing operation of the kharif crops. Such practice may also be considered similar to that of reserving a part of land as grass land.

[2]For some references on this subject, see Selected Bibliography.

[3]Hence, for the purpose of prediction, Chapter IV utilizes the same per acre coefficients of cost of different inputs and gross revenue of various crops for both groups of farmers (Table 7 in Chapter III).

[4]Even these two $R^2$ are statistically not significant.

to various crops.[5] It is therefore considered that the per acre use of each input and per acre output of each crop are fixed.[6]

Last but not the least important assumption is that farmers first decide the amount of their aggregate family consumption expenditure at a given point in time and then allocate this given amount over different items of consumption. This assumption implies that the family expenditure on each commodity is a function of total consumption expenditure, besides the family size. Such an assumption is tenable particularly if the analysis of expenditure on individual goods and services is restricted to nondurable and regular items of consumption. It also holds for those farm households that are characterized by high degree of urbanization as in the sample (Appendix Table 1). Further, most consumption pattern studies on India are based on National Sample Surveys which permit specification similar to the one in this study. And thus, the results would remain comparable with the results based on the most important source of consumption data in India.

Considering these assumptions, the behavioral sequence of the four economic activities and factors influencing them are now outlined.

### Behavioral Sequence and Factors Influencing the Four Economic Activities

Visualize a group of farmers who, at the beginning of a crop-year, take recursive decisions about consumption and production. In their recursive behavior, at a given point in time, the farmers are assumed first to take dairy-farming and consumption decisions followed by crop-farming activity. Both dairy-farming and consumption, unlike crop-farming, are characterized by a continuity of flow of receipts and expenses. Hence, at the beginning of the cropping season farmers are assumed to foresee a commitment of continuous nature to maintain themselves and their families including dairy animals.

As regards dairy-farming, consistent with the assumption of recursive behavior, the farmers first invest in variable inputs for dairying and then this investment together with other factors determines the dairy output. Thus, such investment is a function of herd size, composition of herd, availability of fodder land, and family labor all of which together determine gross revenue from dairying.

The main determinants of aggregate consumption expenditure are expected net family income, expected intensity of crop-farming, wealth, and family size. Both the expected net family income and expected intensity of crop-farming are defined, respectively, as net family income and ratio of aggregate gross returns to investment in variable inputs of year $t - 1$. The higher the expected intensity of crop-farming, holding other factors constant, the lower would be the aggregate consumption. This can be a result of inadequate capital market as such market hinders the substitutability of credit for internal finance. It could also be an outcome of increases in expected returns to investment on account of technological improvements in agriculture. Thus, under the conditions characterized by these forces, farmers may have time preference weighted toward future rather than present consumption.

The aggregate consumption expenditure so determined influences the expenditure on various goods and services. The other factor which determines allocation of expenditure is the size of the family.

Having taken the dairy-farming and consumption decisions, the farm-families determine their crop pattern. The allocation of land to alternative crops is influenced by their expected per acre net returns, availability of family (or internal) finance, net cultivable land, net irrigable land, and wealth.[7]

From the viewpoint of a farm-family the availability of family finance can be defined as net flow of funds formed from inflow of current dairy and non-agricultural incomes plus past saving minus current outflow of aggregate consumption expenditure. Therefore, at the beginning of a crop-year the net flow of funds would influence the decision to adopt one versus the other crop. This linkage of family capital and crop-production decision is important under the conditions of risk as well as imperfections in the capital market for borrowing and lending. Imperfections in the capital market manifest themselves in such factors as untimely and inadequate supply of credit, procedural inconveniences, lack of competitive interest rates, requirement of tangible collateral, and lack of knowledge about off-farm investment opportunities. These in turn would increase farmers' reliance on internal capital. The supply of internal funds may be further enhanced by the improvements in technological conditions on farms. Moreover, inasmuch as such improvements also enhance the risks associated with the higher level of returns to investment, the farmers may further increase the supply of internal funds to preclude the uncertainties of repayment

[5]Various crops are defined to include high-yielding and traditional varieties of the same crop as being separate crops, besides two or more different types of crops.

[6]This implies a Leontief production function for a particular product as is used in input-output and linear programming models.

[7]Credit and prices of crops are excluded from this list of factors influencing crop pattern, because the available data revealed lack of variation in these variables. However, the importance of nonprice variables in determining acreage (supply) response of various agricultural commodities for the time-series data of a district or state has long been recognized. See, for examples, Raj Krishna, "Farm Supply Response in India and Pakistan: A Case Study of the Punjab Region," *Economic Journal,* Vol. 73, (September, 1963), p. 477. Dharm Narain, *The Impact of Price Movements on Areas under Selected Crops in India, 1909-39,* (Cambridge University Press, 1965). Kalpana Bardhan, "Relative Prices and Allocation of Land and Other Inputs Among Competing Crops," in *Readings in Agricultural Development,* ed. A. M. Khusro, (Calcutta: Allied Publishers, 1968). Robert W. Herdt, "Dissaggregate Approach to Aggregate Supply," *American Journal of Agricultural Economics,* Vol. 52, No. 4 (November, 1970), p. 512.

of loans. Thus, all these forces together provide a rationale for the linkage of internal finance and production.

Two precise hypotheses about the effect of net flow of funds on crop pattern may be stated. One, the higher the inflow of funds from such sources as dairy income, and nonagricultural income, holding other factors constant, the higher the probability of land being allocated to high-return crops that are relatively working capital-intensive. Two, the probability of growing such crops would, however, be inversely related, holding other factors constant, to the outflow of aggregate consumption. Thus, the regularity of flow of dairy plus nonagricultural incomes helps release the constraints of internal capital supply as well as willingness and ability to bear risk in growing various crops.

Similarly, the availability of net irrigable land, holding other factors constant, would have positive influence on the proportions of land under irrigated crops that are both high-return and working capital-intensive. But the proportions of acreage under low-return unirrigated crops would be inversely related to the availability of net irrigable land.

The cropping pattern so determined, together with the per acre use of variable inputs for each crop, would then determine the aggregate investment in these inputs. Similarly, the aggregate gross returns of farmers would be a function of cropping pattern and the per acre revenue of each crop.

The intent of this descriptive economic framework is to determine the changes in input use and income as a result of changes in dairy and crop enterprises of farm-families. These changes are predicted for the year t by varying some of the explanatory factors such as net irrigable land, and size and composition of dairy herd. And finally, the increases in income of year t are related to the farmers' aggregate consumption and in turn their consumption pattern of year t + 1. The entire framework may now be presented in the form of behavioral equations and identities.

The framework consists of the following nine behavioral equations and five identities.[8] One of the behavioral equations, namely, aggregate consumption function of year t will not be estimated because of nonavailability of data on income and intensity of crop-farming of year t — 1.

**Dairy-Farming Model of Year t**

1. $I_D = f_1 \left[ TH, DBM, IBM, N, L_D \right]$
2. $R_D = f_2 \left[ I^*_D, TH, DBM, IBM, N \right]$[9]
3. $Y_F = (R^*_D - I^*_D) + Y_N$

Where

$I_D$ = Investment in variable inputs for dairy-farming (in Rupees)

TH = Total milking plus supporting herd (in number)

DBM = "Desi" breed milking buffalo (in number)

IBM = Improved breed milking buffalo (in number)

N = Family labor (number of female adults)

$L_D$ = Fodder land (in acres with two decimals)

$R_D$ = Gross revenue from dairy-farming (in Rupees)

$Y_N$ = Non-farm income (in Rupees)

$Y_F$ = Total flow of net dairy plus non-farm incomes (in Rupees)

**Aggregate Consumption Function of Year t**

4. $C = f_4 \left[ Y_{T,\, t-1}, \left(\frac{R}{I}\right)_{CT,\, t-1}, W, F \right]$

Where

C = Aggregate family consumption expenditure (in Rupees)

$Y_{T,\, t-1}$ = Total net income of family in year t — 1.

$\left(\frac{R}{I}\right)_{CT,\, t-1}$ = Ratio of aggregate gross revenue to investment in variable inputs for crop-farming of year t — 1.

W = Value of farm and non-farm assets excluding land (in Rupees)

F = Family size (in number)

**Crop-Farming Model of Year t**

5.i $L_{i/Lnc} = f_{5i} \left[ (Y^*_F - C^*), L_{nc}, L_{nI}, W, \pi_{i,\, t-1}, \pi_{q,\, t-1} \right]$

6.i $L_i = (L_{i/Lnc})^* \; Lnc$

7.m.i $I_{cmi} = f_{7mi} (L^*_i)$, linear by assumption.

8.i $R_{Ci} = f_{8i} (L^*_i)$, linear by assumption.

9.i $I_{CTi} = f_{9i} (L^*_i)$, linear by assumption.

10.i $Y_{Ci} = (\Sigma_i R^*_{Ci} - \Sigma_i I^*_{CTi})$

11. $Y_H = \Sigma_i Y^*_{Ci}$

12. $Y_T = (Y^*_H + Y^*_F + Y_X)$

$i = 1, \ldots I$ crops

$q \neq i$, when $i = I$

$m = 1, \ldots M$ inputs

[8]For convenience in presentation of the equations subscript t for the current year and subscript n for farm number are not used.

[9]The starred variables that appear on the right hand side of some equations are determined in the model.

Where

$L_i$ = Acreage under $i^{th}$ crop (in acres with two decimals)

$L_{nc}$ = Net cultivable land (in acres with two decimals)

$L_{nI}$ = Net irrigable land (in acres with two decimals)

$\pi_{i, t-1}$ = Per acre net returns of $i^{th}$ (own) crop in year t − 1 (in Rupees)

$\pi_{q, t-1}$ = Per acre net returns of $q^{th}$ (competing) crop in year t − 1 (in Rupees)

$I_{Cmi}$ = Expenditure on $m^{th}$ input for $i^{th}$ crop (in Rupees)

$R_{Ci}$ = Gross Revenue from $i^{th}$ crop (in Rupees)

$I_{CTi}$ = Total expenditure on all inputs for $i^{th}$ crop (in Rupees)

$Y_{Ci}$ = Net revenue from $i^{th}$ crop (in Rupees)

$Y_H$ = Net returns of all crops (in Rupees)

$Y_X$ = Net income from mango orchards (in Rupees)

$Y_T$ = Total family net income (in Rupees)

**Aggregate Consumption Function of Year t + 1**

By implication that the aggregate consumption of year t is a function of, among other variables, family income and intensity of crop-farming of year t − 1, the aggregate consumption function of year t + 1 would be:

$$13. \quad C_{t+1} = f_{13}\left[Y_T^*, \left(\frac{R}{T}\right)^*_{CT}, W_{t+1}, F_{t+1}\right]$$

Where

$C_{t+1}$ = Aggregate family consumption expenditure of year t + 1 (in Rupees)

$Y_T^*$ = Total family net income of year t (in Rupees)

$\left(\frac{R}{I}\right)^*_{CT}$ = Ratio of aggregate gross revenue to investment in variable inputs for crop-farming of year t.

$W_{t+1}$ = Value of farm and nonfarm assets excluding land of year t + 1 (in Rupees)

$F_{t+1}$ = Family size of year t + 1 (in number)

**Engel Functions of Year t + 1**

$$14.j \quad E^j_{t+1} = f_{14j}\left[C^*_{t+1}, F_{t+1}\right]$$

j = 1, ... J expenditure categories

Where

$E^j_{t+1}$ = Family expenditure on $j^{th}$ category of expenditure in year t + 1 (in Rupees)

*CHAPTER III*

# INTERRELATION OF CONSUMPTION AND PRODUCTION IN CHANGING AGRICULTURE – AN EMPIRICAL APPLICATION OF A FRAMEWORK

## Introduction

This chapter is concerned with an empirical application of the conceptual framework developed in the preceding chapter. The chapter is divided into four sections which correspond to the four activities, namely, dairying, crop-farming, aggregate consumption, and its allocation over different items.

### Section 1: Dairy-Farming Activity of Year t

As was discussed in Chapter II, at the beginning of the crop season of year t (1969-70), the sample farmers take their dairy-farming decisions. This is because dairying being characterized by a continuity of flow of funds can help farmers by providing assured minimum income. Such a characteristic can enhance the farmers' willingness and ability to bear risk in growing various crops. It can also aid in generating an internal flow of capital which can be utilized to finance the adoption of alternative crops. The average farm-family in the sample earned about twelve percent of its total income from dairying.[1]

Consistent with the basic assumption of sequential decision-making it is assumed that farmers first invest in variable inputs for dairy-farming and then, this investment, in addition to other factors, would determine their revenue from dairying. Accordingly, this section explores the short-run constraints on farmers in keeping dairy animals and what determines their dairy revenue.

**Factors Influencing Investment in Variable Inputs**

The main variable inputs for dairying are fodder, concentrates, labor, and veterinary services. Due to non-availability of data on family labor, only hired labor is considered in this study. The cost of each input of all the farm-families is imputed at the same price. Considering the behavioral equation 1 in Chapter II, the following relation was estimated:

[1]In a survey of sample farmers of the same district conducted by Schluter in 1971-72, dairying provided about 18 percent of total family income on irrigated farms as against a corresponding percentage of about 22 on unirrigated farms. See M. G. G. Schluter, "The Interaction of Credit and Uncertainty in Determining Resource Allocation and Incomes on Small Farms, Surat District, India", (Unpublished Ph.D. Thesis, Cornell University, 1973), p. 158, and Appendix Tables 13 and 14. The difference in Schluter's and our results is largely because the sample utilized in this study was drawn from the universe that excluded farmers with less than three acres of operational holdings.

$$(3.1.1)^2 \quad \frac{I_D/12}{TH} = \beta_0 + \beta_1 \, TH + \beta_2 \frac{DBM}{TH} + \beta_3 \frac{IBM}{TH} + \beta_4 \frac{N}{TH} + \beta_5 \frac{L_D}{TH} + \epsilon$$

Where

| | |
|---|---|
| $I_D/12$ | = Per month investment in variable inputs (in Rupees) |
| TH | = Total herd size – DBM + IBM + SH (in numbers) |
| DBM | = "Desi" breed milking (DBM) buffaloes (in numbers) |
| IBM | = Improved breed milking (IBM) buffaloes (in numbers) |
| N | = Availability of family labor (number of female adults) |
| $L_D$ | = Availability of fodder or grass land (in acres with two decimals) |
| $\epsilon$ | = Unobserved residual |

$\beta$'s are unknown parameters.

The separate specification of "desi" and improved breed milking buffaloes, like the distinction between the two varieties of a crop, is important in examining the effects of technological change. $\beta_3$ associated with the ratio of improved breed milking to total herd is expected to be larger than the $\beta_2$. This is because there is greater economic incentive to maintain the improved breed buffaloes in a better way[3] than the "desi" ones.

Total herd size is defined to include "desi" breed (DBM), improved breed (IBM) milking animals plus the supporting (SH) animals, (i.e. non-milking animals, and young calves). It is one of the relevant variables influencing per animal investment, because it shows whether or not scale or size effect is operating. Thus, estimate of $\beta_1$ is expected to be positive and significant.

Table 1 presents the results of estimated model and Theil's "U" statistic[4] along with its decomposition to test the accuracy with which the model can predict.

All the coefficients have the logical signs. As expected, $\hat{\beta}_3$ is larger than $\hat{\beta}_2$. This indicates a larger increase in per animal monthly investment in variable inputs as a result of change in the composition of herd from "desi" to improved breed milking buffalo.

The model is not reestimated after excluding the variable of total herd size to test whether or not the scale economies are in operation, because $\hat{\beta}_1$ is nonsignificant. This result is presumably because there are no potentialities for scale economies under the existing technological conditions characterized in low capital-labor ratio in dairy-farming.

Although only 38 percent of the variations in per animal investment in variable inputs are explained by the model, the "U" statistic (.1675) is reasonably close to the ideal value, namely, zero, for accurate prediction. The coefficient of correlation between actual and predicted values of per animal monthly investment in variable inputs is 0.61. The results on three partial coefficients of inequality show that almost 76 percent of the difference between actual and predicted values is caused by imperfect covariation, whereas the remaining 24 percent is caused by unequal variation.

**Factors Influencing the Gross Revenue**

The per animal monthly investment in variable inputs so determined, in addition to the other factors, would influence the per animal per month gross revenue – $\frac{R_D/12}{TH}$ from dairying. The gross revenue is defined to include the value of milk and dung manure, both of which are measured in constant prices. The following equation was specified using the behavioral equation 2 in Chapter II:

$$(3.1.2) \quad \frac{R_D/12}{TH} = \beta'_0 + \beta'_1 \, TH + \beta'_2 \frac{DBM}{TH} + \beta'_3 \frac{IBM}{TH} + \beta'_4 \frac{N}{TH} + \gamma \frac{I_D/12}{TH} + \epsilon'$$

The definitions of the variables are the same as before. The results are given in Table 2.

The significant coefficients for the ratios of two different breeds of milking to total herd size support the primary emphasis of this section. As was hypothesized, $\hat{\beta}'_3$ is larger than $\hat{\beta}'_2$. This implies that the increase in per animal monthly gross revenue from dairying as a result of replacement of "desi" by improved breed milking buffalo would be larger.

The coefficients associated with herd size and per animal availability of family labor are not significant. The nonsignificance of the coefficient associated with the total herd size indicates the absence of size economies in dairy-farming of the sample farmers. This could be explained by the nature of existing technology in dairy-farming.

The model explains 50 percent of variation in per animal gross revenue from dairying. The results on Theil's

---

[2]For convenience in presentation subscript n for number of farms and t for current year are omitted from this and other equations in the chapter. Fourteen of the original size of 99 sample farmers were excluded for this study because of failure of crop harvest and incomplete data on input and output of certain crops.

[3]An average farmer in the sample from the same district studied by Schluter spent Rs. 2.59 per day on concentrates for an improved breed buffalo compared with Rs. 2.07 for a "desi" buffalo. This farmer obtained an additional milk yield of 1.19 liters per day from an improved buffalo. Schluter, *op. cit.*, pp. 85 and 164.

[4]A note in the Appendix explains this statistic.

method of error analysis can be interpreted to indicate conclusions similar to those of equation (3.1.1). Equation (3.1.2) was analyzed in a similar manner using predicted instead of observed values of per animal monthly investment in variable inputs. "U" coefficient derived from this analysis is very similar to that derived from using observed values of this variable. However, there is a decline, although small in magnitude, in the percentage difference between actual and predicted values of per animal monthly gross revenue attributable to the imperfect covariation – $UC^2$.

Finally, monthly net income from dairying can be computed, as will be done in Chapter IV, by using equations (3.1.1) and (3.1.2).

**Table 1. Estimated OLS Parameters and Results of Theil's Method of Error Analysis of the Equation for Factors Influencing Per Animal Monthly Investment in Variable Inputs for Dairy-Farming of Sample Farmers, Surat District, 1969-70**

| | Explanatory variables | | | | | |
|---|---|---|---|---|---|---|
| | TH | $\frac{DBM}{TH}$ | $\frac{IBM}{TH}$ | $\frac{N}{TH}$ | $\frac{L_D}{TH}$ | Constant |
| Coefficients | 0.392 | 27.437 | 42.817 | –1.851 | 4.506 | 7.080 |
| Standard errors | 0.486 | 5.738 | 9.052 | 2.583 | 1.600 | 4.769 |
| | $R^2$ = .373 | | | | | |

Theil's Method of Error Analysis

| | |
|---|---|
| U | 0.1675 |
| $UM^2$ (%) | 0.00 |
| $US^2$ (%) | 24.15 |
| $UC^2$ (%) | 75.85 |
| r | 0.6109 |

**Table 2. Estimated OLS Parameters and Results of Theil's Method of Error Analysis for the Equation for Factors Influencing Per Animal Monthly Dairy Revenue of Sample Farmers, Surat District, 1969-70**

| | Explanatory variables | | | | | |
|---|---|---|---|---|---|---|
| | TH | $\frac{DBM}{TH}$ | $\frac{IBM}{TH}$ | $\frac{N}{TH}$ | $\frac{I_D/12}{TH}$ | Constant |
| Coefficients | 0.141 | 38.379 | 72.542 | 1.386 | 0.590 | 6.495 |
| Standard errors | 0.806 | 10.832 | 16.868 | 4.189 | 0.185 | 7.953 |
| | $R^2$ = .495 | | | | | |

Theil's Method of Error Analysis

| | Using observed $\frac{I_D/12}{TH}$ | Using predicted $\frac{I_D/12}{TH}$ |
|---|---|---|
| U | 0.1584 | 0.1695 |
| $UM^2$ (%) | 0.00 | 0.00 |
| $US^2$ (%) | 15.92 | 19.80 |
| $UC^2$ (%) | 84.08 | 80.20 |
| r | 0.7005 | 0.6486 |

### Section 2: Crop-Farming Activity of Year t
### Assumptions Revisited and Importance of Crop Pattern

Given the internal flow of funds from such sources as dairy plus non-farm incomes, the farmers take their crop-farming decisions of year t (1969-70). For the multi-crop producing farm-families the question of allocation of their land to various crops is far more important. This is because once the land input is committed for a particular crop it cannot be diverted to other crops until the next crop-season. Moreover, under the conditions of constant output-input prices the per acre aggregate input use and per acre aggregate gross revenue of such farms are largely associated with the crop pattern (Table 3). However, the percentage of variation in per acre net returns of each crop explained by such factors as net cultivable land, supplementary incomes, value of assets, and family size is extremely small (Table 4). Therefore, the per acre input use and per acre revenue of each crop are considered fixed. Finally, it is assumed that all crops compete with each other.

### A Stylized Model of Crop Pattern and Its Results

Under the above assumptions which are consistent with the sample data under study, the farmers' decision to grow various crops is influenced by two sets of explanatory factors. The first set of variables include their monthly inflow of family capital from current dairy *plus* non-farm incomes, *minus* their monthly outflow of current aggregate consumption expenditure. The net flow of funds formed from these can be termed as net family (or internal) finance that would influence the choice of crops. This integration of family finance and crop pattern decisions of farmers is important under the imperfections in capital market as well as risks in crop-farming.

The second set of predetermined variables include the farm size, availability of net irrigable land, wealth, and the per acre expected net returns from own and competing crops.[5] The per acre net returns from own and competing crops of year t – 1 are defined as per acre expected net returns. Since the data for the year t – 1 were not available the data for this variable for the year t were used. This is an improper specification because farmers' per acre *expected* net returns must be defined and measured in terms of their past experience to analyze their influence in the current period. Nevertheless, this specification is used, because inclusion of an improperly measured variable

[5] As was mentioned in Chapter II, prices of crops and availability of credit are excluded from this list of variables because the available data did not contain variation in them.

Table 3. Estimated Equations showing the Importance of Cropping-Pattern in Determining Variation in Per Acre Gross Revenue and Per Acre Expenses on Variable Inputs, Sample Farmers, Surat District, 1969-70

| Independent variables (proportion of size of farm under various crops) | Dependent variables (in 000 Rs. per acre of farm): All variable inputs | Hired labor | Ferti-lizers | Irriga-tion | Oil cakes | Gross reve-nue |
|---|---|---|---|---|---|---|
| High-yielding paddy | 0.641 | 0.280 | 0.900 | 0.058 | 0.012 | 1.080 |
| | (0.103) | (0.046) | (0.032) | (0.014) | (0.020) | (0.230) |
| Wheat | 0.747 | 0.298 | 0.172 | 0.004 | 0.162 | 1.340 |
| | (0.272) | (0.120) | (0.085) | (0.054) | (0.076) | (0.606) |
| Sugarcane | 1.451 | 0.452 | 0.265 | 0.223 | 0.130 | 2.886 |
| | (0.059) | (0.026) | (0.018) | (0.012) | (0.017) | (0.132) |
| Banana | 1.556 | 0.326 | 0.410 | 0.285 | 0.208 | 2.328 |
| | (0.099) | (0.044) | (0.307) | (0.020) | (0.028) | (0.220) |
| Other foodgrains[1] | 0.014 | –0.026 | –0.013 | — | — | 0.193 |
| | (0.086) | (0.038) | (0.027) | | | (0.193) |
| Other nonfoodgrains[2] | 0.183 | 0.083 | 0.023 | — | — | 0.286 |
| | (0.077) | (0.034) | (0.024) | | | (0.171) |
| r | .981 | .963 | .952 | .962 | .850 | .973 |

Figures in parentheses are standard errors.

[1] Other foodgrains include jowar, tur and val.

[2] Other nonfoodgrains include cotton and groundnut.

Table 4. Estimated Regression Equations for Factors Explaining Per Acre Net Returns on Various Crops, Surat District, 1969-70

| Independent variables | Dependent variables (in 000 Rupees) Per acre net returns on: Sugarcane | Banana | High-yielding paddy | Wheat | Other food-grains | Other nonfood-grains |
|---|---|---|---|---|---|---|
| Net cultivable land (in acres with two decimals) | .0058<br>(.0174) | .0059<br>(.0279) | –.0043<br>(.0085) | .0049<br>(.0066) | –.0011<br>(.0032) | –.0029<br>(.0058) |
| Monthly dairy plus nonagricultural income (in Rupees) | .0004<br>(.0005) | –.0010<br>(.0016) | .0001<br>(.0002) | –.0002<br>(.0001) | .0001<br>(.00008) | .0001<br>(.0001) |
| Value of assets other than land (in 000 Rupees) | .0024<br>(.0039) | .0069<br>(.0055) | .0005<br>(.0018) | –.00003<br>(.0013) | –.0002<br>(.0007) | .0004<br>(.0012) |
| Family size (in number) | .0031<br>(.0309) | –.0440<br>(.0545) | –.0115<br>(.0133) | .0083<br>(.0091) | –.0037<br>(.0047) | .0005<br>(.0081) |
| Constant | 1.1407<br>(.3050) | 0.9799<br>(.4273) | 0.7268<br>(.1154) | 0.2633<br>(.0861) | 0.1619<br>(.0417) | 0.2338<br>(.0748) |
| $R^2$ | .035 | .119 | .020 | .123 | .055 | .049 |

being a reasonable indicator was considered more appropriate than its total exclusion from the model.

Furthermore, the per acre expected net returns of each crop of a given farmer was specified in two different ways because every farmer did not grow all the crops.[6] Thus, when a given farmer did not grow a particular crop, his expectation of per acre net returns was defined and measured as being positive constant (1) by creating a dummy variable. Against this, when a farmer did grow the crop, his positive per acre net returns for the crop was used as the variable. This procedure implies an assumption of constant per acre expected net returns of a crop for those farmers who did not grow the crop. However, the expectations of those farmers who did grow the crop are assumed to vary.

The results of the above model were, however, inconsistent in the sense that the estimated parameters associated with the per acre expected net returns of own and competing crops did not have logical signs. For example, in the equation for own ($i^{th}$) crop the sign of the coefficients for per acre expected net returns of this crop was negative, whereas that for the competing ($q^{th}$) crop was positive. Similarly, the sign of the coefficients associated with the monthly net flow of funds in different equations was also illogical. Contrary to the hypothesis, the probability of growing high-return high-working-capital-intensive crops was inversely related to the net flow of funds formed from dairy plus non-farm incomes minus consumption expenditure. Hence, in the rest of this section and study we shall utilize that model from which per acre net returns, and net flow of funds variables are excluded.

**Empirically Accepted Model of Crop Pattern and Its Results**

The estimated form of the model is outlined below:

$$(3.3.1.i) \quad \frac{L_i}{L_{nc}} = \hat{a}_i + \hat{\beta}_{i1} L_{nc} + \hat{\beta}_{i2} y_F + \hat{\beta}_{i3} W + \hat{\beta}_{i4} L_{nI} + \hat{\beta}_{i5} F$$

i = 1, ... 6 crops

Where

$L_1$ = Land under $i^{th}$ crop (in acres with two decimals)

$L_{nc}$ = Net cultivable land (in acres with two decimals)

$y_F$ = Per month net income from dairy plus non-farm jobs (in Rupees)

W = Value of assets excluding land (in 000 Rupees)

$L_{nI}$ = Net irrigable land (in acres with two decimals)

F = Family size (in number)

[6] And consequently, the data recorded zero per acre net returns of those crops that were not grown by a farmer.

Crop pattern is defined as the proportion of land under $i^{th}$ crop to net cultivable land instead of gross cropped area. This is because net cultivable land unlike gross cropped area[7] reflects the size of a farm which is considered for collateral and such other purposes by public policy agencies. Moreover, use of this definition permits prediction of intensity of cropping on given land.[8] The results of estimated model are given in Table 5.

The negative coefficient for farm size in case of high-return crops such as sugarcane, banana, high-yielding paddy, and desi wheat indicates that as farm size increases, the proportion of acreage under these crops declines. This finding can be explained by marketing and other constraints that may have influenced crop pattern. The marketing constraint is particularly operative for sugarcane and banana which most farmers in Surat district grow for the cooperative marketing and processing societies. This constraint primarily operates through the existing crushing capacity of sugar factories and the transport facilities available to the fruit and vegetable marketing cooperatives in the district.

The diseconomies of scale in managing labor force on large farms, shortage of labor and other inputs, particularly at the peak period of demand for them are some of the other important factors explaining the above result.

The availability of net irrigable land was considered a relevant variable for the unirrigated crops of other foodgrains and other non-foodgrains, because unirrigated crops can also be grown on irrigable land. It is, however, expected that the relationship between these variables would be inverse. The coefficient associated with net irrigable land has the logical sign in all crop-equations, it

[7] Gross cropped area itself could vary with the variation in net cultivable land.

[8] It is because of this definition and also because of the existence of double cropping by sample farmers, the model specified does not require the additivity constraint on its parameters. This specification implies:

$$\sum_{i=1}^{6} \alpha_i > 1, \text{ and } \sum_{i=1}^{6} \hat{\beta}_{ik}=0 \text{ for each k.}$$

These restrictions are reasonably met by the estimated model (Table 5).

Table 5. Estimated Equations for Factors Influencing Crop-Pattern of Sample Farmers, Surat District, 1969-70

| Dependent variables | Explanatory variables | | | | | Constant | $R^2$ |
|---|---|---|---|---|---|---|---|
| | $L_{nc}$ | $y_F$ | W | $L_{nI}$ | F | | |
| $L_{HYP}/L_{nc}$ | −.0181<br>(.0079) | .0002<br>(.0001) | .0002<br>(.0011) | .0053<br>(.0090) | −.0149<br>(.0081) | .4895<br>(.0708) | .1584 |
| $L_{SC}/L_{nc}$ | −.0326<br>(.0086) | — | .0019<br>(.0011) | .0293<br>(.0098) | −.0034<br>(.0088) | .2543<br>(.0765) | .1805 |
| $L_{BN}/L_{nc}$ | −.0136<br>(.0056) | — | .0001<br>(.0007) | .0200<br>(.0064) | .0016<br>(.0057) | .0615<br>(.0500) | .1297 |
| $L_{WT}/L_{nc}$ | −.0040<br>(.0024) | .0001<br>(.00004) | .0001<br>(.0003) | .0030<br>(.0028) | −.0007<br>(.0025) | .0523<br>(.0219) | .1097 |
| $L_{OFG}/L_{nc}$ | .0149<br>(.0083) | .0003<br>(.0001) | −.0019<br>(.0012) | −.0227<br>(.0094) | −.0055<br>(.0084) | .4327<br>(.0737) | .1818 |
| $L_{ONFG}/L_{nc}$ | .0333<br>(.0066) | −.0001<br>(.0001) | −.0014<br>(.0009) | −.0297<br>(.0074) | −.0027<br>(.0067) | .1655<br>(.0584) | .2834 |

Figures in brackets are standard errors.

$L_{HYP}$ = Acreage under high-yielding paddy
$L_{SC}$ = Acreage under sugarcane
$L_{BN}$ = Acreage under banana
$L_{WT}$ = Acreage under wheat
$L_{OFG}$ = Acreage under other foodgrains (jowar, tur and val)
$L_{ONFG}$ = Acreage under other nonfoodgrains (cotton and groundnut)

$\sum_{i=1}^{6} \hat{a}_i = 1.4558$
$\sum_{i=1}^{6} \hat{\beta}_{i1} = -0.0201$
$\sum_{i=1}^{6} \hat{\beta}_{i2} = +0.0005$
$\sum_{i=1}^{6} \hat{\beta}_{i3} = -0.0010$
$\sum_{i=1}^{6} \hat{\beta}_{i4} = +0.0052$
$\sum_{i=1}^{6} \hat{\beta}_{i5} = -0.0188$

being positive for high-return crops such as sugarcane, banana, HYV paddy, and negative for low-return crops of other foodgrains and non-foodgrains. In addition, the pattern of size of this coefficient in different equations is also logical. The coefficient for sugarcane which is the most remunerative crop being the largest, followed by banana, high-yielding paddy, wheat, other foodgrains and other non-foodgrains in that order of importance. The results suggest that increasing the availability of net irrigable land would increase the proportion of land allocated to high-return crops such as sugarcane, and HYV paddy, whereas it would decrease the proportion of land under low-return crops of other foodgrains, and other non-foodgrains.

The estimated parameter for wealth, a proxy for incorporating risk and uncertainty hypothesis, has the positive sign for such crops as sugarcane, banana, HYV paddy, and wheat, as against negative for other foodgrains and other non-foodgrains. This result suggests that as farmers' ability and willingness to take risks increase, the crop pattern would shift from low-risk to high-risk crops.

On a priori considerations, family size variable was specified as a proxy for aggregate consumption expenditure. For the sample under study, this variable may not be interpreted as a proxy for family labor except for supervisory work for crop-farming. This is further reinforced by the sign of the coefficient in the equation for banana which requires the most supervision as well as watching.

The two sources of non-crop-incomes were first specified separately to find out whether or not their effect on cropping pattern was the same. The "t" test performed for this revealed that their effect was the same. Hence, the model was reestimated after combining the two sources of non-crop incomes. However, this variable was omitted from the equation for the two most risky as well as working capital-intensive crops, namely, sugarcane and banana. This is because the sign of the coefficient associated with this variable in these two crop-equations was negative. Given the supplementary nature of these two sources of income and given the long-duration as well as very high working capital-intensity of these crops farmers' view of the role of these incomes may not be similar to that conceptualized in the a priori hypothesis. Therefore, omitting this variable from the model would give better predictions of crop pattern than its inclusion.

As regards the predicting ability of the different equations, the following may be noted: the lower $R^2$ is largely because of the use of ratios as dependent variables. The "U" statistic ranged between .2719 for other foodgrains to .5159 for banana, indicating thereby a varying predicting ability of different crop-equations (Table 6).

**Table 6. Results of Theil's Method of Error Analysis for the Equations for Factors Influencing Crop-Pattern of Sample Farmers, Surat District, 1969-70**

| Statistics | $L_{HYP}/L_{nc}$ | | $L_{SC}/L_{nc}$ | | $L_{BN}/L_{nc}$ | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 1 | 2 | 1 | 2 |
| U | .3118 | .3139 | .4142 | same | .5150 | same |
| $UM^2$ (%) | 0.00 | 0.00 | 0.00 | as | 0.00 | as |
| $US^2$ (%) | 44.86 | 42.57 | 46.48 | for | 52.99 | for |
| $UC^2$ (%) | 55.14 | 57.43 | 53.52 | 1* | 47.01 | 1* |
| r | 0.4114 | 0.3952 | 0.4306 | | .3638 | |

| | $L_{WT}/L_{nc}$ | | $L_{OFG}/L_{nc}$ | | $L_{ONFG}/L_{nc}$ | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 1 | 2 | 1 | 2 |
| U | .4730 | .4677 | .2719 | .2764 | .3578 | .3584 |
| $UM^2$ (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $US^2$ (%) | 53.67 | 50.49 | 42.64 | 40.23 | 30.80 | 30.88 |
| $UC^2$ (%) | 46.33 | 49.51 | 57.36 | 59.77 | 69.20 | 69.12 |
| r | 0.3206 | 0.3446 | 0.4594 | 0.4262 | 0.5312 | 0.5282 |

1 denotes using observed values of all explanatory variables.

2 denotes using predicted value of dairy income and observed values of all other explanatory variables.

* This is because $y_f$ which includes dairy income is not an explanatory factor influencing $L_{SC}/L_{nc}$ and $L_{BN}/L_{nc}$.

The two most common crop combinations, namely, paddy, and other foodgrains have the lowest "U" statistic. The coefficients of correlation between actual and predicted ratios of land under various crops to net cultivable land ranged between 0.32 for wheat and 0.53 for other non-foodgrains. More than 50 percent of the difference between actual and predicted values is caused by the imperfect covariation between them. Finally, these results remain unchanged even when residuals were anlyzed using the predicted values of dairy income which is included in variable $y_F$.

### Input Requirements and Gross Revenue of Crops

Considering the relations 7.m.i, 8.i, and 9.i specified in Chapter II, the estimated linear equations for $m^{th}$ input for $i^{th}$ crop, gross revenue of $i^{th}$ crop and total expenditure on all m inputs for $i^{th}$ crop are given below:

(3.2.2.m.i) $I_{cmi} = \hat{\delta}_{im} L_i$

(3.2.3.i) $R_{ci} = \hat{\theta}_i L_i$

(3.2.4.i) $I_{CTi} = \hat{\lambda}_i L_i$

Where i = 1, .... 6 crops

m = 1, .... 4 variable inputs (hired labor, fertilizers, oil cakes, and irrigation charges)

$I_{cmi}$ = Expenditure on $m^{th}$ input for $i^{th}$ crop (in Rupees)

$L_i$ = Acreage under $i^{th}$ crop (in acres with two decimals)

$R_{ci}$ = Gross revenue of $i^{th}$ crop (in Rupees)

$I_{CTi}$ = Total expenditure on all farm inputs (bullock labor, farm yard manure, besides the above mentioned four inputs) for $i^{th}$ crop (in Rupees).

The estimated equations show high degree of association between the acreage under $i^{th}$ crop, and the concerned dependent variable (Table 7). The coefficients $\hat{\delta}_{im}$, $\hat{\theta}_i$,

Table 7. Estimated Regression Equations for Expenses on Variable Inputs and Gross Revenue of Various Crops, Sample Farmers, Surat District, 1969-70[a]

| Independent variables (in acres with two decimals) | Dependent variables (in Rupees) | | | | | |
|---|---|---|---|---|---|---|
| | All variable inputs | Hired labor | Fertilizers | Irrigation | Oil cakes | Gross revenue |
| Sugarcane | 1460.511 | 459.423 | 247.316 | 209.392 | 162.674 | 3010.789 |
| | (51.270) | (21.347) | (13.816) | (8.092) | (16.258) | (169.673) |
| r | .973 | .954 | .935 | .967 | .828 | .934 |
| Banana | 1753.727 | 394.882 | 429.872 | 270.549 | 221.490 | 2608.184 |
| | (114.554) | (35.792) | (34.071) | (14.757) | (29.491) | (210.945) |
| r | .947 | .904 | .925 | .962 | .822 | .923 |
| High-yielding paddy | 627.443 | 192.991 | 102.327 | 35.807 | 31.332 | 1188.362 |
| | (22.840) | (8.481) | (7.088) | (2.128) | (5.129) | (45.857) |
| r | .951 | .931 | .850 | .883 | .564 | .946 |
| Wheat | 345.739 | 79.278 | 88.804 | 58.495 | 20.538 | 577.375 |
| | (14.706) | (8.612) | (7.666) | (5.620) | (3.915) | (32.381) |
| r | .967 | .831 | .883 | .860 | .648 | .945 |
| Other foodgrains | 109.665 | 42.753 | 3.059 | — | — | 238.068 |
| | (5.141) | (2.201) | (.841) | | | (9.521) |
| r | .924 | .910 | .381 | | | .943 |
| Other non-foodgrains | 166.979 | 72.042 | 19.732 | — | — | 352.941 |
| | (12.037) | (7.698) | (18.251) | | | (23.796) |
| r | .894 | .804 | .453 | | | .906 |

Figures in parentheses are standard errors.

[a]Each coefficient represents per acre value of the relevant dependent variable.

Table 8. Results of Theil's Method of Error Analysis for Equations Estimating Gross Revenue and Expenditure on Variable Inputs for Various Crops, Sample Farmers, Surat District, 1969-70

| | | HYV paddy | Sugarcane | Banana | Wheat | Other foodgrains[3] | Other non-food-grains[4] |
|---|---|---|---|---|---|---|---|
| | | **Gross revenue (RCi) from** | | | | | |
| U | (1)[1] | .1693 | .1836 | .2269 | .1852 | .1706 | .2239 |
| | (2)[2] | .2993 | .3882 | .4263 | .4242 | .2930 | .3853 |
| $UM^2$ (%) | (1) | 0.76 | 0.69 | 0.70 | 0.55 | 0.95 | 0.72 |
| | (2) | 0.23 | 0.19 | 0.28 | 0.63 | 0.43 | 0.30 |
| $US^2$ (%) | (1) | 3.05 | 8.26 | 5.86 | 3.06 | 10.22 | 4.24 |
| | (2) | 29.27 | 22.81 | 35.51 | 15.32 | 31.73 | 12.28 |
| $UC^2$ (%) | (1) | 96.19 | 91.05 | 93.44 | 96.39 | 88.83 | 95.04 |
| | (2) | 70.50 | 77.00 | 64.21 | 84.05 | 67.84 | 87.42 |
| r | (1) | .8451 | .9061 | .8788 | .9055 | .9035 | .8437 |
| | (2) | .4464 | .5698 | .6406 | .4862 | .7293 | .5182 |
| | | **Expenditure on all variable inputs ($I_{CTi}$) for** | | | | | |
| U | (1) | .1624 | .1171 | .1941 | .1502 | .1988 | .2362 |
| | (2) | .3173 | .3710 | .4252 | .3912 | .2864 | .3570 |
| $UM^2$ (%) | (1) | 0.00 | 0.36 | 0.92 | 0.75 | 0.60 | 0.44 |
| | (2) | 0.00 | 0.05 | 0.27 | 0.09 | 0.28 | 0.24 |
| $US^2$ (%) | (1) | 7.58 | 3.58 | 4.25 | 0.62 | 3.50 | 5.97 |
| | (2) | 31.59 | 17.45 | 31.85 | 18.01 | 25.82 | 16.88 |
| $UC^2$ (%) | (1) | 92.42 | 96.06 | 94.83 | 98.63 | 95.90 | 93.59 |
| | (2) | 68.41 | 82.50 | 67.88 | 81.90 | 73.90 | 82.88 |
| r | (1) | .8699 | .9583 | .9095 | .9376 | .8496 | .8312 |
| | (2) | .4267 | .5664 | .6218 | .5839 | .7001 | .6127 |
| | | **Expenditure on hired human labor ($LE_i$) for** | | | | | |
| U | (1) | .1908 | .1532 | .2385 | .3202 | .2156 | .3299 |
| | (2) | .3166 | .3768 | .4348 | .5179 | .2790 | .4431 |
| $UM^2$ (%) | (1) | 0.55 | 0.28 | 0.45 | 3.74 | 0.21 | 0.21 |
| | (2) | 0.19 | 0.06 | 0.19 | 1.64 | 0.18 | 0.14 |
| $US^2$ (%) | (1) | 5.13 | 5.21 | 7.80 | 5.18 | 9.88 | 13.91 |
| | (2) | 30.63 | 19.77 | 37.22 | 18.08 | 40.41 | 22.58 |
| $UC^2$ (%) | (1) | 94.32 | 94.51 | 91.75 | 91.08 | 89.91 | 85.88 |
| | (2) | 69.18 | 80.17 | 62.59 | 80.28 | 59.41 | 77.28 |
| r | (1) | .8121 | .9306 | .8693 | .7334 | .8449 | .7100 |
| | (2) | .4076 | .5697 | .6364 | .2575 | .7857 | .4628 |
| | | **Expenditure on fertilizers ($FE_i$) for** | | | | | |
| U | (1) | .2862 | .1829 | .2116 | .2684 | .6222 | .4352 |
| | (2) | .3624 | .3977 | .4500 | .4420 | .6250 | .4897 |
| $UM^2$ (%) | (1) | 0.34 | 0.00 | 1.10 | 0.00 | 0.02 | 0.11 |
| | (2) | 0.20 | 0.00 | 0.34 | 0.00 | 0.00 | 0.09 |

Table 8. — Continued

| | | Expenditure on fertilizers ($FE_i$) for | | | | | |
|---|---|---|---|---|---|---|---|
| | | HYV paddy | Sugarcane | Banana | Wheat | Other foodgrains[3] | Other non-food-grains[4] |
| US² (%) | (1) | 13.12 | 5.45 | 5.90 | 7.49 | 39.17 | 21.12 |
| | (2) | 41.42 | 19.23 | 30.94 | 25.63 | 58.65 | 34.17 |
| UC² (%) | (1) | 86.54 | 94.55 | 93.00 | 92.51 | 60.71 | 78.77 |
| | (2) | 58.38 | 80.77 | 68.72 | 74.37 | 41.35 | 65.74 |
| r | (1) | .6470 | .9008 | .8946 | .8341 | .1874 | .5605 |
| | (2) | .4006 | .5147 | .5697 | .5324 | .2763 | .4661 |

| | | Expenditure on irrigation ($WE_i$) for | | | |
|---|---|---|---|---|---|
| | | HYV paddy | Sugarcane | Banana | Wheat |
| U | (1) | .2596 | .1302 | .2010 | .2765 |
| | (2) | .3321 | .3800 | .4234 | .3850 |
| UM² (%) | (1) | 1.45 | 0.56 | 0.85 | 1.91 |
| | (2) | 0.93 | 0.07 | 0.28 | 1.37 |
| US² (%) | (1) | 5.25 | 1.21 | 2.26 | 13.12 |
| | (2) | 32.42 | 14.73 | 29.69 | 43.78 |
| UC² (%) | (1) | 93.30 | 98.23 | 96.89 | 84.97 |
| | (2) | 66.65 | 85.20 | 70.03 | 54.85 |
| r | (1) | .6573 | .9458 | .9005 | .8328 |
| | (2) | .3725 | .5169 | .6127 | .7487 |
| | | **Expenditure on oil cakes ($OC_i$) for** | | | |
| U | (1) | .5298 | .3062 | .3282 | .4602 |
| | (2) | .6202 | .4313 | .4785 | .5365 |
| UM² (%) | (1) | 1.02 | 1.44 | 1.20 | 1.12 |
| | (2) | .84 | 0.88 | 0.76 | 1.07 |
| US² (%) | (1) | 53.77 | 18.90 | 10.00 | 27.63 |
| | (2) | 65.17 | 37.42 | 39.81 | 51.73 |
| UC² (%) | (1) | 45.21 | 79.66 | 87.90 | 71.25 |
| | (2) | 33.99 | 61.70 | 59.43 | 47.20 |
| r | (1) | .4922 | .7849 | .7609 | .6142 |
| | (2) | .1563 | .5949 | .5719 | .5693 |

(1) refers to value predicted by using *observed* acreage under the crop.

(2) refers to value computed by using *predicted* acreage under the crop.

[3]Other foodgrains include jowar, tur and val.

[4]Other nonfoodgrains include cotton and groundnut.

and $\hat{\lambda}_i$ represent, the per acre expenditure on $m^{th}$ input for $i^{th}$ crop, per acre gross revenue of $i^{th}$ crop, and per acre expenditure on all variable inputs respectively. Finally, net income from crops can be computed, as will be done in Chapter IV, by using these per acre coefficients and the acreage under various crops predicted from equations (3.2.1.i) discussed earlier.

The "U" statistic that is calculated by using observed acreage under a crop is smaller than that computed by using predicted acreage under a crop. The percentages of difference between actual and predicted values caused by unequal central tendency and imperfect covariation are lower when they are calculated by using predicted instead of observed acreage under a crop. Hence, the percentage of difference between actual and predicted values caused by imperfect variation is higher when it is calculated by utilizing predicted instead of observed acreage. Finally, "U" statistic calculated by utilizing predicted acreage under a crop exceeds 0.50 for only 4 out of 32 equations (Table 8).

### Section 3: Aggregate Consumption Activity of Year t + 1

It may be recalled from Chapter II that in the sequential decision-making process the farmers were assumed to take their monthly aggregate consumption decision at the beginning of every crop-year. Hence, at the beginning of year t + 1 (i.e. 1970-71), the farmers take their decision to consume. The factors influencing aggregate consumption expenditure of the sample farm-families are now examined.

#### Factors Influencing Aggregate Consumption Expenditure

Using the behavioral equation 13 specified in Chapter II, the following model was estimated:

$$(3.3.1)\quad \frac{C_{t+1}}{12} = \beta''_0 + \beta''_1\, y_T + \beta''_2\, \frac{1}{y_T} + \beta''_3 \left[\left(\frac{R}{I}\right)_{CT} \cdot y_T\right] + \beta''_4\, W_{t+1} + \beta''_5\, F_{t+1} + \epsilon''_{t+1}$$

Where

$C_{t+1}/12$ = Monthly aggregate consumption expenditure of year t + 1 (in Rupees)

$y_T$ = Monthly net family income of year t – termed as expected income (in Rupees)

$(R/I)_{CT}$ = Ratio of aggregate gross value of output to investment in variable inputs for crop farming of year t – termed as expected intensity of crop-farming

$W_{t+1}$ = Value of farm and non-farm assets excluding land in year t + 1 (in 000 Rupees).

$F_{t+1}$ = Family size in year t + 1 (in number)

$\epsilon''_{t+1}$ = Unobserved residual of year t + 1

$\beta''_0$ and $\beta''_1 \ldots \beta''_5$ are unknown parameters.

The main determinants of monthly aggregate consumption expenditure of year t + 1 are expected intensity of crop-farming, expected monthly net family income[9], wealth, and family size. The expected intensity of crop-farming is defined as the ratio of aggregate gross revenue to investment in variable inputs in year t. This variable is specified because the farm-family, unlike the industrial firm, is both a producer and a consumer. This hypothesis of inverse relationship between expected returns to investment and aggregate consumption expenditure (i.e. the negative sign for the parameter $\beta''_3$) is particularly relevant in an agriculture that faces imperfections in capital market and also characterized by rapid productivity changes. Furthermore, the variable of expected intensity of crop-farming is specified so that its effect varies with the level of income. This can be seen by differentiating C with respect to $(R/I)_{CT}$, i.e.

$$\frac{\partial C}{\partial (R/I)_{CT}} = \beta''_3\, y_T$$

Since we expect $\beta''_3 < 0$, $\frac{\partial C}{\partial (R/I)_{CT}}$ also must be negative. Thus, as the expected intensity of crop-farming increases, holding other factors constant, the farmer with a low income will reduce the aggregate consumption by a smaller amount than the farmer having higher level of income. This is because at a lower level of income consumption being low the scope for reducing consumption would also be low.

The expected net family income is specified to incorporate the hypothesis of varying marginal propensity to consume with respect to income. This is seen by differentiating C with respect to $y_T$, i.e.

$$\frac{\partial C}{\partial y_T} = \beta''_1 - \frac{\beta''_2}{y_T^2} + \beta''_3 \left(\frac{R}{I}\right)_{CT}$$

The estimated OLS parameters of the model and the results of Theil's Method of Error Analysis are given in Table 9.

All the coefficients have the expected signs. Fifty-three percent of variation in aggregate consumption expenditure

[9]An unrestricted model that specified expected crop-income and expected dairy plus non-farm incomes separately was tested against the restricted model which did not distinguish between these two sources of income. The "F" test, at 5 percent significance level, revealed that the two models were the same implying thereby that the marginal propensity to spend the two types of income did not differ.

Table 9. Estimated OLS Parameters and the Results of Theil's Method of Error Analysis of the Equation for Factors Influencing Monthly Aggregate Consumption Expenditure, Sample Farmers, Surat District, 1970-71

| | Explanatory variables | | | | | |
|---|---|---|---|---|---|---|
| | $y_T$ | $1/y_T$ | $(R/I)_C{}^*y_T$ | $W_{t+1}$ | $F_{t+1}$ | Constant |
| Coefficients | 0.499 | −6047.389 | −.136 | 0.938 | 34.448 | 184.992 |
| Standard errors | 0.139 | 14004.38 | 0.052 | 1.014 | 7.365 | 87.711 |
| | $R^2$ = .525 | | | | | |

Theil's Method of Error Analysis

| | Using observed $y_T$ and $(R/I)_C$ | Using predicted $y_T$ and $(R/I)_C$ |
|---|---|---|
| U | 0.1474 | 0.1459 |
| $UM^2$ (%) | 0.00 | 0.00 |
| $US^2$ (%) | 19.60 | 20.20 |
| $UC^2$ (%) | 80.40 | 79.80 |
| r | 0.7189 | 0.7175 |

is explained by the model. Both the "U" coefficients are quite close to zero (the ideal value) and are also the same. A large percentage difference between the actual and predicted values of monthly aggregate consumption is caused by the imperfect covariation. This is true for the residual analysis carried out by both the procedures as indicated in Table 9. Finally, exclusion of the variable of expected intensity of crop-farming from the model reduces the marginal propensity to consume with respect to the expected net family income by almost 33 percent.

### Section 4: Allocation of Aggregate Consumption Expenditure on Various Goods and Services of Year t + 1

In the sequential decision-making process the decision consequent to the farmer's decision for aggregate consumption expenditure is the allocation of this expenditure on various goods and services. The pattern of consumption expenditure of sample farmers is now examined.

**Model on Engel Functions**

Using the behavioral equation 14 that was specified in Chapter II, the model is outlined below:

$$\frac{E^j_{t+1/12}}{C_{t+1/12}} = \alpha_j + \beta_j \left(\text{Log}\, C_{t+1/12}\right) + \gamma_j F_{t+1} + \epsilon^j_{t+1}$$

$$j = 1, \ldots .19 \text{ categories}$$

Where

$\frac{E^j_{t+1}}{12}$ = Monthly family expenditure on $j^{th}$ category in year t + 1 (in Rupees)

$\frac{C_{t+1}}{12}$ = Monthly total family expenditure in year t + 1 (in Rupees)

$F_{t+1}$ = Family size of year t + 1 (in number)

$\epsilon^j_{t+1}$ = Unobserved residual of $j^{th}$ category of year t + 1

The estimated form of the above model which was computed after suppressing the intercept to the origin is:

$$(3.4.1.j) \qquad E^j_{t+1/12} = \hat{a}_j \left[C_{t+1/12}\right] + \hat{\beta}_j \left[\left(\log C_{t+1}/12\right) C_{t+1/12}\right] + \hat{\gamma}_j \left[\left(F_{t+1}\right) C_{t+1/12}\right]$$

The advantage of this model is that it does not force either the marginal propensity or the elasticity of expenditure on individual items with respect to total expenditure, to be constant. However, the function also "implies a decline in expenditure elasticities with rising total consumption expenditure. This is more marked the more the elasticity differs from unity."[10]

This functional form is, nevertheless, chosen for the following reasons: One, in the context of increasing incomes and hence expenditure examination of marginal propensity to spend rather than expenditure elasticities of various goods is more relevant in judging the pattern of additional demand. Two, this model satisfies the additivity constraint. The additivity constraint implies that: $\Sigma_j a_j = 1$

[10] C. E. V., Leser, "Forms of Engel Functions," *Econometrica*, Vol. 31, No. 4 (October, 1963), p. 696.

and $\Sigma_j \beta_j = \Sigma_j \gamma_j = 0$ which follow from the fact that $\Sigma_j E^j = C$.[11] Three, the model under study unlike the log-log-inverse (LLI) function[12] gave more plausible results of marginal propensity to expend and its behavior along the total expenditure scale in the sample data. The LLI model gave negative marginal propensity to spend for two items, namely, beverages and education at the minimum level of C in the sample data. More importantly, it also gave declining behavior of the marginals as C increased for such luxury items as toiletry goods, travel and recreation.

### Estimated Engel Functions

Table 10 gives the estimated OLS parameters of the earlier mentioned Engel function for 19 consumption expenditure categories. The coefficients of multiple correlation for all the equations except for travel and recreation, and education were greater than 0.85. All the significant coefficients have the logical signs. The significant positive sign of $\hat{\beta}_j$ associated with $(\log C/_{12} * C/_{12})$ in the equations for travel and recreation, education and medical services is consistent with a priori expectations. The negative sign of the corresponding coefficient in the equation for vegetables and fruits could largely be due to the inclusion of expenditure on potatoes in this category. Similarly, the negative sign of $\hat{\beta}_j$ in the domestic and consumer services equation needs an explanation. This is a result of the inclusion of expenditure on such functionaries as barbers, potters, etc. whose services are substituted at the high level of aggregate expenditure by means that do not involve purchase of these services. It could also be the available data on consumption expenditure did not include the cost of time spent on household work by the permanent farm servant who usually does both household and farm work. This explanation, however, assumes that the allocation of time between the two

[11]This is shown below:

$$E^j = (\alpha_j + \beta_j \log C + \gamma_j F)\, C$$

$$\frac{\partial E^j}{\partial C} = (\alpha_j + \beta_j \log C + \gamma_j F) + \beta_j \frac{1}{C} C$$

$$= \frac{E^j}{C} + \beta_j, \text{ using } (\alpha_j + \beta_j \log C + \gamma_j F) = \frac{E^j}{C}$$

Summing over j both the sides of the equation:

$$\sum_j \frac{\partial E^j}{\partial C} = \sum_j \frac{E^j}{C} + \Sigma_j \beta_j = 1 + 0 = 1$$

The additivity constraint can intuitively be defined as the marginal change in expenditure on various items with respect to the marginal change in total expenditure must add up to 1.

[12]This model for the $j^{th}$ item of consumption may be written as:

$$E^j = e^{a_j + b_j/C} C^{d_j} F^{g_j} \quad \text{or}$$

$$\log E^j = a_j + b_j \frac{1}{C} + d_j \log C + g_j \log F$$

This function does not permit the additivity constraint, because sum of log $E^j$ does not make any meaning.

**Table 10. Estimated Engel Functions of Various Expenditure Categories, Sample Farmers, Surat District, 1970-71**

| Expenditure on $j^{th}$ category | Coefficients | | | |
|---|---|---|---|---|
| | $\hat{\alpha}_j$ | $\hat{\beta}_j$ | $\hat{\gamma}_j$ | r |
| 1. Cereals | .620<br>(.103) | –.067<br>(.016) | .006<br>(.002) | .971 |
| 2. Pulses | .094<br>(.018) | –.010<br>(.003) | .001<br>(.0004) | .961 |
| 3. Milk and ghee | .318<br>(.051) | –.031<br>(.008) | .001<br>(.001) | .974 |
| 4. Vegetables and fruits | .196<br>(.063) | –.021<br>(.010) | .0003<br>(.001) | .856 |
| 5. Sugar and gur | .104<br>(.023) | –.011<br>(.004) | .001<br>(.0004) | .953 |
| 6. Edible oil | .231<br>(.034) | –.027<br>(.005) | .001<br>(.0007) | .956 |
| 7. Beverages | .062<br>(.013) | –.007<br>(.002) | .001<br>(.0002) | .956 |
| 8. Spices | .142<br>(.019) | –.017<br>(.003) | .0004<br>(.0004) | .950 |

Table 10. – Continued

| Expenditure on $j^{th}$ category | Coefficients | | | |
|---|---|---|---|---|
| | $\hat{\alpha}_j$ | $\hat{\beta}_j$ | $\hat{\gamma}_j$ | r |
| 9. Fuel and light | .259<br>(.023) | –.033<br>(.004) | .0008<br>(.0004) | .963 |
| 10. Tobacco and its products | .061<br>(.021) | –.006<br>(.003) | .0002<br>(.0004) | .893 |
| 11. Washing soap and other materials | .030<br>(.006) | –.003<br>(.0009) | –.00007<br>(.0001) | .946 |
| 12. Toiletry goods | .010<br>(.004) | –.0004<br>(.0006) | –.00008<br>(.00008) | .944 |
| 13. Footwear | .025<br>(.009) | –.003<br>(.001) | .0003<br>(.0002) | .849 |
| 14. Cotton textiles | .064<br>(.101) | .0002<br>(.0158) | .0032<br>(.0020) | .860 |
| 15. Domestic services | .146<br>(.027) | –.016<br>(.004) | –.001<br>(.0005) | .906 |
| 16. Travel and recreation | –.360<br>(.084) | .069<br>(.013) | –.005<br>(.002) | .825 |
| 17. Utilities | .034<br>(.012) | –.002<br>(.002) | –.0008<br>(.0002) | .911 |
| 18. Education | –.603<br>(.099) | .099<br>(.015) | –.0008<br>(.0091) | .781 |
| 19. Medical services | –.432<br>(.087) | .086<br>(.014) | –.0091<br>(.0017) | .849 |

Figures in parentheses are standard errors:

$\sum_{j=1}^{19} \hat{\alpha}_j = 1.001$, $\sum_{j=1}^{19} \hat{\beta}_j = 0.0002$, $\sum_{j=1}^{19} \hat{\gamma}_j = 0.0007$

*Definitions of Expenditure Categories*

*Cereals* include rice, wheat, and jowar
*Pulses* include tur, mung, urad, gram, and beans
*Milk and ghee, sugar and gur (molasses), and footwear* are self-explanatory
*Vegetables and fruits* mainly include green vegetables, potatoes, onions, mango, chikoo, banana, etc.
*Edible oil* includes groundnut and sesamum oil
*Beverages* include tea and coffee
*Spices* include red chillies, salt, turmeric, cumin, mustard, etc.
*Fuel and light* include coal, wood, gas, and matches
*Tobacco and its products* include cigarettes, bidis, chewing tobacco and snuff
*Washing soap and other washing materials* include soaps, detergent, indigo, etc.
*Toiletry goods* include bathing soap, hair oil, toothpaste, cosmetics, etc.
*Cotton textiles* include mill-made khadi and handloomed cotton clothing including ready-made garments, and bedding
*Domestic and consumer services* include services of house-maid and village functionaries like barbers, potters, etc.
*Travel and recreation* include visits to towns, cities, etc. by bus and railway and visit to cinema houses
*Utilities* include electricity charges, radio license fees, house tax, etc.
*Education* includes school and college tuition fees, books, stationery and newspaper
*Medical services* include physician and surgeon's services and medicines.

Table 11. Results of Theil's Method of Error Analysis of the Estimated Engel Functions of Sample Farmers, Surat District, 1970-71

| Statistics | Engel Functions for | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Cereals | | Pulses | | Milk & ghee | | Veg. & fruits | | Sugar & gur | |
| | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| U | .1213 | .1408 | .1408 | .1728 | .1144 | .1583 | .2783 | .2897 | .1541 | .1778 |
| $UM^2$ (%) | 0.09 | 0.49 | 0.00 | 0.15 | 0.01 | 0.31 | 0.01 | 0.19 | 0.01 | 0.11 |
| $US^2$ (%) | 14.87 | 23.94 | 11.92 | 24.38 | 11.96 | 28.23 | 43.30 | 57.68 | 13.04 | 26.47 |
| $UC^2$ (%) | 85.04 | 75.57 | 88.08 | 75.47 | 88.03 | 71.46 | 56.69 | 42.13 | 86.95 | 73.42 |
| r | .8310 | .6382 | .7603 | .6080 | .8225 | .6247 | .4485 | .3759 | .7326 | .6231 |

| Statistics | Engel Functions for | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Edible Oil | | Beverages | | Spices | | Fuel & light | | Tobacco | |
| | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| U | .1497 | .1632 | .1495 | .1817 | .1595 | .1683 | .1365 | .1427 | .2381 | .2536 |
| $UM^2$ (%) | 0.01 | 0.58 | 0.08 | 0.05 | 0.13 | 0.16 | 0.00 | 1.39 | 0.00 | 0.04 |
| $US^2$ (%) | 22.04 | 37.76 | 8.07 | 14.06 | 17.91 | 31.72 | 30.64 | 39.90 | 28.13 | 44.03 |
| $UC^2$ (%) | 77.95 | 61.66 | 91.85 | 85.89 | 81.96 | 68.12 | 69.36 | 58.71 | 71.87 | 55.93 |
| r | .6825 | .6121 | .7767 | .6461 | .4908 | .3659 | .5241 | .4424 | .5239 | .4304 |

| Statistics | Engel Functions for | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Washing soaps, etc. | | Toiletry goods | | Footwear | | Cotton textiles | | Domestic services | |
| | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| U | .1665 | .1849 | .1685 | .1882 | .2713 | .2928 | .2856 | .3271 | .2209 | .2342 |
| $UM^2$ (%) | 0.00 | 0.27 | 0.01 | 0.00 | 0.09 | 0.14 | 0.00 | 0.10 | 0.01 | 0.38 |
| $US^2$ (%) | 23.56 | 48.06 | 13.90 | 47.34 | 27.09 | 47.26 | 37.21 | 33.97 | 44.65 | 68.04 |
| $UC^2$ (%) | 76.44 | 51.67 | 86.09 | 52.66 | 72.82 | 52.60 | 62.79 | 65.93 | 55.34 | 31.58 |
| r | .6390 | .5417 | .7224 | .6818 | .6475 | .4473 | .4846 | .4293 | .4535 | .3403 |

| Statistics | Engel Functions for | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Travel & recreation | | Utilities | | Education | | Medical services | |
| | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| U | .3076 | .4364 | .2096 | .2292 | .3461 | .4758 | .2811 | .4567 |
| $UM^2$ (%) | 0.02 | 0.30 | 0.01 | 0.01 | 0.14 | 0.83 | 0.04 | 0.37 |
| $US^2$ (%) | 15.43 | 43.87 | 22.71 | 60.84 | 13.72 | 37.42 | 12.19 | 40.80 |
| $UC^2$ (%) | 85.55 | 55.83 | 77.28 | 39.15 | 86.14 | 61.75 | 87.77 | 58.83 |
| r | .7166 | .4599 | .5902 | .5395 | .7329 | .5780 | .7627 | .3768 |

1 denotes using observed values of $C_{t+1}/12$

2 denotes using predicted values of $C_{t+1}/12$

types of work of the farm servant would be different in large compared to that in small farm-families.

The negative sign and significance of $\hat{\gamma}_j$ associated with (F * C/12) variable in the equations for domestic and consumer services, travel and recreation, utilities which include electricity charges, radio license fees, etc., education and medical services shows that these expenditure categories may be termed as "luxury" items for the sample under study. Finally, the estimated equations for travel and recreation, medical services and education may be treated with caution for predicting expenditure on these items at the low level of monthly aggregate consumption expenditure.

The results on residual analysis are given in Table 11. The "U" statistic calculated by using the observed values of monthly aggregate consumption expenditure ranged between .1214 for cereals to .3461 for education equation. The percentage difference between actual and predicted values caused by the inequality in their mean values is less than one for all equations. Against this, the one that is caused by the imperfect covariation between the actual and predicted values is more than 70 for all except three equations. The results may be interpreted to signify that these equations exhibit a fair degree of forecasting ability. This interpretation remains unchanged even for the results of residual analysis that is based on predicted instead of actual values of per month aggregate consumption expenditure. The only exception is that the percentage difference between actual and predicted values caused by imperfect covariation has increased, whereas that caused by unequal variation has decreased. This result is, however, marked only for 7 out of 19 equations.

### Estimated Pattern of Marginal Propensity to Expend by a Typical Small versus Large Farm-Family

Table 12 presents the estimated marginal propensity to spend on various items of consumption of farm-families having 4 and 16 acres, and for the sample as a whole. A typical 4 acre farm-family in the sample spends, at the margin, on foodgrains about twice as much as does a typical large farmer having 16 acres of net cultivable land. The marginal propensity to expend (MPE) on pulses by a small farm-family is about one-eighth of the aggregate of MPE on foodgrains. The corresponding figure for a large

**Table 12. Estimated Pattern of Marginal Propensity to Spend by Representative Small and Large Farm-Families, Surat District, 1970-71**

| Expenditure categories | Representative Farm-Families | | |
|---|---|---|---|
| | Small | Large | Sample |
| 1. Cereals | .217 | .109 | .168 |
| 2. Pulses | .034 | .025 | .026 |
| Sum: Foodgrains | .251 | .134 | .194 |
| 3. Milk and ghee | .121 | .099 | .096 |
| 4. Vegetables and fruits | .062 | .026 | .038 |
| 5. Sugar and gur | .037 | .029 | .028 |
| 6. Edible oil | .066 | .034 | .042 |
| 7. Beverages | .020 | .015 | .016 |
| 8. Spices | .036 | .016 | .020 |
| Sum: Nonfoodgrains foods | .342 | .219 | .240 |
| 9. Fuel and light | .052 | .043 | .020 |
| 10. Tobacco and its products | .024 | .017 | .020 |
| 11. Washing soap and other materials | .011 | .006 | .007 |
| 12. Toiletry goods | .007 | .006 | .007 |
| 13. Footwear | .007 | .005 | .005 |
| 14. Cotton Textiles | .080 | .092 | .090 |
| Sum: Nonfood nonservice | .181 | .169 | .149 |
| 15. Domestic and consumer services | .041 | .016 | .021 |
| 16. Travel and recreation | .058 | .148 | .112 |
| 17. Utilities | .019 | .014 | .014 |
| 18. Education | .029 | .149 | .130 |
| 19. Medicines and medical services | .079 | .151 | .140 |
| Sum: Services | .226 | .478 | .417 |

farm-family is nearly one-sixth. This illustrates the importance of pulses in the diet of even a rich farmer.

A small farm-family's MPE on milk and ghee forms only about one-third of the sum of its MPE on non-foodgrain food items. The corresponding figure for a large farm-family is about one-half. However, the share of MPE on vegetables and fruits in the sum of MPE on non-foodgrain food items is about the same for both the small and large farm-families. This is presumably because of the inclusion of potatoes in the definition of this expenditure category.

Although the MPE on clothing is about the same for the two types of farm-families, the share of this category in the sum of MPE on non-food non-service items is larger for a large farm-family than that for a small one. The reasons for such a result have been discussed in the preceding section. The MPE on travel and recreation, education, and medical services together has nine-tenths share in the sum of incremental expenses on non-food service items of a large farm-family as against seven-tenths of a small one.

### Conclusions

1. Analysis of dairy-farming enterprise reveals that the high-yielding milking buffalo, unlike a "desi" breed milking buffalo, can generate much larger inputs including labor use, milk output, and also net returns. Hence, Chapter IV will compare the estimated increase in net returns from the acquisition of an improved quality buffalo with that from a "desi" breed buffalo to determine how long it takes for farmers to recover the incremental fixed capital cost.

2. Dairy income can generate a continuous flow of funds which together with non-farm income is indicative of relaxing capital and risk-bearing constraints for crop-farming. The results of the Surat sample show that increases in the flow of income from dairying and non-farm jobs would increase the proportion of acreages under HYV paddy and wheat, whereas it would decrease the proportion of land under cotton and groundnut.

3. The sample data show the overwhelming importance of crop pattern in determining farmers' use of inputs such as fertilizers and labor and also their gross revenue from crops. Factors such as net cultivable land, supplementary incomes, values of assets and family size explain an extremely small percentage of variation in per acre net returns on crops.

4. The proportion of land under such high-return-high-working-capital-intensive crops as sugarcane, banana, and HYV paddy is found to be inversely related to the size of a farm. Constraints like marketing, diseconomies of scale in managing labor on large farms and shortage of inputs could be responsible for this result.

5. The availability of net irrigable land has positive influence on the proportion of land allocated to these high-return crops, while it has negative influence on the proportion of land allocated to the low-return unirrigated crops. Thus, Chapter IV will predict the change in crop pattern resulting from an increase in the availability of net irrigable land up to 100 percent of the farm size of the sample farmers.

6. Similarly, increasing the ability and willingness to undertake risk as is indicated by the wealth of farmers would shift the crop pattern in favor of high-risk crops such as sugarcane and HYV paddy from such low-risk crops as other foodgrains and other nonfoodgrains.

7. The analysis of aggregate consumption function shows that as expected gross returns per rupee of investment in variable inputs for crop-farming increase, the aggregate consumption expenditure declines. The significance of this result is reinforced by the sensitivity of an estimate of marginal propensity to consume in a model that excludes this variable.

8. The analysis of expenditure patterns, like the previous analysis,[13] shows that the pattern of *additional* expenditure (i.e. marginal propensity to spend) by farm-families is fairly diversified. For an average farmer in the sample, the marginal propensity to spend on milk, ghee, fruits and vegetables together is about the same as the marginal propensity to spend on manufactured nonfood items as one category. The former group of commodities may have low capital-labor ratios in their production processes. The high level of marginal propensity to spend on education, medicines and medical services, and travel and recreation is noteworthy.

9. Finally, most equations exhibit reasonable degree of accuracy in their prediction ability judged by Theil's method of Error Analysis. Hence, the ensuing chapter will discuss the results of the ex-post predictions. Chapter IV will also analyze the effects of alternative policies to change the availability of net irrigable land, and internal finance through income from dairying on sample farmers' crop pattern, input use, income, and hence on expenditure on various goods and services.

[13] B. M. Desai, "Analysis of Consumption Expenditure Patterns in India," Occasional Paper No. 54, Department of Agricultural Economics, Cornell University, USAID – Employment and Income Distribution Project, 1972.

*CHAPTER IV*

# POLICY ANALYSES – PREDICTIONS OF CHANGES IN CROP PATTERN, INPUT USE, INCOME AND ITS DISTRIBUTION, AND CONSUMPTION PATTERN OF FARM-FAMILIES

## Introduction

This chapter utilizes the empirical model estimated in Chapter III to predict crop pattern, input use, income and its distribution, and consumption pattern of sample farmers. The first set of predictions are computed prior to changing the observed values of all the explanatory variables in the model. The other set of predictions are carried out after changing the observed values of two variables, namely, net irrigable land, and size of dairy herd. For this purpose, the policy of differential change, among other policies, in the existing availability of these resources of small and large farmers is also considered. This is particularly relevant because there exists plethora of programs for reducing income disparities and employment creation.[1]

Section 1 covers the methodological procedure of making the two sets of predictions in addition to briefly describing the results of first set of predictions. Section 2 discusses the existing availability and feasibility of changing the two resources, namely, net irrigable land, and size of herd of the sample farmers. Analysis of the results of the second set of predictions is presented in Section 3. Before presenting these sections, the mechanism by which the model leads to the effects of change in the existing availability of resources on crop pattern, input use, incomes, and hence consumption pattern may be briefly stated.[2]

It may be recalled from the preceding chapter that increasing the existing availability of net irrigable land would shift the crop pattern in favor of high-return crops of sugarcane, followed by banana, HYV paddy and wheat from such other crops as jowar, tur and cotton. These shifts would in turn cause changes in input including labor use and also in incomes of farmers. The increased incomes would consequently lead to change in aggregate consumption expenditure, and hence in expenditure on various goods and services.

The change in existing size and composition of herd leads to increase in input use for and also in revenue from dairying. The increased dairy income by providing internal finance relaxes capital and risk constraints on growing various crops. And hence, it leads to shifts in crop pattern from such crops as cotton and groundnut to crops such as HYV paddy and wheat. These, in turn, cause change in input use, incomes and consequently in aggregate consumption, and in expenditure on various goods and services.

[1]For some citations on this subject on India, see Selected Bibliography.

[2]The effects of price and short-term credit policies on crop pattern could not be examined, because the empirical model is based on data which do not contain variation in prices and credit.

## Section 1: Methodological Procedure for Computing Predictions

Each of the equations discussed in Chapter III is utilized to compute the dependent variables for every farm-family in the sample. This is done twice, once before and again after changing the resource or explanatory factor under consideration. Under the former are included two types of predictions. The first type of prediction is carried out by using observed values of all the explanatory variables in the model. This is referred to as R1 in Table 13. The second type of prediction is computed by using predicted values of those explanatory variables that are determined in the model, in addition to utilizing observed values of other explanatory factors.[3] This is referred to as R2 in Table 13. The model, as expected, exhibits reasonable degree of accuracy in its predicting ability (Table 13). Hence, the results of predicted values of different variables designated as R2 are utilized in the rest of this chapter.

The other set of predictions are those that are computed after changing the existing level of the two resources. The predictions so computed are referred to as P1 to P7 which correspond to seven alternatives considered for the change in the two resources.

The values predicted before change in the existing level of resources (designated as R2) are then subtracted from those estimated after changing the resources. This computational procedure gives the magnitude of change in the variable under study. In the text such change is referred to as effect of varying the existing level of resource considered.

## Section 2: Existing Resource Availability and Justification for a Change

As mentioned earlier, this chapter intends to examine the impact of changing two resources, namely, net irrigable land, and size and composition of dairy herd of the sample farmers. These variables are selected because availability of irrigable land is a pre-condition for the successful introduction of new technology as embodied in new seed varieties, high-return cash crops, such as sugarcane, banana,[4] and also multiple cropping. Adding an improved

[3]The explanatory variables that are determined in the model are designated with stars in Table 13.

[4]These crops are more labor-intensive compared to the alternative crops (see Table 7 in Chapter III). Also see Gunvant M. Desai and M. G. G. Schluter, "Generating Employment in Rural Areas," *Seminar Series XII*, Seminar on Rural Development for Weaker Sections, Indian Society of Agricultural Economics, Bombay and Indian Institute of Management, Ahmedabad, May 1974. Pp. 143-152.

Table 13. Comparison of Average of Observed and Ex-Post Predicted Values of Dependent Variables of the Model, Surat District, 1969-70 and 1970-71

| | Observed (0) | Predicted[1] (R1) | Predicted[2] (R2) |
|---|---|---|---|
| Diary-farming | | in Rupees | |
| 1. Investment in variable inputs ($I^*_D$) | 1452.12 | 1451.88 | 1451.88 |
| 2. Gross revenue ($R^*_D$) | 2438.52 | 2436.84 | 2436.84 |
| 3. Net income ($Y^*_D$) | 986.40 | 984.96 | 984.96 |
| Crop-acreages | | in acres with 2 decimals | |
| 1. Sugarcane ($L^*_{SC}$) | 1.76 | 1.77 | 1.76 |
| 2. Banana ($L^*_{BN}$) | 0.92 | 0.93 | 0.92 |
| 3. High-yielding paddy ($L^*_{HYP}$) | 2.35 | 2.37 | 2.35 |
| 4. Wheat ($L^*_{WT}$) | 0.45 | 0.47 | 0.47 |
| 5. Other foodgrains[3] ($L^*_{OFG}$) | 3.24 | 3.22 | 3.25 |
| 6. Other nonfoodgrains[4] ($L^*_{ONFG}$) | 1.89 | 1.90 | 1.88 |
| Inputs use for crops | | in Rupees | |
| 1. Hired labor ($\Sigma_i LE^*_i$) | 1967.66 | 1933.34 | 1935.36 |
| 2. Fertilizers ($\Sigma_i FE^*_i$) | 1210.11 | 1160.47 | 1161.55 |
| 3. Irrigation charges ($\Sigma_i WE^*_i$) | 762.22 | 726.61 | 727.09 |
| 4. Oil cakes ($\Sigma_i OC^*_i$) | 524.39 | 521.94 | 522.25 |
| 5. All inputs ($\Sigma_i I_{CTi}$) | 6589.96 | 6471.82 | 6478.59 |
| Gross Revenue from Crops ($\Sigma_i R^*_{CI}$) | 12255.89 | 12164.66 | 12177.46 |
| Net income from all crops ($\Sigma_i Y^*_{Ci}$) | 5665.93 | 5692.84 | 5698.87 |
| | | in Rupees | |
| Aggregate consumption expenditure ($C^*$) | 7564.08 | 7420.20 | 7599.36 |
| Expenditure on ($E^j$) | | | |
| 1. Cereals | 1760.30 | 1774.59 | 1805.36 |
| 2. Pulses | 272.19 | 271.48 | 276.14 |
| 3. Milk and ghee | 936.00 | 938.68 | 953.65 |
| 4. Vegetables and fruit | 446.25 | 449.65 | 458.96 |
| 5. Sugar and gur | 307.06 | 305.93 | 311.01 |
| 6. Edible oil | 484.80 | 486.35 | 497.79 |
| 7. Beverages | 178.87 | 177.18 | 180.56 |
| 8. Spices | 262.45 | 259.20 | 266.26 |
| 9. Fuel and light | 368.38 | 364.24 | 377.22 |
| 10. Tobacco and its products | 176.47 | 175.62 | 178.59 |
| 11. Washing soap and other materials | 73.69 | 73.84 | 75.25 |
| 12. Toiletry goods | 48.56 | 48.28 | 48.71 |
| 13. Footwear | 60.14 | 60.42 | 61.69 |
| 14. Cotton textiles | 673.98 | 687.95 | 690.92 |

| Table 13. – Continued | | | |
|---|---|---|---|
| **Expenditure on ($E^j$)** | | | |
| 15. Domestic and consumer services | 256.94 | 258.35 | 264.99 |
| 16. Travel and recreation | 400.49 | 395.44 | 373.84 |
| 17. Utilities | 114.65 | 114.07 | 115.20 |
| 18. Education | 301.27 | 284.61 | 252.42 |
| 19. Medical services | 445.41 | 438.07 | 411.10 |

*NOTES*

[1] R1 refers to mean of values predicted by using the observed data on all the explanatory variables. Values of those variables that were measured in per month terms were multiplied by 12 to obtain their annual values, whereas those measured on per animal basis were multiplied by the total herd size to obtain their values for a farm-family. This was also done for prediction R2 and all other alternative predictions analyzed in this Chapter.

[2] R2 refers to mean of values computed by using the predicted values of the starred variables, in addition to using observed data of other explanatory factors in the concerned equations. This was done because a recursive model requires using predicted instead of observed values of those explanatory variables that get determined in the model.

[3] Other foodgrains include jowar, val, and tur.

[4] Other nonfoodgrains include cotton, and groundnut.

Table 14. Existing Availability of Total Net Cultivable Land, Net Irrigable Land and Dairy Herd of the Sample Farmers, Surat District, 1969-70

| | Net Cultivable Land Size Groups (in Acres with two decimals) | | |
|---|---|---|---|
| | Less than 7.50 | 7.50 and more | Sample |
| 1. Number of farmers | 35 | 50 | 85 |
| 2. Total net cultivable land | 180.09 | 626.50 | 806.59 |
| 3. Irrigable net cultivable land | 133.39 | 471.96 | 605.35 |
| 4. % of irrigable to total net cultivable land | 74.07 | 75.33 | 75.05 |
| 5. Number of farmers owning less than average percentage of irrigable to total net cultivable land | 11 | 19 | 30 |
| 6. These farmers total net cultivable land | 63.84 | 261.27 | 325.11 |
| 7. Their net irrigable land | 29.56 | 124.15 | 153.71 |
| 8. Percent of irrigable to total net cultivable land of these farmers | 46.30 | 47.51 | 47.28 |
| 9. Number of dairy animals | 122 | 264 | 386 |
| 10. Number of milking buffaloes | | | |
| (a) "Desi" | 57 | 89 | 146 |
| (b) Improved | 4 | 29 | 33 |

breed buffalo instead of "desi" buffalo represents a shift in the production function similar to that for new varieties of crops. Such shifts would lead to increases in income from dairy enterprise. Dairy income being continuous in character, may help farmers by providing assured minimum income. The emphasis is, therefore, on expanding the existing proportion of net irrigable land to total (net) cultivable land and also on increasing the number of improved breed milking buffalo.

An examination of Table 14 on the availability of the two resources reveals that almost three-fourths of the farmers' net cultivable land is irrigable. In contrast, a negligible proportion of their dairy herd is represented by the improved quality of buffalo. The former result holds for both the groups of farmers, whereas the latter one is less applicable to farm-families with 7.5 and more acres. The other reasons for expanding the availability of the two resources are discussed at length to gain a perspective on the feasibility of changing these resources. The past and anticipated development of new rice varieties, sugarcane and banana farming, canal and underground well irrigation, and milk-marketing and processing facilities in Surat district are, therefore, described.

The progressive areas of this district have witnessed successful adoption of new rice varieties. They provide a striking illustration of a high degree of complementarity between irrigation and marketing facilities required to induce farming of sugarcane and banana. Although it took about twelve years since the inception of a sugar factory in 1955 to double the cane crushing capacity in the district, this capacity increased threefold in as short a period as four years. By 1973-74, it is estimated that the crushing capacity in the district would rise to 7,000 (from 4,000 in 1971-72) tons per day which would require 39,000 (instead of 14,250 in 1970-71) acres of sugarcane in the district.[5]

As regards banana farming, there are at present in Surat district 20 cooperative fruit and vegetable growers' marketing societies and one cooperative processing and preservation plant for fruits and vegetables.[6] These societies together form the Gujarat State Cooperative Fruits and Vegetables Marketing Federation at the district level. This Federation, since its establishment in 1964-65, has exported 1.08 million tons of bananas to Kuwait, Bahrain, U.S.S.R., Abu Dubai, Qatar, Japan, and Iran.

Regarding the development plans for irrigation, it has been anticipated that with the completion of the Ukai multi-purpose river valley project in the district, an additional 0.65 million acres would receive irrigation. Along with the existing Kakrapar weir project, this project will serve a gross command area of 1.33 million acres. Of this, 0.95 million acres will receive perennial irrigation.[7] Notable progress in underground well irrigation has also been made in recent years.[8] A cooperative milk marketing and processing plant SUMUL has been established in the district. This plant will be developed on a similar pattern as AMUL (in Kaira district of Gujarat) which is known for its rapid progress. The plant in Surat district provides marketing, veterinary, and processing facilities to farmers through its village-level cooperatives.

## Section 3: Predictions After Resource Changes – Analyses of Results

### Alternative Policies Considered

The following seven alternative policies to change the level of the two resources of farmers are considered to analyze their effects on crop pattern, input use, incomes, and consumption patterns:

P1: Farms with less than 7.5 acres[9] are assumed to undertake fixed capital investment (a) to acquire *two* improved quality milking buffaloes, and (b) to increase their net irrigable land up to 100 percent of their farm size by *well* irrigation.[10] Against this, the farmers with 7.5 and more acres are assumed to undertake *only* well irrigation investment to increase their net irrigable land up to 100 percent of their farm size.

P2: Whereas the small farmers would acquire only *one* improved quality milking buffalo, besides receiving *canal* water to increase their irrigable land by similar magnitude as in P1, the large farmers would increase their irrigable land up to 100 percent *only* by investing in well irrigation.

P3: For the former group of farmers, we assume that they could increase the proportion of net irrigable to cultivable land up to 100 percent by receiving canal water. In contrast, the large farmers are assumed not to change the proportion of net irrigable land.

P4: Both the groups of farmers would increase the herd size by acquiring an additional "desi" breed buffalo.

[5] Desai and Schluter, *op. cit.*, p. 4.

[6] Appendix Table 4 gives the membership of sample farmers to these and other such societies.

[7] M. S. Randhawa, et. al., *Farmers of India*, Vol. IV, (New Delhi, Indian Council of Agricultural Research, 1968) p. 192.

[8] Twenty-three percent of irrigated area in Surat district received water by well irrigation systems in 1965-66, as against about 18 percent in 1960-61. In a period of seven years the number of wells in Gujarat State has increased by 18.96 percent, whereas the number of wells fitted with pumpsets has increased by 34 percent. Similar data for Surat district are, however, not available. See, Desai, *op. cit.*, p. 27, and S. M. Patel et. al., "Management of Lift Irrigation (Report on Pilot Research Project in Gujarat)," (Ahmedabad, Indian Institute of Management, 1969), p. 16.

[9] This limit of 7.5 is arbitrarily set. In this study, it is, however, primarily guided by the fact that the sample was drawn from a universe that excluded farms below three acres of operational holding (see the discussion on sampling design in Chapter I). It may be noted that the agencies such as Small Farmers Development Agency consider five acres as maximum holding for being a small farm holding in a district like Surat.

[10] Appendix 5 gives an estimated fixed capital and fixed maintenance cost of a typical lift irrigation system in Surat district.

Table 15. Estimates of Level of and Changes in Fixed Capital Investment, Crop-Acreages, Family Net Income, Inputs Use, Working Capital Use, Milk Production and Consumption Patterns Prior to and after Change in Resources of an Average Farm-Family, Surat District

| Per farm-family | Predicted level | Predicted Changes Under Various Policies[1] | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | R2 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| 1. Fixed capital investment (in Rupees) | – | 15241 | 8864 | – | 800 | 1400 | – | 14088 |
| 2. *Crop pattern* (in acres with two decimals) | | | | | | | | |
| (a) Sugarcane | 1.76 | 1.10 | 1.04 | 0.10 | 0.01 | 0.02 | 0.85 | 1.08 |
| (b) Banana | 0.92 | 0.59 | 0.59 | 0.07 | 0.01 | 0.01 | 0.58 | 0.59 |
| Sub-total | 2.68 | 1.69 | 1.63 | 0.17 | 0.02 | 0.03 | 1.43 | 1.67 |
| | (100.00)[2] | (63.30) | (61.05) | (6.37) | (0.75) | (1.12) | (53.36) | (62.55) |
| (c) HYV paddy and wheat | 2.81 | 0.35 | 0.30 | 0.03 | 0.08 | 0.16 | 0.24 | 0.27 |
| | (100.00) | (12.46) | (10.68) | (1.07) | (2.85) | (5.69) | (8.54) | (9.61) |
| (d) Other foodgrains | 3.25 | –0.82 | –0.80 | –0.08 | 0.08 | 0.15 | –0.66 | –0.89 |
| | (100.00) | (–25.23) | (–24.62) | (–2.46) | (2.46) | (4.62) | (–20.31) | (–27.39) |
| (e) Other nonfoodgrains | 1.88 | –1.19 | –1.10 | –0.10 | –0.03 | –0.06 | –0.87 | –1.03 |
| | (100.00) | (–63.30) | (–58.51) | (–5.32) | (–1.60) | (–3.19) | (–46.28) | (–54.79) |
| 3. Net income (in Rupees) | 8437 | 2560 | 2245 | 198 | 431 | 825 | 1687 | 2000 |
| | (100.00) | (30.34) | (26.61) | (2.35) | (5.11) | (9.77) | (19.99) | (23.71) |
| 4. Income inequality ratio[3] | .172822 | –.049343 | –.028724 | –.014740 | –.014739 | –.026352 | –.010176 | –.012037 |
| | (100.00) | (–28.55) | (–16.62) | (–8.53) | (–8.53) | (–15.25) | (–5.89) | (–6.96) |
| 5. Inputs use (in Rupees) | | | | | | | | |
| (a) Hired labor (crops plus dairy) | 2109.62 | 742.33 | 681.29 | 66.80 | 76.34 | 16.68 | 570.29 | 661.49 |
| | (100.00) | (35.19) | (32.29) | (3.17) | (3.62) | (5.53) | (27.03) | (31.36) |
| (b) Fertilizers | 1161.55 | 535.88 | 517.19 | 54.54 | 11.81 | 21.99 | 466.05 | 525.55 |
| | (100.00) | (46.09) | (44.53) | (4.70) | (1.02) | (1.89) | (40.12) | (45.25) |
| (c) Irrigation Charges | 727.09 | 404.80 | 390.52 | 40.73 | 6.88 | 12.64 | 347.80 | 399.16 |
| | (100.00) | (65.67) | (53.71) | (5.60) | (0.95) | (1.74) | (47.83) | (54.90) |
| (d) Oil cakes | 522.25 | 319.72 | 308.81 | 32.29 | 4.84 | 8.84 | 275.75 | 315.78 |
| | (100.00) | (61.22) | (59.13) | (6.98) | (0.93) | (1.69) | (52.80) | (60.47) |
| 6. Total working capital use (Crops plus dairy) | 5732.45 | 2572.22 | 2226.21 | 229.04 | 293.74 | 425.18 | 1956.46 | 2247.62 |
| | (100.00) | (44.87) | (38.84) | (4.00) | (5.12) | (7.42) | (34.13) | (39.21) |
| 7. Milk production (in litres) | 1827.74 | 828.53 | 412.73 | – | 620.64 | 1009.80 | – | – |
| | (100.00) | (45.33) | (22.58) | | (33.96) | (55.25) | | |
| 8. Consumption patterns (in Rupees) | | | | | | | | |
| (a) Cereals | 1805.36 | 121.70 | 104.48 | 10.45 | 19.56 | 86.84 | 80.33 | 92.76 |
| (b) Pulses | 276.14 | 18.92 | 16.24 | 1.70 | 3.02 | 5.70 | 12.42 | 14.40 |
| Sub-total | 2081.50 | 140.62 | 120.72 | 12.15 | 22.58 | 42.54 | 92.75 | 107.16 |
| | (100.00) | (6.76) | (5.80) | (0.58) | (1.08) | (2.04) | (4.46) | (5.15) |
| (c) Milk and ghee | 953.65 | 68.33 | 58.59 | 5.93 | 10.89 | 20.56 | 45.03 | 51.81 |
| (d) Vegetables and fruits | 458.96 | 28.52 | 24.29 | 2.69 | 4.64 | 8.72 | 18.50 | 21.46 |
| Sub-total | 1412.61 | 96.85 | 82.88 | 8.62 | 15.53 | 29.28 | 63.53 | 73.27 |
| | (100.00) | (6.86) | (5.87) | (0.61) | (1.10) | (2.07) | (4.50) | (5.19) |

Table 15. – Continued

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (e) Sugar and gur | 311.01 | 21.18 | 18.21 | 1.84 | 3.47 | 6.48 | 14.12 | 16.24 |
| (f) Edible oil | 497.79 | 27.67 | 23.43 | 2.54 | 4.50 | 8.50 | 17.93 | 20.61 |
| (g) Beverages | 180.50 | 11.16 | 9.60 | 0.99 | 1.73 | 3.35 | 7.35 | 8.62 |
| (h) Spices | 266.20 | 12.85 | 10.87 | 1.27 | 2.10 | 4.01 | 8.19 | 9.46 |
| Sub-total | 1255.62 (100.00) | 72.86 (5.80) | 62.11 (4.95) | 6.64 (0.53) | 11.80 (0.94) | 22.34 (1.78) | 47.59 (3.79) | 54.93 (4.38) |
| (i) Fuel and light | 377.22 | 11.44 | 9.32 | 1.42 | 2.06 | 3.82 | 6.78 | 7.91 |
| (j) Tobacco and its products | 178.59 | 12.56 | 10.87 | 0.99 | 1.93 | 3.67 | 8.19 | 9.60 |
| (k) Washing soap and other materials | 75.25 | 5.08 | 4.23 | 0.42 | 0.79 | 1.55 | 3.24 | 3.67 |
| (l) Toiletry goods | 48.71 | 4.51 | 3.81 | 0.28 | 0.65 | 1.27 | 2.96 | 3.38 |
| (m) Footwear | 61.69 | 3.67 | 3.11 | 0.29 | 0.65 | 1.13 | 2.40 | 2.83 |
| (n) Cotton textiles | 690.92 | 65.22 | 56.61 | 5.08 | 10.85 | 9.20 | 43.90 | 50.82 |
| Sub-total | 1432.38 (100.00) | 102.48 (7.15) | 87.95 (6.14) | 8.48 (0.59) | 16.93 (1.18) | 30.64 (2.14) | 67.47 (4.71) | 78.21 (5.46) |
| (o) Domestic and consumer services | 264.99 | 14.54 | 12.14 | 1.41 | 2.32 | 4.52 | 9.17 | 10.59 |
| (p) Travel and recreation | 373.84 | 89.50 | 78.07 | 6.49 | 13.47 | 5.12 | 60.98 | 70.30 |
| (q) Utilities | 115.20 | 10.31 | 8.75 | 0.99 | 1.64 | 3.11 | 6.78 | 7.76 |
| (r) Education | 252.42 | 97.70 | 85.98 | 19.91 | 14.20 | 27.11 | 67.63 | 78.36 |
| (s) Medical services | 411.10 | 108.15 | 93.89 | 44.90 | 15.84 | 30.08 | 73.14 | 84.57 |
| Sub-total | 1417.55 (100.00) | 320.20 (22.59) | 278.83 (19.67) | 73.70 (5.20) | 47.47 (3.35) | 89.94 (6.34) | 217.70 (15.36) | 251.58 (17.75) |

*NOTES*

1. For description of various policies P1 to P7, see text, pages 86 and 87.
2. Figures in brackets are percentages. Such figures under the columns for various policies represent percentage change in the concerned variable over that its level prior to change in resources (i.e. R2).
3. Income inequality ratio was calculated using the following formula proposed by Henry Theil in *Economics of Information Theory*. (Rand McNally, 1967), p. 91.

$$I = \Sigma_n \left[\frac{X_N}{X_o}\right] \log \left[\frac{NX_N}{X_o}\right]$$

Where $I$ = Income inequality
$X_N$ = Net income of $N^{th}$ family
$X_o$ = Sum of net income of families, i.e. $\Sigma_n X_N$

This measure instead of Gini ratio is used because calculation of the latter using ungrouped data of sample families is very inconvenient, time-consuming and amenable to errors. No computer program is readily available to calculate the area under Lorenz Curve on which the computation of Gini Ratio using ungrouped data is based.

P5: An increase in the herd size by purchasing an additional improved quality buffalo by both the groups of farmers is assumed.

P6: It is assumed that both the groups of farmers increase their net irrigable land up to 100 percent of the farm size by canal water.

P7: A similar magnitude of increase in net irrigable land as for P6 by the two groups of farmers investing in well irrigation is assumed.

The first three policies may be considered to represent differential change in the two resources of small versus large farmers, whereas policies P4 to P7 represent identical change in the resources of both the groups of farmers.

P1 will be compared with the remaining six policies to show the nature of differential change in the two resources of the small and large farmers that may be most facilitated by development programs.

Alternative P2 is considered for such reasons as preferential treatment of small farmers for supplying canal water, and also for considering development of their dairy farming on a scale smaller than under P1. P3 will be compared with P6 to show the macro effects of restricting changes in irrigation resources to small farmers alone.

P4 and P5 will be analyzed to bring out the differences in the effects of changing the size of dairy herd by two different breeds of buffalo.

P6 and P7 will be compared to show the difference in the effects of increasing net irrigable land by the canal versus well irrigation facilities because well unlike canal irrigation is characterized by greater certainty of water and may enable farmers to make larger shifts to such crops as sugarcane, banana, HYV paddy and wheat. Moreover, the acquisition of irrigation assets increases productive wealth (designated as W in equation 3.2.1.i in Chapter III) of farmers. This variable conceptually represents the role of risk-bearing ability and willingness of farmers. Analysis of impact of change in the size of wealth due to the acquisition of lift irrigation system by farmers would reveal its role. Thus, increasing the size of net irrigable land by two sources of irrigation would have different impact on crop pattern and hence on input use, incomes, and consequently on consumption patterns of farmers.

**Effects of Suggested Nature of Differential Change in Resources**

A comparison of the results of seven alternative policies to change the resources of farmers reveals that P1 may be preferred (Table 15). Before analyzing the results of P1 it may be recalled that this policy envisages increasing the dairy herd by two improved breed milking buffaloes and also increasing the size of net irrigable land by well irrigation for small farmers, in contrast to only well irrigation investment for large farmers. This policy may particularly be emphasized if the earlier discussed plans of canal irrigation development do not cover the small farmers. Furthermore, well irrigation investment may be encouraged on these farms to ensure greater certainty of water supplies and also for increasing their productive wealth.

P1 would lead to much larger increases in acreages under sugarcane, banana, HYV paddy and wheat as well as in milk-production than any other policy considered[11] (Table 15). As a result, there would be larger increase in input use as well as in production and incomes of farmers.

The increase in the income of an average farmer is 30 percent over that prior to change in his resources. This farmer would be able to gain fixed capital investment of Rs. 15,241 in about six years.

The inequality in the distribution of incomes among farmers under the suggested P1 would be reduced by 29 percent. This reduction is much larger than that under P2 and P7 which are both comparable to P1 from the viewpoints of size of increase in the income of an average farmer and also in use of all inputs other than labor. Indeed, this policy (P1) would lead to a much higher increase in the use of hired labor. Thus, the differences in the increased use of hired labor between P1 and P2 (which is the next high-employment generating policy) is about nine percent. The corresponding result with respect to use of working capital for nonlabor inputs for both crop and dairy farming is 18 percent. Similarly, the differences in increased use of fertilizers between P1 and P2 is 3.52 percent and 3.54 percent for oil cakes. These findings imply that P1 would create larger potential for indirect effects of inducing interregional as well as intersectoral growth linkages caused by larger increases in use of oil cakes and other inputs.[12]

The demand-induced growth linkages[13] may arise not only from increased use of working capital and production inputs but also from increased expenditure on consumption goods and services. P1 may be preferred to other policies for this reason too (Table 15). Thus, a larger increase in consumption of such items as milk, ghee, vegetables and fruits which are supposed to have low capital-labor ratio in their production processes provide

[11]The exception being only with respect to milk production under P4 which envisages increasing herd size of every farmer, small and large alike, by one improved breed milking buffalo. However, the policy for enlarging dairy herd of large farmers may not be accepted by them on such grounds as higher preference for leisure than for labor including management labor. This reasoning assumes that these farmers will not be able to meet increased labor requirements by hiring more labor.

[12]The interregional and intersectoral growth linkages that are particularly relevant here are those that would result through the expansion in acreages under groundnut cultivation and that in processing activities of groundnut oil cakes. Groundnut is widely grown in unirrigated tracts of Surat and other districts. Incidentally, this crop is more labor-intensive than the competing crops such as cotton, and jowar in these areas; see Desai and Schluter, *op. cit.*, pp. 11 and 12. These authors have also discussed similar effects on employment that may result from increased sugarcane output to be processed by sugar factories.

[13]For the study of demand-induced growth linkages for Indian economy, see, John W. Mellor, *op. cit.*, (forthcoming, 1975).

Table 16. Estimates of Changes in Crop Pattern, Family Net Income and its Distribution, Inputs Use, Working Capital Use, and Consumption Pattern of an Average Farm-Family, Surat District, Under Two Policies[1]

| Per farm-family | Predicted changes P3 | Predicted changes P4 | Difference between predicted changes[2] | % Difference, i.e. [Clm. 3 / Clm. 1] x 100 |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 1. Crop pattern (in acres with two decimals) | | | | |
| (a) Sugarcane | 0.10 | 0.85 | 0.75 | 750.00 |
| (b) Banana | 0.07 | 0.58 | 0.48 | 658.71 |
| Sub-total | 0.17 | 1.43 | 1.23 | 723.53 |
| (c) HYV paddy & wheat | 0.03 | 0.24 | 0.21 | 700.00 |
| (d) Other foodgrains | –0.08 | –0.66 | –0.58 | –725.00 |
| (e) Other nonfoodgrains | –0.10 | –0.87 | –0.77 | –770.00 |
| 2. Net income (in Rupees) | 198 | 1687 | 1489 | 752.02 |
| 3. Income inequality ratio | –.014740 | –.010176 | .004564 | 30.96 |
| 4. Inputs use (in Rupees) | | | | |
| (a) Hired labor | 66.80 | 570.29 | 503.49 | 753.73 |
| (b) Fertilizers | 54.54 | 466.05 | 411.51 | 754.51 |
| (c) Water charges | 40.73 | 347.80 | 307.07 | 753.92 |
| (d) Oil cakes | 32.29 | 275.75 | 243.46 | 753.98 |
| 5. Total working capital (cash) use | 229.04 | 1956.46 | 1727.42 | 754.20 |
| 6. Consumption patterns (in Rupees) | | | | |
| (a) Cereals | 10.45 | 80.33 | 69.88 | 668.71 |
| (b) Pulses | 1.70 | 12.42 | 10.72 | 630.59 |
| Foodgrains | 12.15 | 92.75 | 80.60 | 663.37 |
| (c) Milk and ghee | 5.93 | 45.03 | 39.10 | 659.36 |
| (d) Vegetables and fruits | 2.69 | 18.50 | 15.81 | 587.73 |
| Dairy-products, vegetables & fruits | 8.62 | 63.53 | 54.91 | 637.01 |
| (e) Sugar and gur | 1.84 | 14.12 | 12.28 | 667.39 |
| (f) Edible oil | 2.54 | 17.93 | 15.39 | 605.91 |
| (g) Beverages | 0.99 | 7.35 | 6.36 | 642.42 |
| (h) Spices | 1.27 | 8.19 | 6.92 | 544.88 |
| Other foods | 6.64 | 47.59 | 40.95 | 616.72 |
| (i) Fuel and light | 1.42 | 6.78 | 5.36 | 377.46 |
| (j) Tobacco and its products | 0.99 | 8.19 | 7.20 | 727.27 |
| (k) Washing soap and other materials | 0.42 | 3.24 | 2.82 | 671.43 |
| (l) Toiletry goods | 0.28 | 2.96 | 2.68 | 957.14 |
| (m) Footwear | 0.29 | 2.40 | 2.11 | 727.59 |
| (n) Cotton textiles | 5.08 | 43.90 | 38.82 | 760.24 |
| Manufactured nonfood items | 8.48 | 67.47 | 58.99 | 695.64 |
| (o) Domestic and consumer services | 1.41 | 9.17 | 7.76 | 550.35 |
| (p) Travel and recreation | 6.49 | 60.98 | 54.49 | 839.60 |
| (q) Utilities | 0.99 | 6.78 | 5.79 | 584.85 |
| (r) Education | 19.91 | 67.63 | 47.72 | 239.68 |
| (s) Medical services | 44.90 | 73.14 | 28.24 | 62.89 |
| Services | 73.70 | 217.70 | 144.00 | 195.35 |

*NOTES*

1. P3 assumes that farmers with less than 7.5 acres would increase net irrigable land up to 100 percent by receiving canal water, whereas large farmers would not witness any change in their resources.

   P6 assumes an increase in net irrigable land up to 100 percent of the farm size by canal water for both the groups of farmers.

2. Differences between predicted changes is calculated by subtracting values in column 1 from those in column 2.

greater potential for employment-oriented growth strategy. Similarly, there would be significant increases in expenditure on such items as medicines and education, on processed foods such as sugar and edible oil, and on toiletry goods, footwear and clothing including ready-made garments.

Since the suggested policy envisages greater increases in incomes of small farmers the following may be noted:

On an average, these farmers would earn about 40 percent more income than they did prior to their resource changes.[14] In contrast, an average large farmer would witness about 28 percent increase in his income. The small farmers could gain the fixed capital investment of Rs. 16,888 to acquire lift irrigation system and two improved breed milking buffaloes in a little less than eight years. This compares favorably with about five years for large farmers.

It may, therefore, be concluded that the nature of differential change in the two resources of small and large farmers as suggested by P1 may be facilitated by programs for long-term credit with a provision for differential interest rates and more flexible repayment schedule, assessment of the ground water potentials, cattle insurance, veterinary services, marketing and processing facilities for milk, sugarcane and banana.

**Effects of Restricting Change in Irrigation Resource to Small Farmers**

The policy of restricting changes in irrigation resources to small farmers alone (described as P3) may now be compared with the policy which does not restrict these changes to either of the two groups of farmers (described as P6). Differences in the effects of these two policies are considered to dramatize the important role of large farmers in contributing, directly and indirectly, to the earlier discussed employment-oriented growth linkages. The following results are noteworthy:

The loss in income of farmers and hence in their consumption expenditure on various goods and services is very large (Table 16). Similarly, the loss in employment, and in the use of other inputs such as oil cakes and fertilizers due to smaller increases in acreage under such crops as sugarcane, banana, HYV paddy and wheat is also large. Against this, the gain due to reduction in income inequalities among farmers is quite small.

**Effects of Changing Herd Size by Two Different Breeds of Buffaloes**

It may be recalled from Chapter III that change in herd size by improved instead of "desi" breed milking buffalo raises the use of inputs, revenue including milk output and hence dairy income by a larger amount. This, in turn, would cause, by providing larger internal finance, larger shifts in acreages under HYV paddy and wheat and thereby lead to larger increases in the use of labor and other inputs. The crop-farming incomes of farmers would also increase. Hence, the policies three (P3) and four (P4) of expanding the dairy herd of sample farmers by two different breeds of milking buffalo may be compared.

The comparison is attempted first to determine the magnitude of incremental effect on (a) use of variable inputs, (b) gross revenue, and (c) net returns from dairying. Second, the comparison would show whether or not the difference in incremental net return of increasing herd size by an improved instead of "desi" breed milking

[14]The increase in average income of small farmers under P2 is only 23 percent. It may be recalled that P2 envisages increase in net irrigable land through canal irrigation and increase in herd size by only one improved breed milking buffalo for these farmers.

**Table 17. Estimate of Incremental Investment in Variable Inputs, Gross Revenue and Net Returns of An Average Farmer Due to Increasing Herd Size by "Desi" versus Improved Breed Milking Buffalo, Surat District, 1969-70**

| Estimate of incremental | Increasing herd size by an additional buffalo of "Desi" breed | Increasing herd size by an additional buffalo of Improved breed | Difference in incremental effect: i.e. Clm. 3 – Clm. 2 | % change in the difference in incremental effect: i.e. Clm. 4 as a % of Clm. 2 |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| | ............... in Rupees | | ............... | Percent |
| 1. Investment in variable inputs | 461 | 646 | 185 | 40.13 |
| 2. Gross revenue | 827 | 1346 | 519 | 62.73 |
| 3. Net returns (i.e. Row 2 – Row 1) | 366 | 700 | 334 | 91.25 |

buffalo is attractive enough to bear the additional investment for the purchase of an improved breed buffalo by an average farmer. Then follows a brief description of the integrated effects on crop pattern, input use, incomes and consequently on consumption of different items under the two policies.

On an average, the improved breed buffalo generates an additional annual demand of Rs. 185 for variable inputs (Table 17). This forms 40 percent increase over the incremental demand for variable inputs caused by the purchase of an additional "desi" breed milking buffalo. The increase in incremental gross revenue due to the addition of a high-yielding buffalo over that due to a "desi" breed buffalo is Rs. 519 per year. This is about 63 percent of the increments in gross revenue caused by increasing "desi" breed milking herd.

The percentage of increase in annual net returns to farmers due to the acquisition of an additional high-yielding instead of a "desi" breed buffalo is 91. An average farmer in Surat district would receive an annual increment of Rs. 334 by way of net return for expanding his herd size by an improved instead of "desi" breed milking buffalo. Thus, the additional cost, Rs. 600, of purchasing an improved buffalo can be recovered by a farmer in about a year and three quarters. This period of recovery will be further reduced since this additional dairy income would generate additional crop income of Rs. 60 per year through its effect as an internal finance to grow various crops. Considering the total effect, it is found that a farmer can recover the additional fixed investment of Rs. 600 in about a year and a half.

Finally, the larger increase (about 63 percent) in production of milk, a high-income elasticity commodity, on account of acquisition of improved instead of "desi" breed milking buffalo is particularly important in the context of increasing incomes.

As regards the comparison of integrated effects, the following results are noted:

As mentioned earlier, a larger increase in dairy income by providing larger internal finance leads to larger shifts in crop pattern from such low return crops as cotton and groundnut to such high return crops as HYV paddy and wheat (Table 18). As a result, the difference in the increased levels of incomes from crops of an average farmer under the two policies is 92 percent. The corresponding differences in this farmer's use of labor, fertilizers and oil cakes are 53, 86 and 83 percent, respectively. Similarly, the difference in the increased levels of working capital, use for crops and dairy farming is 45 percent. Finally, there is a significant increase in

**Table 18. Estimates of Changes in Fixed Capital Investment, Crop Pattern, Milk Production, Net Income and its Distribution, Inputs Use, Working Capital Use and Consumption Patterns of an Average Farm-Family, Surat District, Under Two Policies[1]**

| Per farm-family | Predicted change: P4 | Predicted change: P5 | Difference between predicted changes[2] | % Difference, i.e. $\left[\frac{\text{Clm. 3}}{\text{Clm. 1}}\right] \times 100$ |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 1. Fixed capital investment (in Rupees) | 800 | 1400 | 600 | 75.00 |
| 2. Crop pattern (in acres with two decimals) | | | | |
| (a) Sugarcane | 0.01 | 0.02 | 0.01 | 100.00 |
| (b) Banana | 0.01 | 0.01 | – | – |
| Sub-total | 0.02 | 0.03 | 0.01 | 50.00 |
| (c) HYV paddy and wheat | 0.08 | 0.16 | 0.08 | 100.00 |
| (d) Other foodgrains | 0.08 | 0.15 | 0.07 | 87.50 |
| (e) Other nonfoodgrains | −0.03 | −0.06 | −0.03 | −100.00 |
| 3. Milk production (in litres) | 620.64 | 1009.80 | 389.16 | 62.72 |
| 4. Net income (in Rupees) | 431 | 825 | 394 | 91.42 |
| 5. Income inequality ratio | −.014739 | −.026362 | −.011623 | 78.86 |
| 6. Inputs use (in Rupees) | | | | |
| (a) Hired labor | 76.34 | 116.68 | 40.34 | 52.84 |
| (b) Fertilizers | 11.81 | 21.99 | 10.18 | 86.20 |
| (c) Irrigation charges | 6.88 | 12.64 | 5.76 | 83.72 |
| (d) Oil cakes | 4.84 | 8.84 | 4.00 | 82.64 |
| 7. Total working capital (cash) use | 293.74 | 425.18 | 131.44 | 44.75 |

Table 18. – Continued

| Per farm-family | Predicted change: P4 | Predicted change: P5 | Difference between predicted changes[2] | % Difference, i.e. $\left[\frac{\text{Clm. 3}}{\text{Clm. 1}}\right] \times 100$ |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 8. Consumption patterns (Rupees) | | | | |
| (a) Cereals | 19.56 | 36.84 | 17.28 | 88.34 |
| (b) Pulses | 3.02 | 5.70 | 2.68 | 88.74 |
| Foodgrains | 22.58 | 42.54 | 19.96 | 88.40 |
| (c) Milk and ghee | 10.89 | 20.56 | 9.67 | 88.80 |
| (d) Vegetables and fruits | 4.64 | 8.72 | 4.08 | 87.93 |
| Dairy products and vegetables and fruits | 15.53 | 29.28 | 13.75 | 88.54 |
| (e) Sugar and gur | 3.47 | 6.48 | 3.01 | 86.74 |
| (f) Edible oil | 4.50 | 8.50 | 3.01 | 86.74 |
| (g) Beverages | 1.73 | 3.35 | 1.62 | 93.64 |
| (h) Spices | 2.10 | 4.01 | 1.91 | 90.95 |
| Other foods | 11.80 | 22.34 | 10.54 | 89.32 |
| (i) Fuel and light | 2.06 | 3.82 | 1.76 | 85.44 |
| (j) Tobacco and products | 1.93 | 3.67 | 1.74 | 90.16 |
| (k) Washing soap and other materials | 0.79 | 1.55 | 0.76 | 96.20 |
| (l) Toiletry goods | 0.65 | 1.27 | 0.62 | 95.38 |
| (m) Footwear | 0.65 | 1.13 | 0.48 | 73.85 |
| (n) Cotton textiles | 10.85 | 19.20 | 8.35 | 76.96 |
| Manufactured nonfood items | 16.93 | 30.64 | 13.71 | 80.98 |
| (o) Domestic and consumer services | 2.32 | 4.52 | 2.20 | 94.83 |
| (p) Travel and recreation | 13.47 | 25.12 | 11.65 | 86.49 |
| (q) Utilities | 1.64 | 3.11 | 1.47 | 89.63 |
| (r) Education | 14.20 | 27.11 | 12.91 | 90.92 |
| (s) Medical services | 15.84 | 30.08 | 14.24 | 89.90 |
| Services | 47.47 | 89.94 | 42.47 | 89.47 |

*NOTES*

1. P4 refers to increasing the herd size by acquiring an additional "desi" breed milking buffalo by both small and large farmers.

   P5 refers to increasing the herd size by acquiring an additional improved breed milking buffalo by both the groups of farmers.

2. Differences between predicted changes is calculated by subtracting values in Column 1 from those in Column 2.

expenditure on such consumption goods as milk, ghee, fruits and vegetables, edible oil, medicines and education.

It may thus be concluded that policies to encourage fixed capital investment to acquire an improved instead of "desi" breed buffalo would be worthwhile both from the point of view of an individual farmer and of an aggregate economy. Inasmuch as the risk caused by the loss of an animal due to disease, flood, etc. hampers farmers' motivation to enlarge their herd size, the cattle insurance scheme is suggested as an important component of the policies for development of dairy-farming. In addition, the programs for developing high-yielding and disease-resistant breed of buffaloes, long-term credit, veterinary services and marketing facilities are suggested.

### Effects of Canal versus Well Irrigation Expansion Policies

For reasons discussed earlier, the two sources of irrigation would have different impact on crop pattern and consequently on input use and incomes of farmers. Hence, the comparison of their effects is important.

The shifts in crop pattern in favor of such crops as sugarcane, banana, HYV paddy and wheat due to increasing the size of net irrigable land by undertaking well irrigation (P7) are larger than those resulting from increasing canal (P6) irrigation (Table 19). As a result, the difference in the increased incomes of an average farmer under the two policies is 19 percent. Furthermore, the reduction in income inequality among sample farm-families under P7 is greater than that under P6.

The significance of the difference (of Rs. 313) in increases in average income of farm-families under the two policies is that the farmers would prefer investment in well irrigation if, and only if, the earlier discussed plans for expansion of canal irrigation facilities do not cover the sample farmers. Assuming that the sample farmers cannot receive canal irrigation nor can they buy water from other farmers to expand their proportion of net irrigable to total land, the fixed capital cost of Rs. 14,088 for an entire lift irrigation system can be recovered by an average farmer in about seven years.

The policy for well irrigation development may be preferred on three grounds. One, it increases the absolute level of income of hired laborers more than the alternative

Table 19. Estimates of Changes in Crop Pattern, Family Net Income and its Distribution, Inputs Use, Working Capital Use and Consumption Patterns of an Average Farm-Family, Surat District, Under Two Policies[1]

| Per farm-family | Predicted changes: P6 | Predicted changes: P7 | Difference between predicted changes[2] | % Difference, i.e. [Clm. 3 / Clm. 1] x 100 |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 1. Crop pattern (in acres with two decimals) | | | | |
| (a) Sugarcane | 0.85 | 1.08 | 0.23 | 27.06 |
| (b) Banana | 0.58 | 0.59 | 0.01 | 0.58 |
| Sub-total | 1.43 | 1.67 | 0.24 | 16.78 |
| (c) HYV paddy and wheat | 0.24 | 0.27 | 0.03 | 12.50 |
| (d) Other foodgrains | –0.66 | –0.89 | –0.23 | –34.85 |
| (e) Other nonfoodgrains | –0.87 | –1.03 | –0.16 | –18.39 |
| 2. Net income (in Rupees) | 1687 | 2000 | 313 | 18.55 |
| 3. Income inequality ratio | .010176 | .012037 | –.001861 | 18.29 |
| 4. Inputs use (in Rupees) | | | | |
| (a) Hired labor | 570.29 | 661.49 | 91.20 | 15.99 |
| (b) Fertilizers | 466.05 | 525.55 | 59.59 | 12.77 |
| (c) Water charges | 347.80 | 399.66 | 51.36 | 14.77 |
| (d) Oil cakes | 275.75 | 315.78 | 40.03 | 14.52 |
| 5. Total working capital (cash) use | 1956.46 | 2247.62 | 291.16 | 14.88 |
| 6. Consumption patterns (in Rupees) | | | | |
| (a) Cereals | 80.33 | 92.76 | 12.43 | 15.47 |
| (b) Pulses | 12.42 | 14.40 | 1.98 | 15.94 |
| Foodgrains | 92.75 | 107.16 | 14.41 | 15.54 |
| (c) Milk and ghee | 45.03 | 51.81 | 6.78 | 15.06 |
| (d) Vegetables and fruits | 18.50 | 21.46 | 2.96 | 16.00 |
| Dairy products and vegetables and fruits | 63.53 | 73.27 | 9.74 | 15.33 |
| (e) Sugar and gur | 14.12 | 16.24 | 2.12 | 15.01 |
| (f) Edible oil | 17.93 | 20.61 | 2.68 | 14.95 |
| (g) Beverages | 7.35 | 8.62 | 1.27 | 17.28 |
| (h) Spices | 8.19 | 9.46 | 1.27 | 15.51 |
| Other foods | 47.59 | 54.93 | 7.34 | 15.42 |
| (i) Fuel and light | 6.78 | 7.91 | 1.13 | 16.67 |
| (j) Tobacco and its products | 8.19 | 9.60 | 1.41 | 17.22 |
| (k) Washing soap and other materials | 3.24 | 3.67 | 0.43 | 13.27 |
| (l) Toiletry goods | 2.96 | 3.38 | 0.42 | 14.19 |

Table 19. – Continued

| Per farm-family | Predicted changes | | Difference between predicted changes[2] | % Difference, i.e. $\left[\frac{\text{Clm. 3}}{\text{Clm. 1}}\right] \times 100$ |
|---|---|---|---|---|
| | P6 | P7 | | |
| | 1 | 2 | 3 | 4 |
| (m) Footwear | 2.40 | 2.83 | 0.43 | 17.92 |
| (n) Cotton textiles | 43.90 | 50.82 | 6.92 | 15.76 |
| Manufactured nonfood items | 67.47 | 78.21 | 10.74 | 15.92 |
| (o) Domestic and consumer services | 9.17 | 10.59 | 1.42 | 15.49 |
| (p) Travel and recreation | 60.98 | 70.30 | 9.32 | 15.28 |
| (q) Utilities | 6.78 | 7.76 | 0.98 | 14.45 |
| (r) Education | 67.63 | 78.36 | 10.73 | 15.87 |
| (s) Medical services | 73.14 | 84.57 | 11.43 | 15.63 |
| Services | 217.70 | 251.58 | 33.88 | 15.56 |

*NOTES*

1. P6 assumes increase in net irrigable land up to 100 percent of the farm size by canal water facilities for both the groups of farmers.

   P7 assumes similar magnitude of increase in net irrigable land as for P6 although by undertaking investment in well irrigation by both the groups of farmers.

2. Differences between predicted changes is calculated by subtracting values in column 1 from those in Column 2.

policy. Two, it reduces the income inequality among farmers more than the other means of irrigation. Three, this policy has other beneficial, although indirect, effects on inducing interregional as well as intersectoral growth linkage caused by larger increases in demand for oil cakes and other inputs. Additionally, it also leads to an increase in consumption of such items as milk, ghee, fruits and vegetables, clothing including ready-made garments, domestic services, medicines and education.

The preceding discussion which argues for policies for well irrigation development is, however, subject to one important qualification. While the suggested policy appears reasonable by analyzing the results of an average farmer in the sample, the same policy is unviable for *sample* farms below 7.5 acres. This is because the incremental annual net returns (Rs. 648) that would be obtained by an average small farmer as a result of change in his cropping pattern are extremely small. This is primarily because of the smallness of his farm. This emphasizes the need for a disaggregative and selective approach in evolving policies for agricultural development. And it brings us to our earlier suggestion of facilitating differential changes in the two resources of small and large farmers (i.e. P1).

## Conclusions

The analysis in this chapter emphasized the importance of policies for facilitating differential change in the availability of two resources, namely, net irrigable land, and size of dairy herd of small versus large farmers. It is, however, suggested that restricting expansion in irrigation resource to small farmers *alone* is not desirable from the viewpoint of overall growth in income and employment. Nonetheless, a selective policy with respect to certain resources such as that for dairy development on small farms is considered desirable. In this context, it may be noted that change in size of dairy herd by an improved instead of "desi" breed buffalo is found economically viable. The additional fixed capital investment for this can be recovered by a farmer in about a year and half.

The suggested policy (designated as P1) of differential change in the two resources of farmers increases the income of a typical small farmer by 40 percent as against 28 percent for a typical large farmer. Further, because the model incorporates both production and consumption aspects of farm-families, we could clearly trace the direct and indirect potentialities for inducing growth linkages through changes in crop pattern and in consumption pattern under this policy. These effects are eventually caused by changes in fixed capital investment needed for resource expansion by farmers. Such changes are considered as pre-conditions for successful adoption of new technologies in crop as well as in dairy farming. Public policies to encourage such investment at the farm level should, therefore, include among others the programs for (i) long-term credit with provisions for differential interest rates and flexible repayment schedule, (ii) cattle insurance scheme, (iii) breeding of high-yielding and disease-resistant buffaloes, (iv) veterinary facilities, and (v) marketing and processing facilities for milk and crops such as sugarcane and banana.

*CHAPTER V*

# CONCLUSIONS AND POLICY IMPLICATIONS

## Main Findings

### Dairy-Farming of Year t

1. Both per animal per month investment and gross revenue from dairying are largely influenced by the composition of herd. The effect of improved breed milking buffalo on both the monthly input expenditure and revenue per animal is larger than that of "desi" breed buffalo. An increment to investment in variable inputs for a dairy herd caused by the addition of an improved instead of "desi" breed buffalo is 40 percent higher. The corresponding change in gross returns is 63 percent. Hence, the additional annual net returns (Rs. 334) to farm-families from an acquisition of improved instead of "desi" breed milking buffalo would enable them to recover the additional fixed capital cost (Rs. 600) in about a year and three quarters.

2. This period of recovery will be further reduced since the additional dairy income, by providing internal finance, would generate additional net crop income of the order of Rs. 60 by causing larger shifts to high-return crops. Considering the total effect, a farmer can gain the additional fixed capital investment of Rs. 600 in about a year and a half. Thus, the analysis of predicting changes in incomes and input use as a result of change in size of dairy herd concentrates on policies to increase the herd size of improved breed buffalo.

### Crop-Farming of Year t

1. Over 85 percent of variation in per acre gross returns and input use of the sample farmers are associated with their crop pattern and hence the emphasis on analyzing crop pattern.

2. The proportion of land allocated to such high-return-high-working-capital-intensive crops as sugarcane, banana and HYV paddy is found to be inversely related to the size of a farm. Constraints such as marketing, timely and adequate availability of inputs and diseconomies of managing labor force on large farms could be responsible for this. Marketing constraint is particularly important for sugarcane and banana which farmers in this district grow primarily for cooperative marketing and processing societies.

3. The analysis of influence of net irrigable land on crop pattern reveals that the estimated parameters have expected signs as well as pattern of their size. Thus, the sign is positive for high-return crops of sugarcane, banana, HYV paddy and wheat, whereas it is negative for such low-return crops as jowar, tur and cotton. Similarly, the size of coefficient for sugarcane is the largest, followed by banana, HYV paddy, wheat, other foodgrains and other non-foodgrains. These results imply that as the availability of net irrigable land increases, the crop pattern would shift from low-return crops to high-return crops. Thus, the analysis of changes in crop pattern and hence in income and input requirements as a result of increasing the size of net irrigable land while holding the total farm size same is important.

4. The estimated parameters for wealth, a proxy for incorporating risk hypothesis and family size to proxy for monthly aggregate consumption expenditure have the logical signs in all the crop-equations, the sign being positive for wealth and negative for family size for high-return-high-working capital-intensive crops.

5. The influence of per acre expected net returns from various crops and monthly net flow of internal finance formed from dairy *plus* non-farm incomes *minus* aggregate consumption expenditure on crop pattern is contrary to the a priori logic behind identifying these explanatory factors. For example, in the equation for own ($i^{th}$) crop the sign of the coefficient for per acre expected net returns of this crop was negative, whereas that for the competing ($q^{th}$) crop was positive. Similarly, the sign of the coefficient associated with the monthly net flow of internal funds in the equation for high-return crop was negative. Therefore, the model was respecified by omitting two variables, namely, per acre expected net returns and aggregate consumption expenditure. The availability of internal finance through dairy plus nonfarm incomes would shift crop pattern from low-return crops of cotton and groundnut to high-return crops of HYV paddy and wheat.

6. The inconsistent results on influence of net flow of internal finance and of per acre expected net returns on various crops on crop pattern may perhaps be due to two reasons. One, the analysis is based only on cross-section data of single point in time. Two, data on cash flows were not available to specify properly the variable of net flow of internal funds. This underscores the need for generating time-series cum cross-section data from the same group of farmers. This would also permit a test of the hypothesis that farmers diversify crop pattern to avoid risk.

### Aggregate Monthly Consumption Expenditure of Year t + 1

1. Expected family net income, wealth, family size and expected intensity of crop-farming are all important factors influencing the aggregate consumption expenditure of the sample farmers. The estimated parameters associated with all these variables have expected signs. As the farmers' expectation of intensity of crop-farming (defined as gross returns per rupee of investment in variable inputs for crop-farming of year t) increases, holding other factors constant, their monthly aggregate consumption expenditure decreases. This could be a result of inadequacy of capital market as well as risks in farming.

2. Exclusion of the variable of expected intensity of crop-farming from the aggregate consumption function reduces by almost 33 percent the marginal propensity to consume with respect to the expected net family income.

### Pattern of Monthly Aggregate Consumption Expenditure of Year t + 1

1. The pattern of additional demand (i.e. marginal propensity to expend) by an average farm-family in the sample is fairly diversified. Thus, the size of this demand for milk, ghee, vegetables and fruits together is about the same as that for manufactured nonfood items such as toiletry goods, tobacco and its products, washing soap and other materials, footwear and clothing. The former group of commodities have low capital-labor ratios in their production process.

2. The share of sugar, gur and edible oil in the sum of marginal propensity to spend (0.11) on all processed foods consumed by these families is 64 percent.

3. Nearly 42 percent of the incremental expenditure on all commodities is on education, medical services, travel and recreation, etc.

4. A typical small farm-family spends, at the margin, on foodgrains about twice as much as a typical large farm-family. The marginal propensity to expend on pulses by the former is about one-eighth of the aggregate of MPE on foodgrains. The corresponding figure for a large farm-family is nearly one-sixth. The MPE on milk and ghee by a small farm-family forms only about one-third of the sum of MPE on nonfoodgrain food items. For a large farm-family the corresponding figure is about one-half. The MPE on travel and recreation, education and medical services claims a much larger share in the sum of incremental expenses on nonfood service items of a large farm-family than in that of a small one.

### Predicted Effects of Change in Irrigation and Dairy Herd Resources of Sample Farmers

Since the estimated model exhibits reasonable accuracy in its predicting ability it was utilized to make alternative predictions of changes in crop pattern, input requirements, income and its distribution and consumption expenditure on various goods and services by sample farmers. For this purpose, increases in the availability of net irrigable land and dairy income of farmers, on account of fixed capital investment in well irrigation and in improved breed milking buffalo respectively are envisaged.

1. The analysis of restricting resource changes to small farmers alone reveals that such policy would not prove desirable from the viewpoint of overall increases in incomes of farmers and laborers, nor for inducing inter-sectoral and interregional growth linkages.

2. It is, however, suggested that the increase in dairy herd size may be encouraged more on small farms, whereas the size of net irrigable land be increased up to 100 percent (either through canal or well water facilities) for both the small and large farmers.

3. The detailed results of suggested policy of increasing the dairy herd of small farmers by two improved breed milking buffaloes and increasing net irrigable land up to 100 percent, for both small and large farmers, by well irrigation are:

a. It increases the incomes of small farmers by 40 percent as against 28 percent of large farmers.

b. It enables small farmers to gain the fixed capital investment of Rs. 16,888 (for acquiring both well irrigation system and two improved breed milking buffaloes) in seven and three quarters years. This is comparable to five years for large farmers.

c. It also leads to larger increases in acreage under sugarcane, banana, HYV paddy and wheat, while decreasing acreage under other crops such as jowar, tur and cotton. This results in larger increases in demand for other production inputs like oil cakes and fertilizers, in addition to larger increases in employment. Larger increase in use of oil cakes is noteworthy for its potentialities to induce interregional and intersectoral growth linkages.

d. This policy also generates larger demand for those consumer goods like milk, ghee, vegetables and fruits, edible oil, footwear, etc. which are known for low capital-labor ratios in their production processes.

e. By increasing small farmers' income this policy enables them to consume more of foods with higher protein and vitamin content like milk, ghee, pulses, vegetables and fruits.

## Policy Measures to Facilitate the Expansion of Two Resources

The preceding section outlined the effects of intensifying agriculture by increasing the acreages under HYV paddy, sugarcane, banana, wheat, and also by improving the quality and number of buffaloes. These changes are eventually caused by changes in fixed capital investment of farmers. Public policies to encourage such investment at the farm level should, therefore, include among others, the following programs:

### 1. Long-Term Credit

The analysis suggests increasing long-term credit availability more for small than for large farmers. This suggestion is made to emphasize the development of dairy-farming on small farms, in addition to developing their irrigation resources. This is because dairy income being continuous in character can help these farmers by providing assured minimum income. Such income can also be considered indicative of relaxing risk and capital constraints which are particularly faced by small farmers.

Flexibility in repayment of loans, closer loan supervision, and also differential interest rates are necessary to encourage fixed investment in irrigation and in acquiring improved quality buffaloes. Further, research is required to determine whether or not these policies would make the business of lending a viable proposition. Research is also required to examine the extent to which the perfection of short-term capital market may reduce the relevance of dairy-farming as a source of internal finance particularly under the conditions of risks in crop-farming. Nevertheless, inasmuch as dairy income may help farmers by providing assured minimum income, long-term credit facilities for dairying may be expanded. Some of the prerequisites to make the above referred long-term credit policies practicable may now be discussed.

### 2. Dairy-Farming Development

The analysis shows that it would be profitable for farmers to invest in improved breed buffaloes. A farmer in Surat district could recover the investment in improved breed buffalo in less than two years. Thus, research in and breeding of high-yielding and disease-resistant buffaloes is essential, in addition to supply of long-term credit. A buffalo insurance scheme is also required to protect farmers from risk of loss which may prevent them from changing the size and composition of their herd. It is, however, recognized that to ensure that farmers take proper care of their animals a penalty would be required in the case of death, in addition to considering different rates of insurance premiums. Facilities for veterinary services should also be improved. Research is required to determine the extent of gain to the farmers as well as to insurance agencies after accounting for the rates of premium and possible penalty. Research is also required to examine the stability of dairy income.

### 3. Well Irrigation Development

An important aspect of making investment in well irrigation a successful proposition is assessment of the ground water potentials, in addition to easy availability of machinery, equipment and other materials including diesel oil and electricity. Such facilities are expected to be provided by government agencies. A close liaison of these agencies with the agencies advancing long-term credit is essential from the viewpoints of both farmers and institutions providing credit and other services.

### 4. Developing Marketing and Processing Facilities

The analysis shows that increasing the existing size of net irrigable land by expansion of irrigation facilities causes shifts in crop pattern in favor of crops such as sugarcane and banana. Similarly, shift in composition of herd from "desi" to improved breed buffalo results in increases in milk production. Thus, public investment in marketing and processing facilities would be required to handle a larger output of these products.

The measures suggested in the preceding discussion would encourage larger shifts in crop pattern in favor of sugarcane and banana as compared to HYV paddy, wheat and other foodgrains. Such shifts in crop pattern may not, however, be desirable in the present conditions of foodgrain shortages in India. In the short-run with which this study is concerned, such shifts in crop pattern may lead to increases in foreign exchange and domestic tax resources, both of which may largely be utilized for the import of foodgrains and also for developing new varieties of foodgrains. However, in the long-run these shifts may not prove as desirable because the international market for both sugarcane and banana is susceptible to instability. Yet another measure to encourage more desirable shifts in crop pattern is to evolve the policy of acreage allocation to various crops. Such policy may particularly be administered in the regions where irrigable land is expanded by earlier discussed programs. Finally, the larger shifts in favor of sugarcane and banana might in the course of time cause relative prices of foodgrains to rise. This, in turn, might lead to new forces of shift in crop pattern. Since the available data did not contain variation in prices, we could not examine effects of these forces through carefully worked out price changes.

# APPENDIX

**Appendix Table 1. Selected Features of Sample Farm-Families, Surat District, 1969-70**

| 1. Educational status of head of a family | Number |
|---|---|
| Illiterate | 4 |
| Up to 5th standard | 27 |
| Secondary level | 55 |
| Matriculation | 9 |
| Undergraduate and graduate | 4 |
| **2. Highest educational attainment in a family** | **Number** |
| Primary | 9 |
| Secondary | 48 |
| Matriculation | 20 |
| Undergraduate | 12 |
| Graduate | 6 |
| Special diploma in agriculture | 1 |
| Other special training | 3 |

| | |
|---|---|
| 3. Income from salaries, remittances, trade and profession | |
| (a) Value per family (Rupees) | 974 |
| (b) Percent share in family income | 11.63 |
| 4. Ownership of financial assets (For example, life insurance policy, shares of cooperatives and sugar factories.) | |
| (a) Value per family (Rupees) | 2023 |
| (b) Percent share in value of farm assets excluding land | 22.89 |
| (c) Percent share in value of farm and non-farm assets excluding land and houses | 9.67 |

Sources: (1) Desai, *op. cit.*, pp. 35-36.
(2) Compiled from data made available for this study.

**Appendix Table 2. Estimated Per Acre Coefficients of Variable Inputs and Gross Revenue of Various Crops of Farms of Less than 7.5 Acres (Small), Surat District, 1969-70**

| | Value in Rupees | | | | | |
|---|---|---|---|---|---|---|
| Crops | Total variable inputs | Hired labor | Fertilizers | Irrigation | Oil cakes | Gross revenue |
| Sugarcane (18)[a] | 1360.557 | 413.397 | 249.739 | 241.056 | 107.801 | 2663.497 |
| | (74.646) | (25.407) | (24.438) | (17.035) | (21.240) | (165.131) |
| r | .975 | .991 | .927 | .960 | .776 | .969 |
| Bananas (8) | 1599.481 | 347.642 | 403.886 | 262.894 | 234.588 | 2587.282 |
| | (132.532) | (43.638) | (44.667) | (27.138) | (61.145) | (332.817) |
| r | .977 | .949 | .960 | .965 | .823 | .947 |
| High-yielding paddy (34) | 646.445 | 229.481 | 87.247 | 44.843 | 32.981 | 1208.718 |
| | (26.083) | (18.489) | (10.925) | (5.202) | (8.078) | (85.903) |
| r | .974 | .908 | .812 | .832 | .579 | .926 |
| Wheat (13) | 381.408 | 130.238 | 58.250 | 42.953 | 11.929 | 679.746 |
| | (36.422) | (23.153) | (16.675) | (6.568) | (6.555) | (97.086) |
| r | .949 | .852 | .704 | .884 | .465 | .896 |
| Other foodgrains (32) | 134.753 | 46.976 | 1.852 | — | — | 174.439 |
| | (10.180) | (4.269) | (0.982) | | | (22.702) |
| r | .922 | .892 | .321 | | | .810 |
| Other nonfoodgrains (17) | 164.662 | 73.487 | 23.423 | — | — | 323.841 |
| | (17.216) | (11.991) | (24.819) | | | (37.337) |
| r | .923 | .837 | .230 | | | .908 |

Figures in parentheses are standard errors.

a = Numbers in brackets are number of observations.

Appendix Table 3. Estimated Per Acre Coefficients of Variable Inputs and Gross Revenue of Various Crops of Farms of More than 7.5 Acres (Large), Surat District, 1969-70

| Crops | Value in Rupees | | | | | |
|---|---|---|---|---|---|---|
| | Total variable inputs | Hired labor | Fertilizers | Irrigation | Oil cakes | Gross revenue |
| Sugarcane (29)[a] | 1501.393 | 478.671 | 246.325 | 196.441 | 185.118 | 3152.835 |
| | (67.039) | (29.162) | (17.129) | (7.673) | (20.925) | (239.555) |
| r | .973 | .952 | .938 | .979 | .858 | .928 |
| Bananas (20) | 1763.717 | 397.941 | 431.555 | 271.045 | 220.641 | 2609.538 |
| | (139.105) | (43.415) | (41.309) | (17.655) | (35.017) | (254.332) |
| r | .946 | .903 | .923 | .962 | .822 | .920 |
| High-yielding paddy (47) | 623.719 | 185.860 | 105.274 | 34.041 | 31.010 | 1184.384 |
| | (31.421) | (9.739) | (9.304) | (2.282) | (6.748) | (57.750) |
| r | .946 | .942 | .858 | .910 | .561 | .949 |
| Wheat (26) | 341.344 | 72.999 | 92.568 | 60.410 | 21.599 | 564.761 |
| | (16.845) | (8.974) | (8.873) | (7.074) | (4.819) | (34.274) |
| r | .971 | .852 | .902 | .863 | .668 | .957 |
| Other foodgrains (47) | 107.114 | 42.324 | 3.182 | — | — | 244.536 |
| | (6.382) | (2.785) | (1.118) | | | (11.143) |
| | .927 | .913 | .387 | | | .955 |
| Other nonfoodgrains (32) | 167.208 | 71.899 | 18.202 | — | — | 355.812 |
| | (15.210) | (9.668) | (8.657) | | | (29.822) |
| r | .892 | .800 | .497 | | | .906 |

Figures in parentheses are standard errors.

a = Figures in brackets are number of observations.

Note: The 'F' statistic for the test on differences in the above coefficients for small and large farms indicate that none of the coefficients are different, assuming 1 percent level of significance.

Appendix Table 4. Frequency Distribution of Membership of Sample Farmers in Various Cooperative Societies Serving Agriculture, Surat District, 1969-70

| Farm size groups (net cultivable land in acres with two decimals) | Number of farmers | Cooperative Societies | | | | |
|---|---|---|---|---|---|---|
| | | Sugar factories | Fruit and vegetable marketings | Multi-purpose service | Cotton ginning | Milk production and marketing |
| Less than 7.50 | 35 | 21 | 10 | 18 | 20 | 2 |
| 7.50 and more | 50 | 43 | 24 | 31 | 37 | 13 |
| Sample | 85 | 64 | 34 | 49 | 57 | 15 |

Appendix Table 5. Estimated Fixed Capital and Annual Fixed Maintenance Costs of Installing a Typical Lift Irrigation System in Surat District, India

| Fixed Capital Cost | Rupees |
|---|---|
| 1. Electric motor diesel oil engine | 3500/4000 |
| 2. Centrifugal pump | 500 |
| 3. Pipes, fittings belt, pulleys and countershaft | 1300 |
| 4. Installation of machines | 400 |
| 5. Motor engine room and other structures | 1500 |
| 6. Construction of underground well | 5000 |
| Sub-total | 12200/12700 |
| **Annual Fixed Maintenance Cost** | |
| 1. Depreciation of machinery: Items 1 to 3 @ 10% | 530/580 |
| 2. Depreciation of civil structures including well @ 4% | 260 |
| 3. Interest on fixed capital cost @ 9% | 1098/1143 |
| Sub-total | 1888/1983 |
| Grand total | 14088/14683 |

Sources: Adapted from the following two sources:

1. S. M. Patel and K. V. Patel, "Some Techno-Economic Aspects of Lift Irrigation Systems," (Ahmedabad: Faculty for Management in Agriculture and Cooperatives, Indian Institute of Management, 1970), p. 36.
2. Surat District Cooperative Bank Ltd., (Surat, Circular No. 17, 1972-73).

## Appendix Note

### Theil's Method of Analyzing Residuals in an Econometric Model

Theil has proposed a statistic – Inequality Coefficient[1], to test the accuracy with which an econometric model can forecast. This coefficient (U) is:

$$(1)\quad U = \frac{\sqrt{\frac{1}{n}\sum_n (P_n - A_n)^2}}{\sqrt{\frac{1}{n}\sum_n P_n^2 + \frac{1}{n}\sum_n A_n^2}}$$

where $P_n$ and $A_n$ are, respectively, the predicted and the actual values of the dependent variable of the $n^{th}$ observation.

The model predicts perfectly when U = 0. This is because in such event predicted value equals actual value in all observations. When U = 1, the opposite is true. Thus, the closer U is to zero, the better the forecast; the closer it is to one, the poorer the forecast.

The mean squared error of prediction which is the square of the numerator of the U coefficient can be decomposed as follows:

$$(2)\quad \frac{1}{n}\sum_n (P_n - A_n)^2 = (\overline{P} - \overline{A})^2 + (SDP - SDA)^2 + 2(1-r)\ (SDP)\ (SDA)$$

where $\overline{P}$, $\overline{A}$, SDP, SDA are the means and standard deviations of the predicted and actual values, respectively. And r is the coefficient of correlation between the predicted and actual values:

$$(3)\quad U^2 = U_m^2 + U_s^2 + U_c^2$$

Where

$$U_m = \frac{\overline{P} - \overline{A}}{D}, \quad U_s = \frac{SDP - SDA}{D}$$

and D is the denominator of U.

This decomposition into the three parts gives the partial coefficients of inequality. $U_m^2$ is the partial coefficient of inequality representing the difference between the predicted and actual values caused by an unequal central tendency (the mean). $U_s^2$ is the partial coefficient representing the difference caused by unequal variation. $U_c^2$ is the partial coefficient giving the difference caused by imperfect covariation. Furthermore, dividing equation (3) by $U^2$ gives:

$$(4)\quad \frac{U^2}{U^2} = \frac{U_m^2}{U^2} + \frac{U_s^2}{U^2} + \frac{U_c^2}{U^2} = 1$$

Thus, $UM^2$, $US^2$ and $UC^2$ are the proportions of inequality caused by the mean, variance and covariance, in that order, and are convenient to present as is done in the text of the study, in percentages rather than proportions. Errors of unequal means and variances are systematic errors, whereas errors from imperfect covariation are unsystematic.

To recapitulate:

a. U = 0 indicates perfect forecasting.

b. If U ≠ 0, then it is desirable to have U as close to zero in value as possible.

c. If U ≠ 0, the most desirable value for UM and US is zero, whereas that for UC is one. When UM and US equal zero, it means that systematically repeating errors have been eliminated and that the error remaining (UC) is unsystematic and cannot be adjusted.

[1]H. Theil, *Economic Forecasts and Policy*, (Amsterdam: North-Holland Publishing Company, 1965), pp. 31-37.

# SELECTED BIBLIOGRAPHY

Bardhan, Kalpana, "Relative Prices and Allocation of Land and Other Inputs Among Competing Crops," *Readings in Agricultural Development.* ed. A. M. Khusro, Allied Publishers, Calcutta, India, 1968.

Day, Richard H., *Recursive Programming and Production Response,* North-Holland Publishing Company, Amsterdam, 1963.

Desai, B. M. and M. D. Desai, *The New Strategy of Agricultural Development in Operation,* Thacker and Co., Bombay, 1969.

Desai, D. K., *Increasing Income and Production in Indian Farming,* Indian Society of Agricultural Economics, Bombay, 1963.

Desai, D. K. and S. B. Tambad, "Farm Finance by a Commercial Bank," Indian Institute of Management, Ahmedabad, 1970.

Desai, M. B., "Changing Farm Production and Organization in Developing Agriculture, Report for the Years 1968-1970," Department of Agricultural Economics, University of Baroda, Baroda, 1972.

Desai, Mahendra, D. and Bharat D. Naik, "Prospects of Demand for Short-Term Institutional Credit for High-Yielding Varieties," *Indian Journal of Agricultural Economics,* Conference Number, Vol. 26, No. 4 (October-December 1971), p. 458.

Desai, M. D., "Saving and Investment in an Agriculturally Prosperous Area," Research Study No. 30, Agro-Economic Research Centre, Sardar Patel University, Vallabh Vidyanagar, 1973.

Desai, Gunvant M. and Michael G. G. Schluter, "Generating Employment in Rural Areas," *Seminar Series XII,* Seminar on Rural Development for the Weaker Sections, Indian Society of Agricultural Economics, Bombay and Indian Institute of Management, Ahmedabad, May 1974, pp. 143-152.

Goreu, L. M., "Income and Food Consumption," *Monthly Bulletin of Agricultural Economics and Statistics,* Vol. 9, No. 10 (October 1960), p. 1.

Government of India, Ministry of Agriculture, *Interim Report of the National Commission on Agriculture on Credit Societies for Small and Marginal Farmers and Agricultural Laborers,* New Delhi, December 1971.

———, *Report of the National Commission on Agriculture on Milk Production Through Small and Marginal Farmers and Agricultural Laborers,* New Delhi, December 1971.

———, *Crash Scheme for Rural Employment, Guidelines for 1972-73,* New Delhi, March 1972.

———, "Special Projects for Small Farmers, Marginal Farmers and Agricultural Laborers," Note presented at Seminar on Rural Development for the Weaker Sections, organized by the Indian Society of Agricultural Economics and Centre for Management in Agriculture, Ahmedabad, October 1972.

———, Directorate of Economics and Statistics, "Studies into the Economics of Farm Management in the IADP Region of Surat and Bulsar, 1966-1968," New Delhi, 1969 (unpublished).

Herdt, Robert W., "Disaggregate Approach to Aggregate Supply," *American Journal of Agricultural Economics,* Vol. 52, No. 4 (November 1970), p. 512.

Houthakker, H. S. and L. D. Taylor, *Consumer Demand in the United States: Analysis and Projections,* Second edition. Harvard University Press, Cambridge, Massachusetts, 1970.

Islam, Nurul, "Employment and Output as Objectives of Development Policy," in *Theme Papers* for 15th International Congress of Agricultural Economists (Oxford: 1973).

Jodha, N. S., "Prospects and Problems of Dairy Development in a Desert Region (A Study in the Bikaner District of Rajasthan)," Agro-Economic Research Centre, Vallabh Vidyanagar, 1970.

Johnson, S. R., "A Re-examination of the Farm-diversification Problem," *American Journal of Agricultural Economics,* Vol. 49, No. 3 (August 1967), p. 610.

Johnston, Bruce F., "Agricultural and Structural Transformation in Developing Countries: A Survey of Research," *Journal of Economic Literature,* Vol. 8, No. 2 (June 1970), p. 369.

Krishna, Raj, "Farm Supply Response in India-Pakistan: A Case Study of the Punjab Region," *The Economic Journal,* Vol. 7 (September 1963), p. 477.

Krishnaswamy, M. S. and K. V. Patel, "Status of Dryland Agriculture," Centre for Management in Agriculture, Indian Institute of Management, Ahmedabad, 1973.

Lele, Uma J. and John W. Mellor, "Jobs, Poverty and the Green Revolution," *International Affairs,* Vol. 48, No. 1 (January 1972), p. 20.

Leser, C. E. V., "Forms of Engel Functions," *Econometrica,* Vol. 31, No. 4 (October 1963), p. 694.

Mellor, John W., *The Economics of Agricultural Development,* Cornell University Press, Ithaca, 1966.

———, "Accelerated Growth in Agricultural Production and the Intersectoral Transfer of Resources," *Economic Development and Cultural Change,* Vol. 22, No. 1 (October 1973), p. 1.

———, *India and the New Economics of Growth,* New York: Twentieth Century Fund, Forthcoming, 1975.

Mellor, John W. and Uma J. Lele, "Growth Linkages of the New Foodgrains Technologies," *Indian Journal of Agricultural Economics,* Vol. 2, No. 1 (January – March 1973), p. 35.

Narain, Dharm, *The Impact of Price Movements in Areas Under Selected Crops in India, 1909-39,* Cambridge University Press, 1965.

Patel, S. M. and K. V. Patel, "Some Techno-Economic Aspects of Lift Irrigation Systems," Faculty for Management in Agriculture and Cooperatives, Indian Institute of Management, Ahmedabad, 1970.

Patel, S. M., P. P. Madappa and B. M. Desai, "Management of Lift Irrigation (Report on Pilot Research Project in Gujarat)," Indian Institute of Management, Ahmedabad, 1969.

Prais, S. J. and H. S. Houthakkar, *The Analysis of Family Budgets,* The Syndics of the Cambridge University Press, Cambridge, England, 1955.

Randhawa, M. S., et al, *Farmers of India,* Vol. 4, Indian Council of Agricultural Research, New Delhi, 1968.

Schluter, M. G. G., "The Interaction of Credit and Uncertainty in Determining Resource Allocation and Incomes on Small Farms, Surat District, India," Unpublished Ph.D. Thesis, Cornell University, 1973.

Schluter, M. G. G. and Timothy D. Mount, "Management Objectives of the Peasant Farmer: An Analysis of Risk Aversion in the Choice of Cropping-Pattern, Surat District, India," Occasional Paper No. 78, Cornell-USAID Employment and Income Distribution Project, Department of Agricultural Economics, Cornell University, October, 1974.

Singh, R. and Ranbir Singh, "Studies in Economics of Farm Management in Utter Pradesh (Muzaffarnagar District)," Report for the year 1966-67, Directorate of Economics & Statistics, Ministry of Agriculture, Government of India, 1972.

Sinha, R. P., "An Analysis of Food Expenditures in India," *Journal of Farm Economics,* Vol. 48, No. 1 (February 1966), p. 113.

Tendulkar, Suresh D., "Econometric Study of Monthly Consumption Expenditure in Rural Uttar Pradesh," *American Journal of Agricultural Economics,* Vol. 51, No. 1 (February 1969), p. 119.

Theil, H., "A Multinominal Extension of the Linear Logit Model," *International Economic Review,* Vol. 10, No. 3 (October 1969), p. 251.

———, *Economic Forecasts and Policy.* North Holland, 1965.

———, *Economics of Information Theory.* Rand McNally, 1967.

Venkatappiah, B., "Small Farmers Development Agency: Outline of a Programme of Action," address at 29th Annual Conference of the Indian Society of Agricultural Economics, Waltair, December 1969.

Vyas, V. S., "The New Strategy: Lessons of First Three Years," *Economic and Political Weekly,* Vol. 3, No. 43 (October 25, 1968), p. 9.

Vyas, V. S. and K. M. Choudhary, "Economics of Dairy Farming in Mehsana District of Gujarat State," Centre for Studies in Economics of Dairying, Sardar Patel University, Vallabh Vidyanagar, 1971.

Weeks, John, "Uncertainty, Risk and Wealth and Income Distribution," *The Journal of Development Studies,* Vol. 7, No. 1 (October 1970), p. 28.

Yoshihara, Kumio, "Demand Functions: An Application to the Japanese Expenditure Pattern," *Econometrica,* Vol. 37, No. 2 (April 1969), p. 257.