EVALUATING LOAN REPAYMENT IN THE SAUDI ARABIAN

AGRICULTURAL SECTOR BY MEANS OF A FARM

CREDIT INTERDEPENDENT SYSTEM

By

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TABLE OF CONTENTS

LIST OF TABLES

Table   Page

x

LIST OF FIGURES

GLOSSARY OF TERMS

Allied Industries - Industries related directly or indirectly to agriculture, such as fisheries and those processing farm products.

Dunom - Unit of land measure equal to one-fourth acre.

Farm Operator Borrowers - This term includes farmers who are engaged in farming as their occupation and farm owners employing someone else to operate and/or manage their farms and are borrowers from the Saudi Arabian Agricultural Bank (SAAB).

Inputs - This includes farm inputs such as fertilizers, fuel, seeds, labor, and farm machinery and equipment.

Saudi Ryal (SR.) - One SR. is equal to U. S. $0.30.

CHAPTER I

INTRODUCTION

Overview

The economy of the Kingdom of Saudi Arabia is dominated by the
oil industry, which provides the largest percentage of government
revenue and foreign exchange. But since oil is an exhaustible re-
source, the government is emphasizing a new development stragegy of
diversification by developing other non-oil industries such as com-
merce and agriculture. The government has taken steps toward mas-
sive investment in the agricultural sector and has proposed policies
to enhance productivity and thus lessen the Kingdom's dependence on
foreign food stuff imports. Large quantities of agricultural machin-
ery and equipment have been imported. Experimental farms have been
established in most regions of the Kingdom and an agricultural lend-
ing institution has been established to provide farm operators with
needed capital.

But the conditions in agriculture are still characterized by
rudimentary methods of production and lack of knowledge of effective
farming practices. The most important factors contributing to the pre-
vailing conditions of the Kingdom's agriculture are characterized by a
lack of (1) effective agricultural policies pertaining to production
and marketing, (2) coordination and supervision in implementing agri-
cultural development programs, (3) managerial and technical skills by

1

farm operators to adopt modern farming techniques, (4) adequate and effective agricultural extension units to help farm operators and laborers acquire the skills and know-how to adopt the modern technologies, and (5) coordination between the agricultural lending institution and the extension units to jointly assist farm operators in making the best use of capital provided by the government.

Various studies have indicated that the Kingdom's agricultural potential is limited by the amount of cultivable land and water for irrigation. But even with these limitations there is still significant potential for increasing agricultural productivity. The Kingdom could be more self-sufficient in food stuff if government policies were oriented towards better resource management with special emphasis on increasing productivity and efficiency. Government funds allocated for developing the agricultural industry are not being effectively put to use. Extending credit to farm operators without also extending technical assistance does not change agricultural productivity significantly.

Increasing agricultural production is a complex task. It is complex because so many different conditions have to be created or modified by individuals and groups of people. Improved production techniques have to be learned and analyzed but, when combined with appropriate market information and marketing methods, usually result in increased productivity of resource use. This generally requires some analytical ability, imagination, experimentation, and much hard work. Agricultural development is as dependent on how effectively people work together as it is on the natural resources with which they have to work (25, p. 1). If the agricultural production is to

be increased adequately so as to support growth in other economic sectors, funds for investment in agriculture and for services to promote technical improvement are needed.

There is general acceptance of the important role of credit for financing farm investments and a widespread appreciation for the role of government in granting such credit. Even so, an overwhelming majority of farmers in most newly developing countries live and work without any financial help from institutional credit sources. There is a lack of public agencies organized specially for the purpose of granting rural credit or extending credit as part of a more general development program. Although farming is the main activity of rural people, most farmers lack an accessible public agricultural credit institution, but, rather, are assisted by non-institutional credit sources, such as professional moneylenders, merchants, brokers and landlords.

There is a striking contrast between the general interest in giving credit to farmers on the one hand and lack of credit facilities on the other. The main reason for this contrast is deeply rooted in the social, economic, and institutional conditions of agriculture in newly developing countries. Frequently, it is the consequence of the attitude of government authorities toward agriculture in general and credit in particular. It is often believed that, where countries are emerging from a subsistence economy toward a part cash economy, there is no need for credit. This attitude comes about either from a lack of knowledge on the benefits of credit or from an aversion to tackling credit distribution because of its complexity (14, p. 5).

The social and economic conditions of farmers differ widely in

various parts of the world. In general a great majority of farmers in developing countries have insufficient capital (both invested and working), low income, and inadequate knowledge of new methods of farming. These conditions are normally associated with illiteracy and ignorance and thus often related to prejudice against new farming methods. Agricultural credit in many developing countries is static credit (has no effect on increasing production and income), yielding little net increase in the output or income of farmers or in farm assets. This means that at the end of a credit period they are no better off than at the beginning. Static or subsistence credit has little or no impact on the development of agriculture or on the improvement of the living conditions of the rural population, although conditions might be worse without it. The goal should be to convert static credit into dynamic credit, which means that at the end of the credit period the farmer has increased his assets, productivity, power and income. This leads to a gradual change in the internal economic structure of the farm, by providing the fixed and/or semi-fixed means of production necessary to enhance the efficiency of labor and to change traditional, primitive farming practices. A mere increase in the quantity of credit is unlikely, by itself, to lead to this result. Credit must be so designed as to have a strong positive inducement to the improvement of farm techniques, institutions and organizations and it must be supported by, and closely linked with, such related services as cooperatives, agricultural extension, marketing and agrarian reform programs (14, p. 5).

As agriculture increasingly becomes commercial, more credit is needed, and agricultural extension and cooperative support services

must be expanded to train farmers in making appropriate use of credit.
Therefore, agricultural development depends to a large extent on the
amount and availability of financial resources, the terms and condi-
tions under which borrowed funds can be obtained and the amount of
managerial and technical assistance available to farm operator borrow-
ers.

Farm operators obtain the capital to operate their business from
different sources including savings, gifts or borrowing from mer-
chants, brokers, individuals, moneylenders, or lending institutions.
Most farm operators in the Kingdom are unable to obtain the needed
capital by savings (retained farm income) because their farm oper-
ations are so small that they generate only enough income to pay for
present farm expenses and withdrawal for family living. As a result,
little use is made of new or improved inputs including modern farm
machinery and equipment. The traditional sources of borrowed funds
are inadequate in meeting the credit requirements of the farm oper-
ators. The cost of borrowed funds from private moneylenders, mer-
chants, brokers, and individuals is generally very high, ranging from
20 to 30 percent.

As indicated by M. P. Mirale, decision making by farmers can
vary because of capital considerations and there are reasons to
expect variations in decision making even among small farmers if they
become dependent on sources outside the family for capital (27, p. 8).
Where family capital is obtained only through savings, the range of
enterprise combinations and techniques considered is severely restrict-
ed by the volume of savings. Farmers who can borrow from relatives
but cannot, or will not, borrow elsewhere can consider a somewhat

larger range of innovations. However, by borrowing they also place
themselves in a situation involving more uncertainty and generally
at a cost of capital, although cost of capital may be either explicit
or implicit (implicit, for example, through an agreement to pay the
lenders a share of any net return resulting from the loan). If, how-
ever, farmers rely on sources of credit outside the kinship group, the
uncertainty added is usually higher, the obligation to repay may be
stronger, and the farmer may lose a great deal of his independence as
a decision maker. Especially where capital is obtained largely from
buyers of crops, as seems to be common in developing countries, farm-
ers may have their freedom to make decisions regarding crops and tech-
niques severely restricted.

The Saudi Arabian Government, therefore, took the initiative to
make loanable funds available to farm operators through its lending
institution, the Saudi Arabian Agricultural Bank (SAAB). The SAAB was
founded in 1963 and in 1964 began making interest free loans to farm
operators, herdsmen, and to persons who are primarily engaged in agri-
culture or allied and subsidiary industries. There is no limit to the
amount the SAAB can withdraw from the government treasury to lend to
farm operators and the allied or subsidiary agricultural industries.

<div align="center">

Specific Problems in Supplying SAAB

Credit to Farm Operators

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The Saudi Arabian Agricultural Bank has been providing crop pro-
duction credit, short and intermediate-term, to the farm operators
since it began its operation in 1964. However, it has not completely
displaced merchants, individuals, and brokers who still loan money

to farmers, frequently at very high interest rates. At present, only
5 percent of farmers in the Kingdom have received credit through the
SAAB (33, p. 121).

Delinquency related to non-repayment of SAAB loans has been and
still is one of the major problems facing the institution. The trend
for loan delinquency over the 1964/65 to 1977/78 period is shown in
Table I. The amount of delinquent loans changed from a low of 6.5
percent in 1964/65 to a high of 34 percent in 1973/74. As of 1977/78,
the delinquency rate was 22 percent.

Defaults to formal credit agencies may result from a lack of
credit-worthiness on the part of the small farmer, inappropriate farm
plans, loans too small to raise production significantly, reduction in
the family farm labor force through death or marriage, or other prob-
lems at the farm level. On the other hand, it may simply be due to
the fact that farmers are not penalized for failure to repay (19, p.
31).

Default is a cost to the credit institution, but to society it
is a transfer payment in the sense that default does not consume
additional resources. However, the benefits of that transfer are not
decided by government and are often most inequitably distributed. To
the lender, default is a cost and there is a trade-off for the insti-
tution between administrative costs and default. The more carefully
the institution scrutinizes the applicants, supervises the use of
loans, and pursues delinquents, the lower the default rate but the
higher the administrative costs (26, p. 11).

It was indicated that SAAB provides interest-free production
credit to farm operators. However, there is a real opportunity

TABLE I

AMOUNT OF SHORT AND INTERMEDIATE-TERM CREDIT AND AMOUNT OF CREDIT
FOR SAAB AGRICULTURAL LOANS FROM 1964 to 1978

Year	Short-Term Credit (SR.1000)	Intermediate-Term Credit (SR.1000)	Total Short and Intermediate-Term Credit (SR.1000)	Amount Due (SR.1000)	Amount Collected (SR.1000)	Amount Delinquent (Percent)
1964/65	131,000	4,258,598	4,389,598	1,515	1,417	6.47
1965/66	294,864	8,632,561	8,927,425	4,225	3,369	20.26
1966/67	1,082,700	12,099,900	13,182,600	8,151	6,318	22.49
1967/68	1,542,000	10,477,800	12,019,800	11,328	9,183	18.94
1968/69	1,676,311	12,300,784	13,877,095	16,939	12,994	23.29
1969/70	3,008,854	13,127,273	16,136,127	21,136	18,295	13.56
1970/71	2,575,222	14,052,406	16,627,628	20,427	17,449	14.60
1971/72	2,265,666	14,292,441	16,558,107	23,184	19,204	17.17
1972/73	2,916,293	16,677,234	19,593,526	30,220	23,220	23.16
1973/74	2,544,710	32,759,095	36,303,805	27,449	18,118	33.99
1974/75	7,181,690	138,323,743	145,505,438	55,354	37,594	32.08
1975/76	8,243,773	261,189,393	269,433,166	118,243	82,343	30.36
1976/77	17,288,098	472,550,263	489,838,361	NA.	NA.	NA.
1977/78	43,713,341	541,954,927	585,668,268	180,877,444	123,585,432	21.80

Source: Saudi Arabian Agricultural Bank Annual Report 1964-78.

cost of using the funds for credit rather than in some other invest-
ment program. Credit programs are costly and in a successful pro-
gram the benefits must exceed the costs. Among the costs are admin-
istrative costs, supervisory costs, opportunity costs on funds
invested, and default costs (26, p. 11).

In trying to provide credit services to farm operators, SAAB
faces the following major problems:

1. Saudi Arabian agriculture is dominated by a complex of very
small farms of about three hectares and medium size units of about
20 to 30 hectares. The farms are not classified according to physical
and/or economic size. Loans to recipients are almost entirely based
on their farm size and subjective judgments of loan analysis. The
larger the size of the farm, the more funds the farm operator is gen-
erally able to obtain from the SAAB. It is believed that larger farms
are more efficient and have higher income potential than the smaller
farms.

The income generating potential of a farm, however, is not only
related to physical area or its land quantity, but also on the level
of technology in use. Therefore, a criteria for defining small farms
should use both physical size and size of the income stream. An addi-
tional criteria is the income potential of the unit as related to
access of technology and other operating inputs (27, p. 9).

Therefore, because of lack of a selection criteria, SAAB's credit
analysts find it difficult to assess the farm operators actual need
and to evaluate their capacity to repay loans.

2. The SAAB's employees, including loan committee members, have
little contact with farming and marketing operations and are not fully

aware of the farmer borrowers' problems. Consequently, loan commit-
tee members have great difficulties in appraising earning potential,
timeliness and dispersement of credit needs, and other factors related
to loan repayment. This frequently results in high loan delinquency
rates among SAAB farmer borrowers.

3. The SAAB employees do not use farm enterprise budgeting and
cash flow analysis in constructing a farm financial plan. Profita-
bility of credit use and credit repayment are subsequently more di-
fficult to determine and lead to higher delinquency rates.

4. There is a need for well trained and motivated personnel with
enough skills to improve the quality of the SAAB portifolio of loans
and loan management at the branches and sub-branches.

5. There is a lack of awareness of the need for an educational
program in farm financial management for clients (analagous to farm
production and marketing management).

6. There is a need for a grading system differentiating clients
at any given point in time, as to their credit worthiness. Such a
system establishes a basis for policy that provides a real incentive
for a client to move upward through a small farmer approved credit
rating system. What seems needed is a strong system of incentive that
provides rewards (and penalties to both agency personnel and clients
(27, p. 61).

7. There is a lack of coordination between the SAAB and exten-
sion activities. Supervision of credit is not provided on the assump-
tion that technical assistance is provided by the Ministry of Agri-
culture through its extension agents.

Objectives

The overall objective of this study is to evaluate and document the nature and causes of small farm operator borrowers' difficulties in repaying intermediate and short-term crop production loans obtained from the Saudi Arabian Agricultural Bank. The study includes the following specific objectives:

1. Analysis of the organizational and procedural structure of SAAB with respect to agricultural credit and loan repayment.

2. Analysis of the small farm operator borrowers' financial, farm and social characteristics with respect to loan repayment.

3. Quantification of the relationship between loan delinquency and hypothesized economic, social, financial management and credit institution policies using a postulated farm production and financial management model.

4. Analysis of credit impact on use of farm production inputs and farm incomes in the farm production and financial management model.

5. Analysis of SAAB policy alternatives in reducing loan delinquency rates and improving farm incomes.

Hypotheses to be Tested

It is hypothesized that loan delinquency rates are related to factors such as:

1. Credit institution policies and procedures such as timeliness of credit and size of annual payments.

2. Farm resource base, such as crop land cultivated.

3. Farm and family financial management efficiency (management of borrowed funds and farm family living expenditures).

4. General agricultural profitability (level of net farm income generated by use of credit).

It is further hypothesized that farm financial management is an interdependent system including farm production, farm income, family financial management and institutional credit policies.

Methodology

Objective one is achieved through an evaluation of SAAB lending policies and procedures in light of present theory and knowledge of agricultural credit and finance.

Objective two is achieved through a tabular analysis of a random sample of SAAB credit files and farm questionnaires in two different areas, Hufuf and Kharj. The stated objective is to be achieved by systematically analyzing (1) the farms' characteristics in terms of size and income generating potential, and (2) the farm operators' characteristics pertaining to economic, social, and financial management having a direct and indirect effect on the delinquency rate.

Data from the farm questionnaires and credit files are used to formulate appropriate regression models for testing hypotheses one and two and achieving objectives three and four. Delinquency rate will be analyzed first using a single equation regression model for the purpose of exploring the underlying hypothesized relationships between delinquency rate and the independent variables. Further analysis of the delinquency rate and impact of credit on farm capital and hence on value of farm output will be done using a farm production and farm

financial management interdependence system. For the latter approach a two stage least square (2SLS) model will be used to test the hypothesized relationships.

Results from the proceeding objectives and results of the reduced form of the financial management independence system are used to analyze SAAB policy alternatives.

CHAPTER II

MEANING AND SCOPE OF AGRICULTURAL FINANCE

Agricultural finance is the economic study of alternative ways
of financing agricultural production. It relates to both the macro
and micro aspects of financing capital requirements of the agricul-
tural sector. The macrofinance aspects pertain to financing agricul-
ture in the aggregate. Since the amount of capital available in the
total economy is limited, macrofinance is concerned primarily with
(1) the amount of capital to be allocated to agriculture, (2) the terms
and conditions under which capital is made available, and (3) the way
in which capital is used to balance production, achieve economic effi-
ciency, and/or achieve other policy goals (26, p. 4).

Lending institutions play a dominant role in macrofinance, par-
ticularly in the first two of these aspects. The government plays a
direct role by establishing lending institutions, directing loan pro-
grams, and assisting farm programs in general. The government also
plays an indirect role through legislation and, in turn, through super-
visory agencies which give overall guidance to lending institutions
with reference to the amount loaned, quality of loans which are ac-
ceptable, and loan terms (26, p. 4).

Micro aspects of agricultural finance pertain to the individual
farm firm. It includes those parts of farm management which relate
to acquisition and use of capital in the farm business. The acqui-

14

sition phase involves determining the sources of capital and the amount to be obtained from each source. It also involves the terms and conditions under which the capital is obtained. The use phase involves allocating the limited supply of capital available between the farm household and the business; i.e., determine the amount of capital available for use in the business. The problem then is to determine where and how to use the capital available to the business so as to maximize income (26, p. 4).

The scope of this study is limited to the evaluation of effective use of short and intermediate-term credit and repayment of loans. Therefore, the macro aspect of agricultural finance will not be dealt with in this study. In the following sections a theoretical review pertaining to the micro aspects of financing capital requirements of the agricultural production sector are presented followed by discussions on sources of credit, lending policies and loan procedures.

Theory of Agricultural Finance

Views of Credit

Four views of credit include that of the (1) economist, (2) credit institution, (3) creditor, and (4) debtor.

The economist views credit largely as an instrument which makes possible a flow of goods to producers, businesses and households. Usually it would be impossible, or at least inconvenient in the extreme, for the individual or corporation to pay in full for goods and services when they are received. Often the manufacturer can pay for raw materials only after he has sold finished products. Likewise, the

wholesaler may not be able to pay for goods until after he has sold them to the jobber; or the jobber, until he has made sales to the retailer; or the retailer, until he has made deliveries to consumers (40, p. 36). Consumers, likewise, use credit to make purchases based on expected future income.

Credit institutions look upon credit as a commodity to be bought and sold. It is in a sense their stock in trade. Such credit institutions include commercial banks and investment companies (40, p. 36).

Credit may be defined by the creditor in terms of confidence in the debtor and payment for the use of capital. An individual trusts his capital only to those in whom he has confidence. The creditor must ordinarily think that those who become indebted to him have both ability and willingness to repay (39, p. 36). The creditor is also interested in what he can get for the use of his money (interest).

To the debtor, credit is that which allows him to obtain, upon his promise to repay in a certain way at a definite future date, the use of capital owned by others. The amount of credit the debtor possesses depends primarily upon three things: first, the value of the property or other assets he owns; second, certain personal characteristics which he possesses such as integrity, thrift, and business acumen; and third, what can be done with credit to increase farm production and improve income (40, p. 36).

Capital Formation and Accumulation

Capital is not easily defined, in part because of continuing debate among economists. However, it is stated that "the proper scope

of capital theory is the elucidation of the causes and consequences of acts of saving and investment" (41, p. 421). As in most definitions of capital, the implication is that capital represents durable goods saved from consumption for the purpose of adding to future production. Capital is also seen as the accumulated stock of real wealth, which covers land as well as produced goods. Saving and investment thus add to the stock of capital. Credit differs from capital in that it represents only one means of obtaining control over durable goods or other assets.

At the micro level capital refers to the productive assets of a firm, including real estate, machinery, livestock, inventories, and cash balances. This concept is consistent with the general connotation of "capitalizing" a business, which refers to the acquisition of all its productive assets rather than just its plant and equipment. Over time, with capital becoming more important relative to labor inputs, increasing attention has been focused on the processes of capital formation and accumulation (40, p. 421).

Obtaining Control of Capital

To become established as a farm operator, the possession and use of some minimum amount of land, labor, capital and managerial ability is required. The passing of each farm generation results in a transfer of the management and the control of farm units to a new generation of farm operators. The prospective new operator is faced with the problem of obtaining possession of the necessary factors of production (41, p. 5).

Changes in farm technology have been rapid and extensive. An economic farm unit today generally requires a higher investment in livestock and machinery, and larger amounts of current operating expenses than was true 20 years ago. In addition, the use of more mechanical power and equipment has greatly increased the capital investment required.

From the individual farmer's standpoint, a major problem will be how he can obtain control of sufficient capital to be successful (42, p. 1542).

Since the central concern of this chapter of the study is with the financing of the individual farm firm, the effect of capital management on growth of the farm firm is explored. Capital management affects the rate of firm growth, through leverage, and the vulnerability of the firm, through liquidity. Capital accumulation constitutes a major form in which farm earnings occur and a major drain upon farm liquidity. A farmer may earn at a satisfactory rate, accumulate an equity in assets, and yet suffer from a low level of disposable income. On the other hand, to divert income from capital accumulation to consumption purposes may so retard the farm firm growth rate as to jeopardize his ability to survive in the dynamics of a capital-using agriculture. Such is the puzzle that faces most farmers in today's agriculture (7, p. 1055).

Levered Growth. It is common to measure growth of the firm either by increments in rate of income flows or in equity of the firm. The normative ideal would be a composite that reflects the increment to utility of the firm operator. Equity seems to be a reasonable welfare

proxy for the operator who owns assets of the firm, either totally or subject to debt. It may not be for the operator who leases a substantial fraction of the firm's assets. For the latter, equity may be more plausible if it includes non-farm assets as well as farm assets. Having selected equity as the growth measure, it seems more convenient to define leverage, L, as the ratio of debt, D, to equity, E, where E is the difference between the value of assets, A, and D (7, p. 1056).

Let the increment in equity be given by:

$$g = (rA - iD) (1 - t) (1 - c) \qquad (1)$$

where

r = rate earned on assets in the firm, net except for interest in taxes,

i = rate paid on debt,

t = rate paid in taxes on returns, and

c = rate spent on consumption out of firm earnings.

It is convenient to express growth g' as the annual percentage change in equity, given by:

$$g' = [L(r - i) + r] K,$$

where

L = D/E, the chosen measure for leverage, and

K = (1 - t) (1 - c), the percent of earnings remaining after consumption and taxes.

This g' is determined by r and L, given the rates of consumption, taxation, and interest.

<u>Limitations of Equity Growth Model</u>. There are three apparent limitations of the levered growth model presented above (7, p. 1058).

1. As incomes increase it is likely that the tax rate, t, will increase. On the other hand, the rate of consumption expenditures may well decrease. Hence a constant value may reasonably approximate the combined effects of r and t.

2. The model represents a firm with constant scale at alternative combinations of debt and equity. Empirical evidence suggests that constant returns may be a good approximation over a wide range of production conditions. But it probably is not safe to assume r constant for some larger sizes implied by higher values of L.

3. The concept of leverage does not include costs other than interest. But to exchange credit for loans (that is, to increase L) entails a loss of liquidity. Held in reserve, unused credit provides liquidity with which to meet the effects of an unfavorable event in production or marketing.

Credit-Liquidity and Equilibrium. Liquidity is an attribute of the financial organization of the firm. The value of a firm is conceived to be the amount that could be obtained from sale of the firm as a complete aggregate. The sale of assets within the firm will in general reduce the value remaining in the firm by as much as or more than receipts from the separately sold assets. If the cash required from separate sale equals exactly the loss in firm value, one concludes that the assets are perfectly liquid. For those assets whose sale would contribute less to cash than to reduction of remaining firm value, the assets are less than perfectly liquid. So conceived, assets can be arranged in terms of their contribution to the liquidity of the firm (7, p. 1058).

Many assets of the firm are not incorporated into the firm's asset structure in expectation of separate sale. Yet they can be used as a partial basis for credit through exchange of a part of the bundle of property rights of a loan. This is the part to which we have assigned the concept of credit. Credit may depend on more than the collateral value of the firm's assets, but it is reasonable to assume that assets contribute to liquidity in the form of "credit" as well as in the form of potential sale (7, p. 1058).

Just as the concept of leverage lacks an explicit cost associated with use, liquidity lacks an explicit return associated with its use. Leverage operates as a multiplier with respect to the marginal value product of resources added to the firm. If the marginal value product is positive, no explicit limit terminates the addition of financed assets. But if liquidity is valuable to the firm, increasing debt relative to equity reduces credit left to finance capital assets or operating expenses in the future, or to meet unforseen financial problems. It is reasonable to argue that as credit is reduced, remaining units of credit acquire successively higher values. That is, credit is used at a cost that increases as debt increases, even though the rate of interest may remain constant over wide ranges of credit use. Liquidity and leverage are concepts of central importance in the financial management of the farm and credit is an important component of a firm's liquidity (7, pp. 1058-1059).

An equilibrium in credit-use is depicted in Figure 1. Increments to costs or returns from credit use are shown on the vertical axis, units of credit or debt on the horizontal axis. The curve labeled i describes increments to loan costs from added units of debt. Its
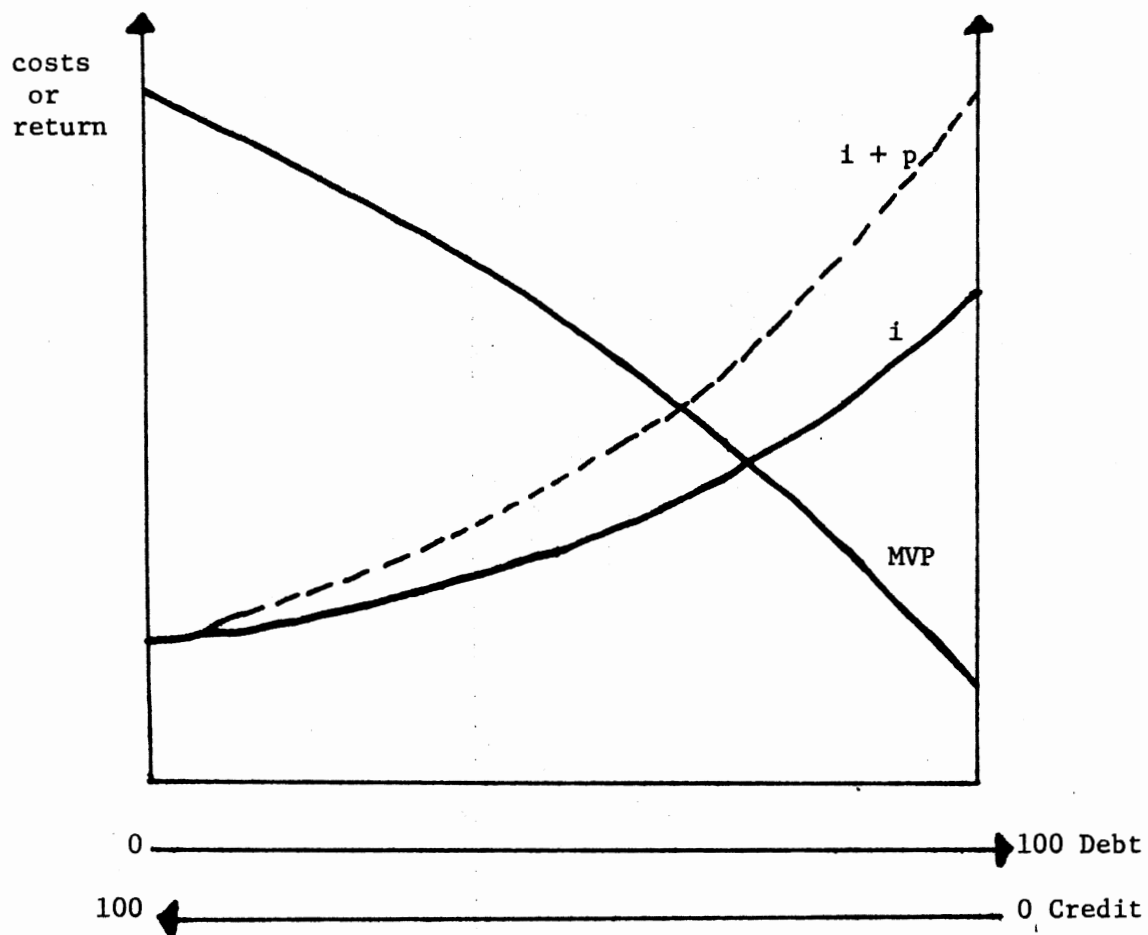
Figure 1. Firm Equilibrium in the Use of Credit

slope reflects the presumption that the farmer faces higher-cost loan sources as his debt increases. The quantity, p, is the value ascribed by the farmer to a unit of credit held in reserve. Its slope reflects the presumption that the value of credit increases as successive units of credit are absorbed by loans (7, p. 1059).

Credit in the Production Organization of the Firm

In context of the theory of production, it is argued that the equilibrium conditions traditionally used by economists must be modified to provide criteria for optimization of resource use by the firm. Important modifications are associated with liquidity attributes of the firm organization. Credit, defined as borrowing capacity, constitutes an important source of liquidity as well as from interest charges on loans. Modifications are suggested in the relevant optimizing criteria relating to the firm to account for liquidity losses associated with borrowing (4, p. 507).

Each firm has a financial component as well as non-financial components. The financial component includes claims held and debts owed, values reported in a balance sheet of the firm. A less evident part of the financial component is liquidity of the firm: access to financial assets and terms on which such access may be gained. Profit-seeking managers are willing to pay for liquidity in more or less tangible terms. The most tangible, perhaps, is found in insurance. The second is in choices that favor liquid relative to illiquid assets and flexibly managed debts relative to inflexible debt commitments. A third is in reservation of "credit" defined as the capacity to borrow. Unused credit, like balance sheet assets that are liquid,

constitute a reserve of liquidity that can be called upon to counter the effects of failure in expectations. Though not included in the balance sheet, liquidity has value (4, p. 507).

Therefore, this section will outline the effects of liquidity value, in the form of "credit", on production organization of the farm firm. A brief outline of the theory of production organization will be presented and then followed by the implication of the theory for incorporating credit as means of financing inputs used in the production organization of the firm.

The Theory of Production Organization. To simplify the discussion which follows, we assume a production function with two variable resources and one constant input. The hypothetical production function in its functional form is the following:

$$y = y \ (x_1, \ x_2/x_f) \qquad\qquad (1)$$

Let y be a single-value continuous function with continuous first and second order derivatives, defined for non-negative values of y (output) and x_i (input). The quantities y and x_i are rates of flow per unit of time and the constant positive input x_f. The level of y with respect to x_1 and x_2 is influenced by the value of x_f and the technology used in production. The rate at which x_1 substitutes for x_2 is given by

$$S = -\frac{dx_2}{dx_1} \qquad\qquad (2)$$

which is economically relevant only where dx_2/dx_1 (and dx_1/dx_2) ≤ 0. The locus of points where dx_2/dx_1, $dx_1/dx_2 = 0$ are "ridge lines." The ridge lines bound the economically relevant area of the produc-

tion surface mapped with isoquants.

Let the cost of production be given by

$$c = p_1x_1 + p_2x_2 + b \qquad (3)$$

where p_i is the price of x_i and b the cost of x_f. We define an "iso-cost" line as the locus of input combinations that can be bought for a given outlay. Specifying c as a parameter,

$$c^\circ = p_1x_1 + b \qquad (4)$$

we solve for

$$x_1 + \frac{c^\circ - b}{p_1} - \frac{p_2}{p_1}x_2$$

and

$$x_2 = \frac{c^\circ - b}{p_2} - \frac{p_1}{p_2}x_1 \qquad (6)$$

The first term on the right side of (5) and (6) defines maxima of x_1 and x_2, respectively, that can be bought at outlay c°. The ratio p_1/p_2 defines the slope of an iso-cost line. On the assumption that the price of input is constant for quantities bought for all inputs, the iso-cost line is straight as between all pairs of inputs.

The output, y, is maximized, given c°, on the condition,

$$-\frac{dx_2}{dx_1} = \frac{p_1}{p_2} \qquad (7)$$

Since y and c° are parameters, both can be shifted. A locus of points generated by (7) is called an expansion path with respect to x_1 and x_2, with the special property that it defines cost-minimizing combinations of x_i for given levels of y. It can be expressed as an implicit

function:

$$S(x_1, x_2) = 0 \qquad\qquad (8)$$

for which (7) is satisfied.

Among other uses, (8) can be used to appraise resource organization in terms of "efficiency", since it traces a path of maximum economic efficiency, as defined above. A combination of x_1, x_2 that fails to meet condition (8) is thus judged to be less than efficient (4, pp. 508-509).

Based on the relevant optimizing criteria relating to the firm outlined in this section, the effect of credit-use on production equilibria of the firm will be outlined.

Financing Inputs. We retain the simplifying assumption that the firm is a pure competitor in the purchase of x_1 and x_2. The purchase of x_1 and x_2 must be financed with loan funds. Hence, the optima specified in (7) must now be specified:

$$-\frac{dx_2}{dx_1} = \frac{p_1 + F_1}{p_2 + F_2} \qquad\qquad (9)$$

where F_i is the marginal cost of finance for each unit of x_i. If the ratio F_1/F_2 equals the ratio p_1/p_2 there is no change in points of efficiency, in the sense of departure from the expansion path. There may, of course, be a failure to reach an optimum rate of output, depending on whether or not the expected lender response to total loan requests constrains the final production organization (4, p. 509).

Assume that the lender is expected to favor x_2 over x_1. The discrimination can take either of two forms. The rate of interest may be lower on a loan to finance x_2 than it is on a loan for x_1. In

this case, the consequence is clear. The numerator in the right-hand term of (9) increases relative to the denominator, thus increasing the value of the right-hand term; x_1 must be reduced relative to x_2. The more likely lender response, however, is more subtle. Suppose that the lender charges the same effective rate of interest, whatever the use of funds. But the loan limit to finance x_1 is less than the loan limit to finance x_2. That is, credit of the firm is absorbed at a rate that is greater for x_1 than it is for x_2. If we assume that credit remaining unused has a value greater than zero, F_1 exceeds F_2 and the optimum quantity of x_1 will be reduced relative to x_2 (4, p. 509).

In Figure 2, the cost of producing y° is minimized with x_1^1 and x_2^1 when it is assumed that the effect on credit is the same per unit of either input. OS_1, traces the path of cost minimizing combinations on this assumption. On the other hand, should the farmer expect lenders to favor x_2 over x_1, the expansion path will steepen (see for example, OS_2). The path of cost-minimizing combinations will reflect different combinations of x_1 and x_2 in equilibria. The cost of producing y° will be increased from c° to c^1.

Similar results hold in the allocation of resources among competing uses. Given that product y_1 and y_2 are each produced optimally (that is, on expansion paths, respectively), it can be shown that inputs common to both products are optimally allocated between the products when

$$-\frac{dy_2}{dy_1} = \frac{p_1}{p_2} \qquad\qquad (10)$$
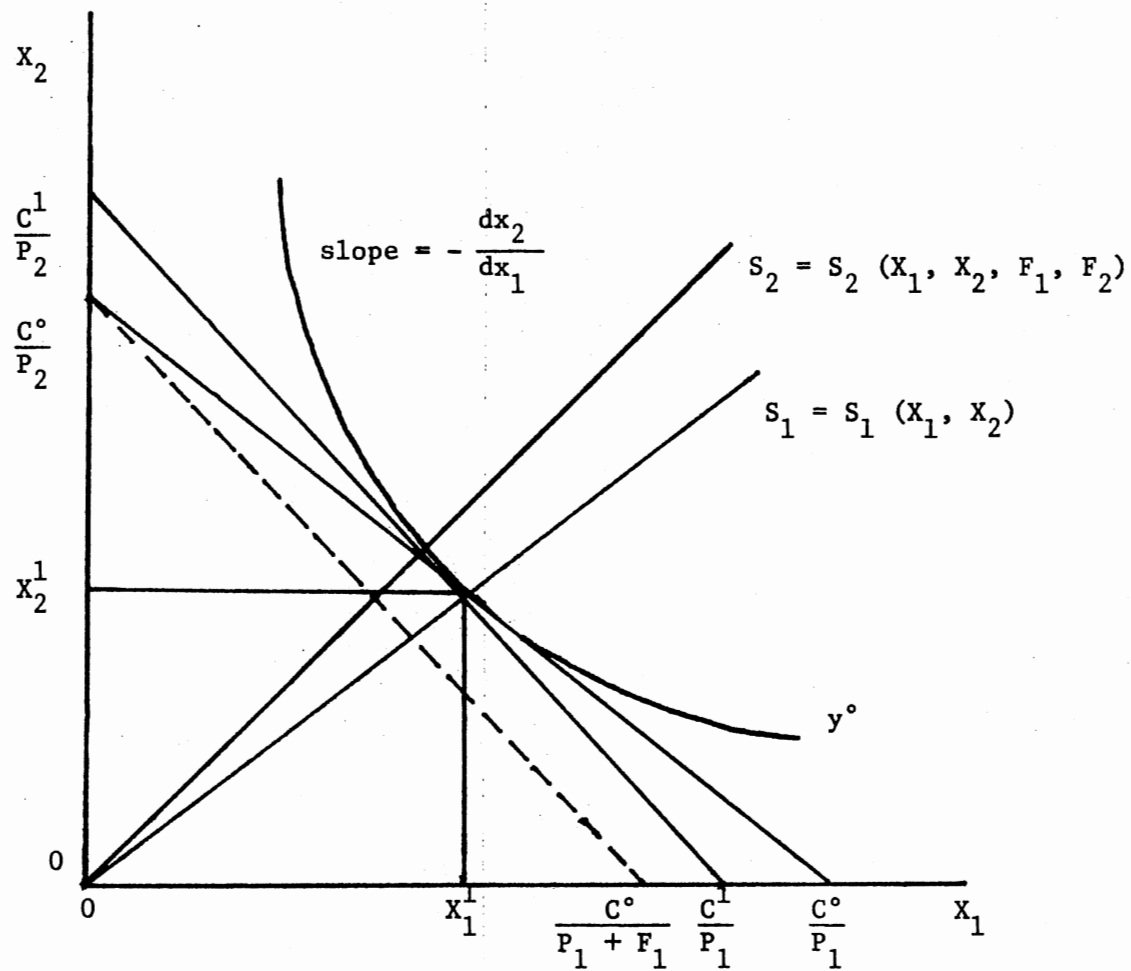
Figure 2. Effects of Finance Cost-Minimizing Combinations of X_1 and X_2

where p_1 and p_2 are prices of y_1 and y_2, respectively. If the firm is a pure competitor in the sale of products, the slope of the "iso-revenue" line, defined by the right side of (10), is a constant.

The rather limited optimum can be extended easily by accounting for the marginal cost, with respect to output, of inputs specific to each product:

$$- \frac{dy_2}{dy_1} = \frac{p_1 - c_1}{p_2 - c_2} \qquad (11)$$

where c_1 and c_2 are marginal costs, with respect to output, of inputs specific to production of y_1 and y_2. respectively. Equation (11) specifies an optimum allocation of all resources: those specific as well as those common to y_1 and y_2.

Suppose that (a) the firm is dependent upon loan funds to finance the expansion of y_1 and/or y_2 and (b) available lenders discriminate, favoring y_2 over y_1. That is credit absorbed to finance y_2 is less than credit absorbed to finance y_1. Under these conditions, an optimal allocation of variable inputs between y_1 and y_2 requires

$$- \frac{dy_2}{dy_1} = \frac{p_1 - c_1 \pm L_1}{p_2 - c_2 \pm L_2} \qquad (12)$$

where L_i is a general term, expressing the cost to the firm associated with credit absorbed in borrowing in terms of output. This cost is associated with loss of liquidity occasioned by borrowing. Again if credit held in reserve is worth anything greater than zero, y_2 will be increased relative to y_1 (4, p. 510).

It can be concluded that an optimal response of the borrowing firm to lender preferences generates a production reorganization that is suboptimal if a market-oriented theory of the firm is taken as the

source of criteria for optimality (4, p. 512). An exception is noted if lender preferences happen to accord with market preferences. That is, should F_1/F_2 equal p_1/p_2, lender preferences would not affect the slope of the iso-cost function and hence would leave the optimally adjusted production organization on expansion path OS_1 (Figure 3). Similarly, in the case of resource allocation, y_1 and y_2 would be produced along OS_1 (Figure 3) if L_1/L_2 happened to equal $(p_1 - c_1)/(p_2 - c_2)$.

Little research has been done to discover lender preferences, yet the available evidence suggests that there is little relation between market preferences and lender preferences. Nor do lenders appraise expectations in the same terms as borrowers. Presumably, the latter are influenced by relative contributions of alternatives to net income (and determinant thereof). Evidence suggests that lenders favor loans that are self-liquidating or asset-generating or both. Neither characteristic necessarily coincides with market preference or borrower preference (4, p. 512).

Resource Efficiency. It was shown in the previous section that the optimum combinations of resources and products will differ from optima based on the price ratios when differences in financing costs are included. It was suggested that the relevant optimum, in terms of social optimizing, will include all differences in the real cost of financing, including risk. Deviation from this optimum can be caused by (1) lender attitudes based on a lack of knowledge of personal preference which leads to responses not supported by differences in the real cost of financing, and (2) erroneous farmer expectation of lender
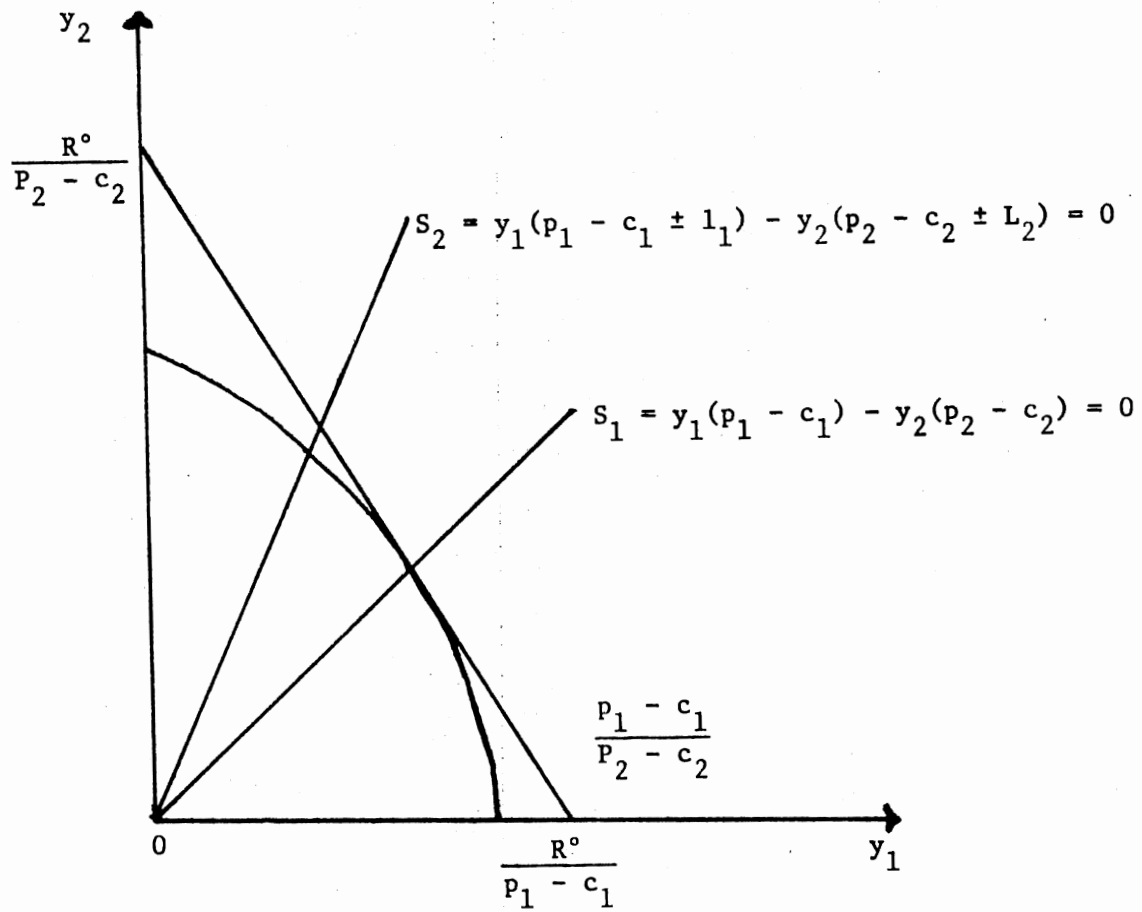
Figure 3. Effects of Finance Costs on Profit-
Maximizing Allocations of Resources
between y_1 and y_2

response. Such a simple matter as helping lenders understand the nature and detail of the farm business in the community and helping farmers sense and understand lenders' attitudes might well shift resource use toward greater efficiency (7, p. 1063).

Furthermore, the heavy reliance on liberal financing to promote sales of some farm inputs might lead to a misallocation of resources. Farmers might substitute a more costly input for a cheaper (but equally effective) one solely because the terms of financing are much more favorable. As a consequence, farmers may be able to obtain more (and possibly cheaper) financing for these inputs than for lower price substitute inputs (7, p. 1063).

In the foregoing discussion, the role of credit in contributing to capital formation and the extent it affects the production organization of the farm firm has been outlined. Therefore, it is worthwhile to give further insight about the scope of agricultural finance in theory as well as practice. The remaining part of this section is devoted to presenting the theoretical principles used by the formal credit institutions as bases in extending credit to the farmers. Based on the presentation of these principles, the SAAB lending policies and procedures will be evaluated in the chapter immediately following.

The next section documents the considerations related to the farm and farm operators' characteristics upon which the formal lenders, in general, base their decision before granting loans, (in addition to the security required). These considerations include returns, repayment capacity, and risk bearing ability of the loan applicants which are referred to as the three R's of credit. In addition to the three R's,

there are other related factors such as character, capacity, and capital (equity or net worth) which are referred to as the three c's of credit. Also, to evaluate the adequacy of capital and the level of performance, the formal lenders make use of financing ratios which relate items on the operator borrower's financial statement and help to evaluate credit worthiness and repayment capacity.

Bases Used in Extending Credit to Farmers

In addition to the security required by the lenders to extend credit to farmers, there are other considerations that are related to the farm and farmers characteristics upon which the lenders base their decision before granting loans. These considerations are referred to as the three r's: returns, repayment capacity, and risk bearing ability.

The first r, returns, refers to the most profitable amount of credit which can be used in the business, while the other two r's indicate restrictions or limitations which may be necessary in some cases for the loan to be sound. Every loan should pass the three tests:

1. Will it produce sufficient returns to cover the costs? In other words, will it pay to borrow the money?

2. Will the borrower have sufficient repayment capacity to repay the loan as provided in the note and mortgage? A loan may be profitable, but the farmer still may not be able to make the payments as they come due.

3. Does the farmer have risk-bearing ability to carry the risk

and uncertainty involved in using the credit?

These three questions should be considered by the farmer as he makes plans for using credit, and by the lender and borrower together as the loan application is studied. The loan should not be made unless both the borrower and lender can answer all three questions in affirmative. A negative answer to question 1 indicates the loan will be unprofitable, in which case there is no point in using the credit. A negative answer to either question 2 or 3 indicates the loan may break down, and a loan should never be made with this probability in the picture (26, pp. 98-99).

The Three C's of Credit and Their Relations
to the Three R's of Credit

In terms of the three c's of credit, the principal factors to be taken into consideration in analysing use or extension of credit are:

1. Character. Character consists of those mental and moral qualities which identify an individual. A high sense of what is morally right, honesty, integrity, fairness, responsibility, trustworthiness and industrious are qualities of fine character. When those

> qualities combine to make an individual conscientious
> concerning his debts, he has credit character. Char-
> acter, undoubtedly, also has a bearing on returns and
> repayment capacity, that men of high character often
> are outstanding in business affairs. However, as will
> become evident as they are analyzed, returns and repay-
> ment capacity are the results primarily of economic
> relationships. This is true if risk-bearing ability is
> comprised of intangibles, of which character is the
> primary component (26, p. 100).

2. Capacity. Capacity, as one of the three c's of credit, sig-nifies the ability to pay when debt is due. Capacity is a function of

income, since payments usually depend upon income rather than upon savings. However, income alone does not indicate capacity. Income may already be so committed to existing obligations that it adds little to capacity (26, p. 100).

3. <u>Capital</u>. Capital, for purposes of the three c's of credit, refers to the equity or net worth of an individual or business. It represents the assurance that funds are available to pay the loan if character and capacity should prove inadequate. Capital is represented by assets which a lender might seize as payment of the debt. Capital comprises one of the basic cornerstones of risk-bearing ability in the context of the three r's of credit. However, it is only one of the aspects of risk-bearing ability (26, p. 100).

Every applicant for a loan is asked to furnish information regarding his financial position. He should prepare a statement which shows:

(a) an itemized list of all he owns--land, livestock, equipment and other assets;

(b) an itemized state of all his debts; and

(c) a statement showing his net worth, which is the difference between total assets and debts.

The lender uses this statement to answer a number of questions about the borrower: How much capital does the applicant control? How much ownership does he have in his assets? Are there debts that may interfere with the prompt payment of the loan being applied for? Does the applicant have property which could be quickly sold for cash to pay current expenses and debts (known as quick assets)? Has the applicant been going forward or backward financially in recent years? (11, p. 11).

Using Financing Ratios

To evaluate the adequacy of capital and the level of performance, various financial statement items can be related to each other. This is best accomplished by calculating appropriate and meaningful basic ratios. Such ratios are helpful in following the financial trend through the years and in comparing the operation under analysis with similar ones. Numerous ratios can be calculated, but not all of these ratios will prove useful, since there is a wide variation in investments and operating programs utilized by the many types of farms that exist. A banker should examine the various ratios and adopt those meaningful to him. Bankers are urged to guard against overloading the the analysis with ratio calculations. However, it is usually best to utilize more than just one ratio, since one alone may not reflect the true picture. The following basic ratios are often found useful in agricultural credit analysis (2, pp. 90-91).

Debt to Net Worth

$$\frac{\text{Total Debt}}{\text{Net Worth}} = \text{Creditor's risk in relation to that of owner}$$

The creditor's contribution to capital as compared to that of the borrower is represented by this ratio. A figure of less than 1.0 indicates that the owner's net worth exceeds the amound of the borrowed funds. In contrast to other basic ratios, a lower figure is desirable. Generally, the borrower should have more money invested than the creditors. There are exceptions, however, such as cases in which the farm is being purchased on contract. In such instances the debt to net worth is usually extremely high; yet no undue hardship exists with respect to repayment ability.

Performance Ratios. These ratios relate the operation to the financial position by using both profit and loss statement and financial statement information. Performance ratios have become increasingly important as a result of the narrowing of profits. The ratios used should be sensitive to change in performance.

1. Gross Receipts to Total Assets

$$\frac{\text{Gross Receipt}}{\text{Total Assets}} = \text{Turnover of Assets}$$

This ratio reflects the effectiveness of the use of assets. The higher the ratio, the greater the turnover of assets, maximizing the opportunity to produce profit.

2. Profit to Total Assets

$$\frac{\text{Profit}}{\text{Total Assets}} = \text{Profitability of all resources utilized}$$

In this ratio the percentage utilized on all invested resources is indicated. A high, or a trend toward a higher, percentage is desirable. Factors involving unusual adjustments in asset evaluation or profit calculation (such as high depreciation allowances) must be considered in interpreting the ratio.

3. Debt Servicing to Gross Receipts

$$\frac{\text{Debt Servicing (Annual Principal and Interest)}}{\text{Gross Receipts}} = \text{Proportion of receipts needed for debt servicing}$$

This ratio indicates the debt-servicing drain on total income. An operation with high proportion of its total receipts earmarked for debt servicing will experience financial pressure, which in turn, will affect both the operation of the business and family living standards.

Use and application by SAAB of the principles of agricultural finance are explored and outlined in the chapter that follows immediately.

CHAPTER III

THE SAUDI ARABIAN AGRICULTURAL BANK

The rapid economic development of Saudi Arabia during recent years has its roots in the economic as well as social changes of the last decade. Population growth and inflow of manpower were important factors contributing to increased demand for food stuff in the Kingdom. Rising demand for food induced Saudi farmers to increase farm production within their capacity and productivity constraints. To increase production, farm operators, in part, were constrained by limited capital. Farm incomes were not sufficient to meet the goal of satisfying farm household consumption needs and have a surplus for investment in farm machinery and equipment and other factor inputs. Furthermore, financial institutions did not lend funds to agricultural producers primarily due to the high risks involved.

Sources of Credit in Saudi Arabia

Sources of agricultural credit in Saudi Arabia can be classified in three general groups: (1) individuals, (2) merchants and dealers, and (3) government lending institution (SAAB).

Individuals

These include retired farmers, close relatives, landlords and individuals not related to the farmer. These individuals are an

39

important source of credit used by farmers.

Individuals vary widely in terms of dependability as a source of credit. Some constitute a dependable source. However, as a group, they are considered to be a comparatively undependable source of credit. Individuals often need their funds for family living or other purposes in difficult times, just at the time when the farmer often is also in great need of funds (26, p. 499).

Merchants and Dealers

Merchants, dealers, processors, and other types of middlemen comprise the original source for agricultural credit. They provide the farm operators with short and intermediate-term credit.

Sales promotion usually is the primary reason why merchants and dealers extend credit to farmers. It facilitates sales of feed, fertilizer, and other supplies, particularly when these items are delivered and the farmer is not at hand to make payment. It also helps in selling items when large amounts are involved. Machinery dealers often extend credit to help close a sale. As purchased inputs become increasingly important in operation of the farm business, the amount of merchant and dealer credit used probably increases. This is likely for two reasons: first, credit extension is a natural by-product of the merchant's primary line of business, and use of such credit is convenient for the farmer; second, the continued use of a substantial amount of merchant-dealer credit in agriculture suggests that both creditors and debtors benefit mutually from its use (26, p. 394).

Government Lending Institutions

The major objective for developing government agricultural lend-
ing institutions is to meet the small farm operators' credit needs
and improvement of farmers' income and welfare. They provide a pack-
age of services including technical assistance, inputs, marketing
services and credit. However, government agricultural credit programs
in most of the least developed countries have thus far fallen short
of achieving the objective of promoting increased agricultural pro-
duction, income, and welfare, and at the same time repayment of bor-
rowed funds from income generated by use of credit.

One of the major reasons contributing to the failure of most
of the credit institutions, in general, is that they have complicated,
cumbersome, and time consuming procedures which results in delays in
approval and in loans not being made available when required. Issuing
of loans may take weeks if not months in most agricultural institu-
tions.

Quite apart from the fact that most agricultural credit institu-
tions follow excessively rigid and time consuming procedures for pro-
cessing loan applications, a number of other shortcomings ranging
from corruption, political interference and favoritism bar their
successful operation (29, p. 4).

Another common problem faced by most of the agricultural credit
institutions in the developing countries is the repayment problem.
Most experience low rates of repayment (27, p. 5).

A major reason for generally low rates of repayment is that most
of the loans are made without any technical analysis of the borrowers'

farming operations. Also, lack of effective follow-up on use of loans has resulted in the diversion of agricultural loans to other uses. Shortage of trained staff and poor office management is another major problem hindering the successful operation of government credit institutions (29, p. 5).

Considering institution characteristics, high loan repayment problem and lack of trained staff, as outlined in the foregoing section, contributes to the failure of most of the agricultural credit institutions in the developing countries and SAAB is no exception. In the following section, SAAB lending policies, procedures, and other factors hindering its effort in reaching the farm operators with its services and collecting loans are evaluated.

SAAB

SAAB, as a government credit institution, was implemented with the following objectives: (1) to provide the Saudi farm operators with adequate capital to increase domestic farm production, and (2) improve farm income sufficiently for the farm operator borrowers to be able to meet their family needs and repay the government loans.

SAAB has been in operation since 1964, however, SAAB has thus far fallen short of achieving the anticipated increase in domestic agricultural production, provision of adequate credit, and improving farm income.

One of the major factors contributing to the problems faced by the SAAB is that its lending operation is undermined by complicated, cumbersome, and time consuming procedures.

Other factors contributing to the unsuccessful effort by SAAB to extend sound credit and collect loans is the lack of well-trained credit analysts that are able to analyze in a technical sense the borrower's farming operations. Lack of effective supervision and poor office management at the branches and offices also are limiting factors hindering the successful lending operation of SAAB.

In relation to extending credit to farmers, it is important to look into the policies of the lender. Are the credit terms adopted to the needs of the agricultural producers? Are repayment schedules fitted to the earnings of the farm and capacity to repay? Is the period of the time for which loans are made adjusted to the length of the time required to complete the operation being financed? Do the loans call for large amounts coming due at any one time, or are payments spread over a reasonable income period? (11, p. 8).

The policy toward borrowers during hard times also is important. Will the lender permit the deserving borrower to carry loans during the temporary periods of low income? Will the lender extend further credit when unusual conditions make it impossible to repay on schedule? If the policies of a prospective lender fall short of satisfactory in any of these areas, it may pay to shop elsewhere even though the lender offers other tempting inducements (11, p. 8).

However, in contrast to the essentials for a sound lending policy of the formal lender outlined above, SAAB structure and lending policies and procedures are outlined in the following section.

Structure of SAAB

The structural framework of SAAB is made up of the main office

in Riyadh, the capitol of the Kingdom of Saudi Arabia. The main office is headed by the director general and three deputies in charge of technical affairs, financial affairs and personnel. At the main office, there is also the board of directors responsible for setting policy and reviewing the SAAB activities. The SAAB is decentralized into branches and offices located in the major agricultural areas in the kingdom to make credit readily available to the farm operators.

SAAB's Effort in Supplying Credit

The SAAB has opened 11 branch banks and 52 sub-branch banks throughout the Kingdom to make credit available to an increasing number of farm operator borrowers, but there is still room for improvement. Farm operator borrowers coming to a small branch of the SAAB to apply for a loan usually have to wait for several hours and sometimes days. When it finally is their turn, the farm operator borrowers are obliged to provide, in the presence of a great number of other persons including other farmers and bank staff, all the personal information regarding their families, prior debts, income, etc., which are needed to fill out the loan application.

As indicated previously, the SAAB currently provides credit to farm operator borrowers without an interest charge, but there are other costs that the borrower incurs in obtaining credit, including the time and cost for travel to and from the bank. It often is necessary for the farm operator borrower to make several trips before his loan is approved and made available.

Purpose, Size and Terms of Loans

The bank makes two types of loans. Short-term or seasonal loans are made to farm operators to meet crop production, harvesting and marketing costs. These are granted for a period not exceeding 12 months and are to be repaid after crops are marketed. Short-term loans may vary in amount depending upon their purposes.

Intermediate-term loans are made for purchase of farm machinery and equipment, livestock, improvement of irrigation systems, vehicles for marketing agricultural products, and for establishing enterprises allied to agriculture. Such loans are normally made for a period of three to five years. The size of the loan depends either on the size of the farm operation or on the loan purpose and the collateral offered as security.

Lending Procedures

Short-term or seasonal loans are made according to estimated budgets prepared by the farm operator applying for the loan with or without assistance of the field representative. Since nearly all of the farm operators are illiterate and none of them keep farm records, loans are often based on wild guesses. As a result, the size of the loan granted is often either much smaller or much larger than the amount that can be used effectively.

The procedures followed by SAAB in evaluating short and inter-mediate-term loan requests are as follows. The farm operator applies for the loan at the nearest SAAB branch or sub-branch. At that time, the field representative fills out an application form and an appoint-

ment is made for the field representative to visit the farm. When the field representative visits the farm, he evaluates the farm's potential to determine whether the loan request meets the needs of the loan purpose and the repayment capacity of the farming operation. Finally, a report is prepared by the field representative and submitted to the SAAB branch or sub-branch's loan committee for action.

Sub-branch managers, branch managers, director of credit department, and the deputy general director for technical affairs are authorized to approve loans not exceeding SR. 100,000, SR. 200,000, SR. 250,000 and SR. 400,000, respectively. The general manager of the SAAB has the authority to approve a loan up to SR. 500,000. Applications for loans exceeding this limit have to be approved by the board of directors.

When an intermediate-term loan is approved the funds are not given directly to the applicant since the loan is specified to be made in kind. The money is paid by the bank to the contractor after the work is completed as specified or to the dealer for farm machinery or equipment. By following this procedure the bank is the purchaser of the item agreed upon.

Short and intermediate-term loans are given in phases according to their purposes:

Short-term Loans. These loans are given in cash following loan approval, and according to the following schedule: (1) A loan not exceeding SR. 20,000 is advanced in full. (2) A loan of more than SR. 20,000 but not exceeding SR. 50,000 is given in two installments; the first is advanced following loan approval and the second is

advanced after 50 percent of the purpose is implemented based on the field follow-up report. (3) A loan ranging between SR. 50,000 and 100,000 is advanced in three equal installments; the first, following loan approval; the second, after completion of 50 percent of the purpose; and the third after 80 percent of the purpose is completed. (4) A loan exceeding SR. 100,000 is given in four equal installments (35, pp. 16-17).

Intermediate-term Loans. Loans for subsidized and non-subsidized farm machinery and equipment are given following loan approval and availability of the item desired by the applicant.

Loans for a large scale specialized commercial project such as poultry and dairy are advanced as follows: 20 percent after loan approval; 40 percent after 30 percent of the project is completed; 20 percent after 70 percent of the project is completed; and 20 percent after 100 percent of the project is completed (35, p. 19).

Credit Policies

Interest Rate. Charging interest on borrowed funds is prohibited by Islam. The SAAB made a three percent per annum charge on loans for in kind purchases until 1974 as nominal commercial profit for administration of borrowed funds. No charge was made on cash loans. The charge was called commercial profit because the SAAB paid the dealer, who then turned over possession of the item to the farm operator in the presence of the SAAB's representative.

In early 1974, this commercial profit charge was abolished on all farm loans advanced by the SAAB. The reason for eliminating the

commercial profit payment was to help farm operators acquire the need-
ed capital to increase agricultural production at zero cost.

Eligibility for Loans. To be eligible for a loan, an applicant
has to be a farm operator, herdsman, or owner of an enterprise allied
to agriculture. Failing that, he must be in a position to employ a
competent manager to look after the operation. Loans for tractors,
hay-harvesting machinery and combines are granted to individuals or
groups who may lease these pieces of equipment or provide custom
service to other farm operators.

Security of Loans. The SAAB accepts collateral or the signature
of a cosigner as security. For short and intermediate-term loans, the
borrower pledges to the bank real estate, such as land and buildings,
or obtains the signature of a cosigner on the loan. The assets offer-
ed as collateral must be registered as free-hold. On-farm family resi-
dence cannot be used as farm loan collateral. Loans secured by real
estate cannot exceed 70 percent of the value of the real estate holdings.

The cosigner must provide the SAAB with a written statement from
the head or the Ameer of the Village verifying that his financial stand-
ing is satisfactory and that he is capable of repaying the loan in case
the farmer defaults. If the cosigner is a government employee, he has
to furnish a written statement from the Ministry or the institution in
which he works. In case of default, he is liable for repayment of the
loan or payments will be deducted from his salary until the loan is re-
paid in full. As a rule, SAAB will not accept as a cosigner a borrower
from SAAB who himself has a loan secured by a cosigner.

Farm machinery and equipment or growing crops or products in

storage cannot be used as collateral to secure loans from the SAAB.
Farm machinery and equipment are not accepted as collateral by SAAB,
but in a way they are used indirectly as collateral. This machinery
and equipment cannot be sold or used for different purposes until the
loan is fully repaid. If the borrower defaults on the loan, the bank
can repossess the machinery or equipment for which the loan was made.

Repayment of Loans. Short-term loans are scheduled to be repaid
in one installment when the crops are marketed. Intermediate-term
loans are paid in installments as specified in the loan agreement. A
bad repayment record may deprive the borrower from future financing
and/or the recall of the loan. Farm machinery and equipment may be
repossessed by the bank if the borrower fails to make the payments as
agreed upon.

When a major agricultural disaster occurs, the bank's management
can amend repayment terms to fit the circumstances involved. In case
of default or delay in making payment, and if the SAAB's field repre-
sentative's report indicates the farm operator borrower has the capac-
ity to repay either from his net farm income of off-farm income but
fails to do so, the farm operator borrower is pressured through the
local authority for the delinquent payment on the outstanding bal-
ances. If the borrower will not repay the loan, then on loans that
have a cosigner, the cosigner is asked to repay the loan. The SAAB
has never taken possession of any real estate offered as collateral
on delinquent loans.

Evaluation of SAAB

In contrast with the principles (three r's and three c's) used in extending credit commonly used by formal agricultural lending institutions in other developing countries as guidelines for extending sound credit, SAAB lending policies are primarily based on subjective value judgment. Farm operator credit worthiness and repayment capacity are evaluated mainly based on the size of land holding and the security offered by the formal applicant.

It is indicated that short-term credit is not extended to the farmer applicant based on cash flow analysis and according to the actual need. Also, size of crop land cultivated is the basic criteria used by SAAB credit analysts for extending intermediate-term credit. This method of evaluating credit needs ignores income generating potential of the farm units and other important farm and farm operator characteristics that are important indicators of the applicant's credit worthiness and repayment capacity.

Since credit terms are fixed at one and five years respectively for short and intermediate-term loans extended by SAAB, credit may not be adjusted to the length of time required to complete the operation being financed.

Also, for successful lending operations, financial planning provides better guidance for decision making by both the credit analysts and farm operator borrowers. By use of a financial plan, the operator borrowers can anticipate as accurately as possible the credit needed to finance the farm enterprises.

A basic requirement for developing farm financial plans is a

general indication of how much capital the farmer has presently.
With this general indication, plans can then be developed for ob-
taining needed additional funds. The specific amount to be used will
depend upon the profitability of using capital, the terms and condi-
tions involved in acquiring capital, and the amount of risk the
family can carry (31, p. 55).

One method which helps assure that funds will be available to
make loan repayments when they come due is to budget use and repay-
ment of credit. The objective is not to determine the amount of
credit it will pay to use, but rather recording in a systematic man-
ner when the credit will be needed during the year and when funds
will be available to repay the loan. The budget also shows cash in-
come and expenses of the farm business by months, together with a
total for each item for the year. Family living expenditures also
are shown by month for the year. On the basis of this data a cash
surplus or deficit is derived each month and for the year (36,
p. 180).

The advantages of a budgeted loan can be summarized as follows:

1. It provides an opportunity for the lender and the borrower
to review and analyze the entire business operation together. In
this analysis, the lender has an opportunity to study the business
and the farmer, and to determine how the financing institution might
be of greatest assistance. The farmer has an opportunity to discuss
various aspects of the business and of financing with the lender.
Together, they can analyse the amount of capital which can be pro-
fitably and safely used, and where it should be used within the
business (31, p. 182).

2, A budgeted loan provides assurance that funds will be avail-
able to carry out business operations. With a budgeted loan the lend-
er gives an overall commitment of funds which the financing institu-
tion will provide during a given period. Without such an assurance
the farmer may be unable to obtain credit to carry out plans under-
way (31, p. 183).

In contrast to the discussion pertaining to financial planning
and cash budgeting outlined in the proceeding section, SAAB credit
analysts do not make use of the cash budget in evaluating the borrower
applicant's credit worthiness, repayment capacity, and dispersement
of loans, Lack of awareness of the usefulness of cash budgeting is
one of the reasons contributing to improper selection of the repay-
ment plan and terms of loans most suitable to the farmer.

Previous Credit Evaluation Studies

Analysis of an interview of 58 farm borrowers who had loans
from SAAB in the Riyadh, Al-Quassim and Taif areas showed that some
of the major reasons for overdue payments were low farm productivity
due to limited operating resources, partial loss of crops because of
floods and frost-damages, and an inadequate supply of irrigation
water. Nearly 31 percent of the farm operators in the study said
they did not repay loans on the due dates because they were not able
to obtain a large enough loan to buy enough inputs to improve pro-
ductivity of their farm lands. The partial loss of crops due to
natural calamities was the reason 22 percent of the farm operators
did not make a loan payment. Seventeen percent gave as their reason

an inadequate supply of irrigation water. Another nine percent of
the farm operators failed to make payments on time because crops
were marketed later than originally planned when the loan was taken
out and the repayment date scheduled (38, p. 34).

Of the farm operators, 23 percent indicated that they gave a
higher priority to repaying other loans before repaying SAAB loans.
They pointed out that they needed these other sources where they
could obtain credit without delay and inconvenience. There may also
be a lack of incentive for some farmers to repay SAAB loans because
of the no interest charges or no penalty enforcements. The bank has
not, through any legal process, taken any of the real estate pledged
as collateral for nonrepayment of loans (38, p. 34).

An agricultural credit study was made by the Saudi Ministry of
Agriculture in 1974 in the area of Riyadh and Al-Quassim. Infor-
mation was obtained by interviewing farm operators who had loans
from the SAAB. The study indicated that the amount loaned by the
SAAB per farm was inadequate relative to the amount of land culti-
vated per farm. It was estimated that the average amount loaned was
slightly above SR. 31 per dunom. The study also concluded that the
five-year limit for loan repayment should be increased.

Another study was made by Dr. J. A. Hopkin for the SAAB. The
purpose of this study was to calculate the SAAB's services to farm
operators and its operational efficiency. The two main divisions
of the report submitted to the SAAB's Board of Directors were recom-
mendations for improving (1) operational efficiency and (2) effective-
ness of the bank (23, p. 6). To improve short-term efficiency the
bank should (1) fill all positions with the best qualified men avail-

able from all sources, (2) have the services of the SAAB be more closely linked and coordinated with those of the Ministry of Agriculture, (3) make changes in standard operating procedures to reduce the number of loan application forms and farm visits per year from new loan requests, and (4) simplify the loan approval procedures to avoid delay so farm operator borrowers can obtain credit when needed.

The study also indicated that for credit to be more effective the bank should (1) develop cash flow budgets as a basis for making operating loans to farmers, (2) strengthen and expand the banks' training program at all levels, and (3) allocate greater resources to research and planning with in-house staff and through the use of consultants.

CHAPTER IV

CONCEPTUAL FRAMEWORK FOR ANALYSING

LOAN DELINQUENCY

In Chapter I, current Saudi Arabian agricultural conditions and the apparent causes for low agricultural productivity were outlined. The government's initiative in establishing SAAB to provide farm operators with needed capital to increase farm production and improve income and hence repay the government loans was evaluated. It was pointed out that SAAB's primary function is to provide interest-free loans and collect the loans when due. However, over the past years of operation, SAAB has fallen far short of achieving the stated objectives. Low rate of loan repayment is one of the problems faced by SAAB. The most apparent important factors contributing to low repayment of loans are related to the farm and farm operator characteristics and to institutional factors related to SAAB.

Furthermore, the role of credit in farm capital formation and accumulation as it affects farm firm liquidity, income and repayment capacity based on the principles of agricultural finance was summarized in Chapter II. The concept of farm capital formation and accumulation, and levered growth provide the basis for measuring the impact of credit on increasing farm productivity and growth, which in turn improves income and the walfare of farmers. Since increasing farm income is one of the primary objectives on which the credit

55

program was implemented, then loan repayment should be closely linked with income generated from using credit. In this regard, farm income is one of the important determinants of the loan repayment problem.

Therefore, the purpose of this section is to systematically analyse the impact of net farm income and other selected variables attributed to the farmer borrowers' nonrepayment of production loans obtained from SAAB.

Default consists of failure of borrowers to conform to contractual obligations. Default is not the sole criterion by which success of the program should be judged. Default can arise from a conscious choice of the borrower or from a misunderstanding of his contractual obligations. He may choose not to repay because he rejects the program and hence does not expect to participate in the future. He also may default because he expects the program will not be continued. The latter reason is plausible when the program contains features likely to cause the program to be culturally rejected (6, p. 11).

Default also can arise from factors external to the client (e.g. weather, prices, illness). Should default from these sources be dismissed? There are attractive features in the concept of converting loans into an income transfer, especially those that materialize from factors over which the borrower has no control. For clients in the lowest income class(es), a strong case could be made on equity grounds if not on efficiency grounds. However, there are two problems with this concept: (1) large defaults can jeopardize the continuation of any credit program that has progressed beyond a pilot stage; (2) to forgive indebtedness once contracted may seriously damage any educa-

tional value derived from developing skills in financial management and also is not a good example for other borrowers. An important financial management skill is the honoring of debt obligations (6, p. 11).

Factors Affecting Delinquency

Important factors affecting delinquency are the following: financial management of the farmer borrowers; social organization and family characteristics; profitability of credit use; credit institution policies and regulations; informal sources of credit; misuse of credit funds; attitudinal conditions favoring non-repayment; and variability of income.

Financial Management

Financial behavior is a part of economic behavior of which the latter consists of choosing and managing alternatives in production. Financial management interacts with other economic behavior. The interaction is especially significant for the small farmer. He must solve problems of cash flow and risk management without an appreciable volume of production. He may be only marginally oriented to the market. The cash flow problem arises from seasonal deficits and surpluses inherent in the biological characteristics of farming. In addition to predicted deficits, he must consider unpredicted failures in growing conditions, disease, markets, personal health, etc. Risks are generated by the uncertain biology of farming, by uncertain markets and by unplanned household events. With a low volume of cash flow he must find a basis in reserves with which to meet both the

predicted deficits and the unpredicted adversities (1, p. 3).

Requirements of the household cannot be ignored in the organi-
zation of the small farm. The degree that the small farmer is a sub-
sistence farmer, crop inventories to meet food requirements of the
household are as important as cash flow requirements to meet oper-
ating expenses of the firm. The subsistence character of small farms
enforces the need to incorporate consumption with production require-
ments in any serious consideration of economic behavior in general
and financial behavior in particular (1, p. 3).

Owing to limited income generating abilities, limited net worth
and small volume of cash flows, small farm operations depend on gov-
ernment credit institutions, friends, relatives and private money-
lenders as sources of financing production, marketing and consumption.

Financing Production. The small farmer's dependence on high cost
informal lending has a severe direct affect on production choices.
Other than for loans from friends and relatives, the small farmer fre-
quently pays the moneylender an interest rate that is much higher than
that charged by the formal moneylenders. Such rates impose severe re-
quirements on rates of return to investment capital thus excluding
many alternatives that otherwise would be economically feasible for
him as well as for the economy of his country. Even important improve-
ments in technology may fail to generate payoffs that reach the 50 per-
cent to 100 percent levels (1, p. 3).

Financing Marketing. Large seasonal variations in product prices
are commonly observed in less developed countries. These variations
comprise one of the most visible characteristics of the small farmer's

economic environment. But his requirement in cash flow, often including a repayment commitment to his lenders, deny him the chance to gain from seasonal price appreciation. The moneylender requires the small farmer to repay at harvest. He may even commit the small farmer to repay in kind. Thus, the moneylender may acquire a crop inventory which permits him to gain in seasonal price appreciation in addition to the high rate of interest extracted from the small farmer. He also reduces the risk of default by controlling the small farmer's marketing (1, p. 4).

Financing Consumption. In the organization of small farms it is difficult and perhaps unrewarding to separate the household from the firm--consumption, as commonly understood, from production. Input requirements for the household are just as demanding as are input requirements for the firm. Here, too, there are not only the predictable deficits and surpluses already noted, but also unpredictable events. Weddings, funerals, and other ceremonies are very real requirements as viewed by many traditional small farmers (1, p. 4).

Social Organizations and Family Characteristics

Kinship structures affect farmer behavior in a number of ways. They will partially or wholly define his access to land and other productive resources; they will define many of the financial responsibilities he must meet to maintain his membership; they will partially or wholly define his relative power within the society. In addition, his kin group may provide a significant informal source of credit (19, p. 9).

The family farm is also directly affected by the natural growth-cycle characteristic of the family. A man with several grown sons living at home has an advantage in food (and cash crop) production over a young family that must support children who provide only marginal amounts of labor. Marriage patterns also partially determines the size of the family group which in turn directly affects the productive capacity of the family farm unit. Men who are able to obtain more wives will be in a better position to increase production (yet more "modern" men are supposed to be monogamous). These various factors together affect the productive and competitive position of the family firm at any particular time and they shape the limits within which a farmer plans his agricultural activity. He cannot operate an optimally large unit when his children are young; similarly, he must retrench his production once they are full-grown and leave the household (19, p. 8).

Since this study only includes family farms, it is essential to understand the fundamental differences between subsistence and commercial farms or, more specifically, differences between a family farm firm and a profit-making firm.

The goal of a family farm is to provide subsistence for all its members and to ensure their well-being as far as possible. Therefore it will utilize family labor even if the productivity of any member falls below the cost required to provide subsistence. With the resources available, the family farm firm will maximize total output, but will not necessarily maximize profit since the latter might require reduction of the work force so that the marginal net productivity of each unit of labor would be greater than zero. In order to

promote profit, some members of the family would probably have to be excluded in the same way that a profit-making enterprise reduces its work force if the profit margin begins to fall (19, p. 6).

Profitability of Credit

Profitable Technology. No public credit program for small farmers will lead to additional output unless the farmers are willing and able to borrow from the institution, to use the borrowed funds primarily for productive purposes and to repay the loan. Before a small farmer will borrow for productive purposes, he must be informed of the investment opportunity and be convinced the expected yield justifies the additional risk (26, p. 10).

Agricultural credit will be ineffective without technology which is profitable to the farmer. Technology in farming is simply the way things are done. A given technology implies a given set of inputs or factors of production. Thus, "traditional technology" means the particular way the traditional inputs of land, labor, seed, hand implements, oxen, organic fertilizer, and water are combined and used. "New technology" is no more than a new set of inputs or factors of production which are different from the traditional set. That is, at least one factor has been added, dropped or changed in some way. New technology has also been classified as biological, chemical, or mechanical innovations (30, p. 3).

To be profitable, the increase in the value of the output resulting from the investment must be more than the increase in the input costs. It has been widely held that large doses of credit are needed to facilitate rapid technological change in agriculture, but, again,

this presupposes that such profitable investment alternatives do, in fact, exist for the farmer. What evidence is there to support this assumption? (39, p. 3).

In a technical sense, it is not credit but the physical inputs of fertilizer, seeds, labor, etc., which are responsible for the increase in output. Where the conditions of success for a credit program for small farmers are not met, alternative programs--subsidies for inputs, price supports for output, more extension services, or even credit to the marketing system rather than the small farmer--may be capable of raising the welfare of small farmers at considerably lower costs than a credit program (26, p. 13).

Farm Size. Farm size can be defined in terms of either or both of the following factors: its physical size and its economic size. A farm with a small area can be the source of relatively high levels of income. Conversely, an extensive size farm may be a poor income producer. The income potential of a farm, however, is not only related to physical area or its land quality, but also to the level of technology in use and the level of administrative skill of the farm operator. A criteria for defining small farms could use both physical size and size of the income stream. An additional criteria should be that of the income potential of the unit as related to the question of access to technology and other operating and facilitating inputs. The range of farm "sizes" covers, therefore, from the large area, good resource quality, high income level farms to small area, low resource quality, very low income level farm. In between one finds differing levels of size, degrees of access to technology and inputs and, as a partial result, differing levels of income and/or income potential.

On the "small" side of the distribution, there will be a continuum of small farm types. A clearer typology within this continuum is obtained by introducing a concept of economic viability. A farm unit can be considered economically viable when it can operate as a reasonably profitable economic enterprise with unhindered access to technology and other operational and facilitating inputs and within a price system which reflects the true scarcity value of productive factors and outputs. Combining these criteria gives us three basic types of small farms:

a. Those which are already operating reasonably profitable enterprises,

b. Those which have the potential to become profitable if access to technology and inputs are possible, and

c. Those with such poor resources that not even improved access or new technology would make them profitable.

By definition, small farms and farmers in category (b) will require very special types of solutions that go well beyond access to credit. Farmers in groups (b) and (c) can be broadly categorized as subsistence farmers (18, pp. 3-4).

Economic theory suggests that economies of size may even be present in small farm agriculture (27, p. 17). This general hypothesis will be further tested to explore the relationship between size of farm and the level of delinquency rate and the response of farm output to farm size of the farmer borrowers.

Credit Institution Policies and Regulations

Credit agencies operate as only one element of the government's banking programs, which is to say that they generally lack autonomy and must be responsive to pressures originating outside their organization. In some cases, the credit agency is dependent upon particular ministries or departments for supporting activities. For example, credit tied to the introduction of new farming practices may require coordination between the credit agency and the Ministry of Agriculture, and this coordination may simply be unachievable because of ministerial rivalry, interbureaucratic ill will, or the like (19, p. 16).

Lending institutions are frequently created to provide credit to small farmers. These organizations may experience severe recuperation problems and have trouble avoiding becoming purveyors of welfare. In cases where they function well they seem to reach a ceiling or at least a leveling off of their operations well short of reaching the majority of the potential clientele. The leveling off process is attributed to various internal and external constraints such as shortage of personnel, limited land held by and limited clientele access to markets (17, p. 4).

The major factors hypothesized to have direct negative impact on loan repayment are the degree of structural complexity of the lending institution for loan application, processing and approval; and terms of credit.

Structural Complexity. Many small farm operator borrowers are unable to understand the procedures involved in securing a loan and complain of the excessive red tape and complexity of the procedures.

Complexity also produces delays which have highly detrimental effects given the farmer's need for timely acquisition of inputs and the increased risk to which delays subject him (17, p. 4).

Even though SAAB as a government development credit institution provides interest free loans to the farm operators, there still are true costs to the borrowers which usually are not accounted for by the credit analyst or the loan committee members. The true costs to the farm operators of official credit include travel costs, loss of working days and other non-monetary costs. The applicants may find it necessary to make repeated trips to the main bank or its branches and offices to negotiate the loans. Bureaucracy, red tape, and delay are directly related to the inefficiency of the credit system in meeting the need of farmers. Credit may be given too late to be useful, leaving the farm operator borrowers in debt without means of repayment.

Terms of Credit and Size of Payments. Other important factors hypothesized to have direct effects on delinquency are the terms and size of annual payments. Terms of credit obtained from SAAB are inflexible. They are fixed at five equal payments for intermediate credit and one single payment for short-term loans to be repaid in one year regardless of the size of the loan. The payments usually are not linked to the marketing period or cash flow needs of the farm enterprises. In some cases the farm operator borrowers mah look at alternative sources of credit for securing additional funds to make payments to SAAB.

Informal Sources of Credit

There are important reasons why a farmer might actually prefer

informal sources of credit over that offered through formal credit institutions. Informal sources of credit seem to share a number of characteristics that make them appealing to the small farmer and at the same time differentiate them from formal credit programs. Informal sources tend to be relatively flexible and free of red tape or complicated procedures. The creditor is generally well-known to the borrower and often has additional ties of relationship to the farmer. The source of credit is nearby, loans are unsupervised, and the farmer has more control over the size of loan he can obtain. The lender knows his credit worthiness, and is usually prepared to give the loan when the latter needs or want is (19, p. 29).

In case of emergencies, the local lender is very likely aware of the situation and can adjust the conditions of the loan accordingly. The formal credit program would generally not make any allowances for family emergencies such as illness, funerals or weddings, as these are seen as consumption items (19, p. 30).

Since moneylenders are important sources of financing the farm enterprises and the farm family needs, the farmers will be reluctant to repay the formal lender first in order not to jeopardise his chance for new credit from the local moneylenders.

Attitudinal Conditions Favoring Non-Repayment

Farmers who do not repay loans despite their apparent ability to repay fall into this category. The consideration of government funds as grants rather than loans and therefore a lack of commitment to repay is the general factor creating this attitudinal characteristic.

This cause is generally closely linked with defects in the credit organizational structure (36, p. 6).

Variability of Income Caused by Fortuitous and Seasonal Factors

The farmer in this category is unable to repay his loan in a particular season owing to a short-fall in production due to total or partial crop failure; loss of the crop by theft, fire or other hazard; a sudden fall in prices; or unmarketability of the produce. In such cases the postponement or rescheduling of the payment would take care of this problem. This is essentially a seasonal problem and there is a probability of such occurrences in every farm enterprise (36, p. 5).

In the foregoing discussion, factors affecting loan delinquency briefly documented in a conceptual framework. However, as suggested in the discussion, deliquency cannot be evaluated independently of the farm and family financial management decisions, farm production, capital formation and resource use. A brief outline of a postulated interdependent farm credit system is presented in the following section.

An Interdependent Farm Credit System

The flow of investment funds from SAAB, other sources of credit (merchants, moneylenders, and farm family savings) and their use for farm production or consumption pruposes is presented in a structural interdependent system (Figure 4). This system attempts to show the relationships and continuous interactions of the exogenous and
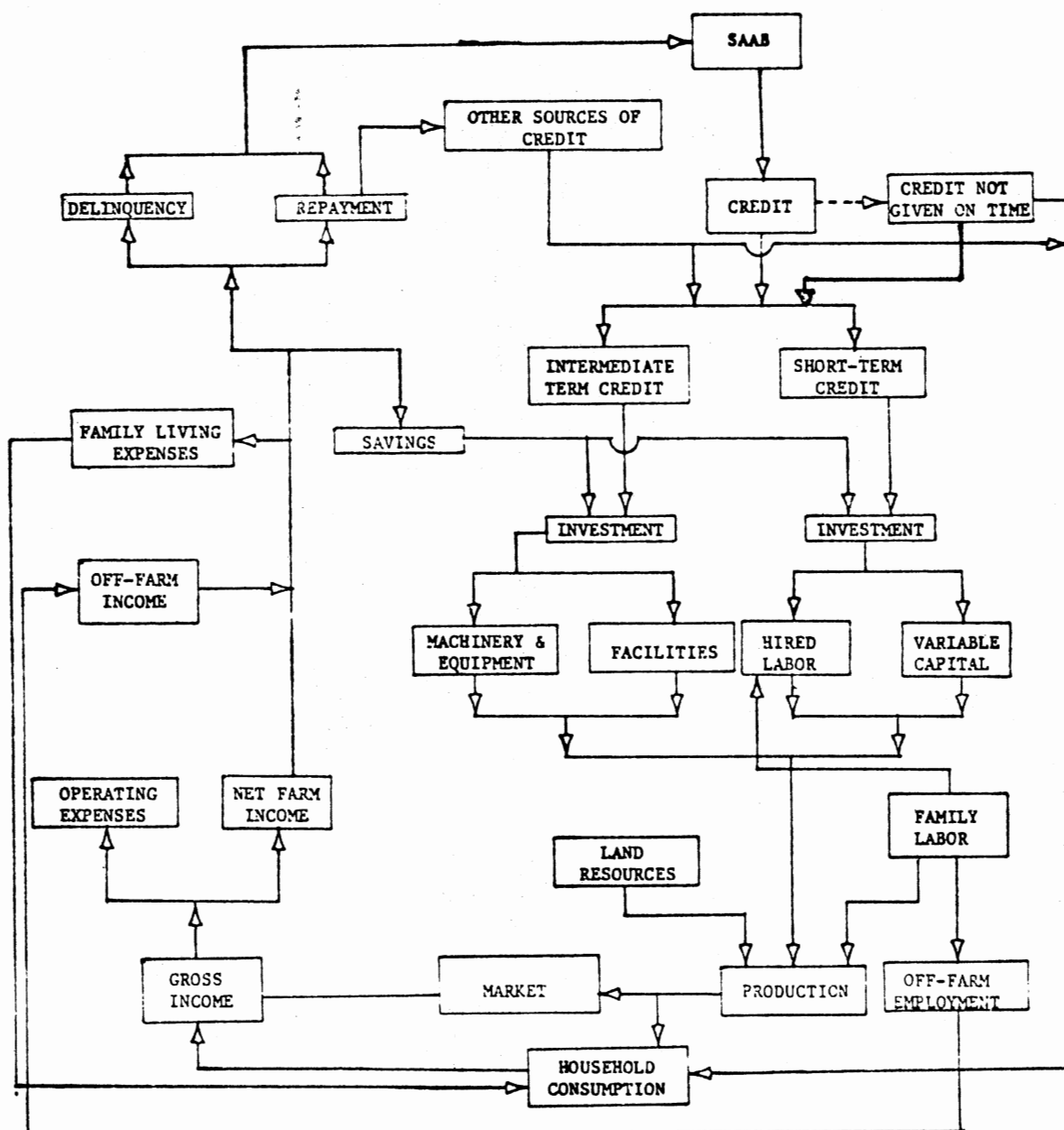
Figure 4:   Structure of the Farm Credit Interdependent System

endogenous forces affecting farm operator decision making in the farm production process.

Financial Management

The farm operator borrowers seek credit in this analytical framework from SAAB and other sources such as moneylenders, merchants and brokers. Credit obtained from SAAB is allocated by the borrowers for acquiring production inputs providing that credit is given when it is needed. If credit is not given at the time when it is most needed, it may be diverted for farm family consumption purposes. Credit obtained from other sources can be used for either production or consumption purposes.

The farmer borrowers as decision makers are striving for the satisfaction of various goals. These goals may be competitive, complementary, or independent.

Goal orientation of the farm families could be grouped into four major areas: living standard; farm ownership; leisure-children; and credit-using, risk-taking behavior. Living standard is interpreted as the desire for current income to provide a satisfactory level of consumption. Farm ownership refers to the desire to own land and accumulate net worth. Leisure-children is interpreted as the desire for leisure time and a family. Credit-using, risk-taking behavior is the willingness to sacrifice security or accept risk in the farm operation in order to achieve other goals. The relative importance of these goals is influential in determining what alternatives (for example, farm organization, land purchase, off-farm work) a farm family will consider (30, p. 491).

Farm Production

Credit as it is obtained is used directly as an input in farm production. It facilitates the means to acquire machinery and equipment, facilities, feed, fertilizer, labor and other factor inputs required for production. Figure 4 indicates that credit obtained for production purposes is classified into short and intermediate-term credit. Short-term credit is used to meet the requirements of hired labor costs and variable capital costs (feed, seeds, fertilizer and fuel). Intermediate-term credit is for purchasing durable capital items (machinery and equipment and facilities). These resources are allocated among farm enterprises to maximize farm production and increase income.

Farm production output is consumed by the farm household or marketed. The cash received from the sale of farm output is used to repay the loans from SAAB and other sources after deducting operating and living expenses. If the farm operators are able to generate high enough income to meet all their expenses including repayment of their loans, the remaining is either saved to meet the farm family requirements or reinvested in the farm enterprises. Income from off-farm employment is also used for consumption, farm capital investment or repaying loans as supplements to farm income.

If the farmer borrowers are able to make their payments in full and on the due dates, they will be eligible for new loans from either SAAB or other sources of credit. However, if the borrowers default, they will be classified as delinquent and denied new loans.

Institutional Management

The government credit institution (SAAB) was established to make capital available to the farm operators as cheaply as possible and with favorable terms. But due to organizational and structural defects, SAAB has not yet been able to provide the farm operator borrowers with adequate credit and under favorable terms. Farm operators still seek substantial borrowed funds from nongovernment sources and generally at high costs. The end result is frequently overloading the farm operators with more high debt and burden of repayment. The consequences are deterioration of the farm operator's financial position which in turn increases the delinquency rate.

Bureaucracy and red tape are the main factors for delay in loan processing and approval. Delay may force the farm operator applicants to turn to the other sources of credit. If credit is given too late to be used for the production period, the borrowers may use it either for consumption purposes or investment in non-farm enterprises and funds that may or may not be readily available when the loans mature. Therefore, timeliness of credit is an important factor affecting delinquency rate.

Terms of credit are another important factor affecting delinquency rate. If the size of annual payment is too large relative to income generated from the purposes for which the loans were given, the farmer borrowers may not be able to repay the loan. To minimize delinquency rate, the annual payment must be scrutinized relative to the income generating potential of the farm enterprises and the borrowers' repayment capacity.

Control variables that are hypothesized to affect delinquency rates are farm operator borrowers financial management ability to acquire the needed capital and combine the available resources efficiently to increase production and improve income; borrowings from other credit sources; size of annual loan payment; timeliness of credit; family living expenses; and timeliness of credit.

The conceptually interdependent model discussed above will be further systematically determined in the following chapter. The relationship between loan delinquency and hypothesized economic, social, financial management and credit institution policy instrument variables will be quantified using a postulated farm production and financial management model.

CHAPTER V

TABULAR ANALYSIS OF DATA FROM SAMPLE OF

SAAB FARM OPERATOR BORROWERS

The following section summarizes the information obtain in personal interviews with farm operators borrowing from the SAAB. The sample included 42 farm operators who had loans in 1978-79 from SAAB in two areas of the Kingdom of Saudi Arabia, Hufuf and Kharj.

Farm Characteristics

Size of Farm

The average size of farm operated by those interviewed in the study was 133 dunoms and ranged from 78 dunoms in Hufuf area to 188 dunoms in Kharj (Table II). The range of size among all farms in the study was from 10 to 1,000 dunoms.

Land Utilization

The main crops grown by farm operators in the study were pasture and animal feeds, vegetables, citrus fruits, dates, and grains such as wheat and grain sorghum.

An average of 44 dunoms or 33 percent of the land in farms was used for agricultural production (Table III). An average of 21 dunoms or 16 percent of the land area in the farm was used to produce pasture

TABLE II

SIZE OF FARM FROM A SAMPLE OF SAAB FARM OPERATOR BORROWERS
IN TWO AREAS OF SAUDI ARABIA, 1979

Item	Unit	Hufuf		Kharj		Both Areas	
		No.	%	No.	%	No.	%
Farm Size (Dunom):							
10-40	Farm	14	67	6	28	20	48
41-70	"	1	4	5	24	6	14
71-90	"	2	10	1	5	3	7
Over 90	"	4	19	9	43	13	31
Total		21	100	21	100	42	100
Average Size of All Farms	Dunom	78	---	188	---	133	---

TABLE III

LAND UTILIZATION FROM A SAMPLE OF SAAB FARM OPERATOR BORROWERS
IN TWO AREAS OF SAUDI ARABIA, 1979

Item	Unit	Hufuf		Kharj		Both Areas	
		Avg.	%	Avg.	%	Avg.	%
Land Cultivated:							
Permanent Crops	Dunom	16	21	26	14	21	16
Rotational Crops	"	23	29	23	12	23	17
Total		39	50	49	26	44	33
Land Not Utilized		39	50	139	74	89	67
Total Land in Farms		78	100	188	100	133	100

and animal feeds, grains and permanent crops such as dates and citrus fruits. Twenty-three dunoms or 17 percent of the land area in the farm was used for vegetables and other rotational crops.

Characteristics of the Farm Operators

Age and Education

The average age of the farm operators was 51 years in the Kharj area and 45 years in the Hufuf area (Table IV). Only 28 percent and 33 percent of the farm operators had any formal schooling in the Hufuf and Kharj areas, respectively (Table IV). The high illiteracy rate makes it difficult to develop programs to teach farm operators improved farming practices and the use of appropriate modern technology. Little direct use can be made by the farmers of any published agricultural information and new findings in relation to improved seeds or farming techniques.

Farm Management

None of the farm operators in the study area kept written farm records (Table IV). This is not surprising since such a high percentage are illiterate. This illiteracy results in not having historical records on which to base management decisions and to provide accurate information for loan application and for financial planning and management.

Loan Supervision

Of the farm operators who had loans from the SAAB, 14 percent in

TABLE IV

AGE, TENANCY AND OTHER CHARACTERISTICS FROM A SAMPLE
OF SAAB FARM OPERATOR BORROWERS IN TWO AREAS
OF SAUDI ARABIA, 1979

Item	Unit	Hufuf		Kharj		Both Areas	
		No.	%	No.	%	No.	%
Age Distribution of Farm Oper- ators in Years:							
20-40	Farms	12	57	5	24	17	40
41-70	"	9	43	16	76	25	60
Avg. Age of Farm Operators	Years	45	--	51	--	48	--
No. of Farm Operators Who Read and Write	Farms	6	28	7	33	13	31
No. of Farm Operators Owning Farm	"	16	76	19	90	35	83
No. of Farm Operators Keep- ing Written Records	"	0	0	0	0	0	0
No. of Farm Operators With Off-Farm Income	"	15	71	15	71	30	71
No. of Farm Operators Visted by Extension Workers	"	3	14	2	10	5	12

the Hufuf area and 10 percent in the Kharj area had agricultural exten-
sion workers visit their farms during the 1978-79 crop year (Table
VII). Visits by the agricultural extension workers to these farms
were limited to spraying chemicals for protection against insects and
plant diseases. Farm operators who were visited in both areas of
study were only visited an average of once a year by extension workers.

Off-Farm Income

Of all the farm operator borrowers in the study, 71 percent in
both the Hufuf and the Kharj areas had some off-farm income (Table IV).

Family and Hired Labor Characteristics

There was an average of 13 farm family members, including the
operator, who were dependent on each farm. This number varied from
15 in the Hufuf area to 10 in the Kharj area (Table V). Of the farm
family members dependent on the farm, only about 10 percent worked
on the farm. The remaining 90 percent were either children still in
school, disabled, too old to work, or worked off the farm.

The farm operator's family was not able to supply all of the
farm labor needed. All farm operators in the study areas hired addi-
tional labor. These farm operators hired an average of five additional
farm workers per farm, usually for the entire cropping season. There
was an average of 6.3 workers per farm including both the hired and
family laborers (Table V).

TABLE V

FAMILY STRUCTURE AND FARM LABOR CHARACTERISTICS FROM A SAMPLE
OF SAAB FARM OPERATOR BORROWERS IN TWO AREAS
OF SAUDI ARABIA, 1979

Item	Unit	Hufuf		Kharj		Total	
		No.	%	No.	%	No.	%
Family Members Depending on the Farm:							
4-10		7	33	13	62	20	47
11-20		9	43	6	28	15	36
21-35		5	24	2	10	7	17
Avg. No. of Family Members Per Farm	Persons	15	--	10	--	13	--
Avg. No. of Family Members Working on Farm	Persons	1.8	--	0.8	--	1.3	--
Farms with Hired Labor (Workers):							
1-5	Farm	15	72	15	72	30	72
6-10	Farm	5	23	3	14	8	19
11-20	Farm	1	5	3	14	4	9
Avg. No. of Workers Per Farm	Workers	4	--	6	--	5	--

Farm Income and Expense Characteristics

Farm Income

The average total gross farm income varied from SR. 140,927 in
Hufuf to SR. 159,854 in Kharj (Table VI). Receipts from livestock
were relatively more important in Hufuf than in Kharj.

Net Farm Income

In estimating net farm income, charges for farm machinery, equip-
ment and building depreciation and family labor expenses were not esti-
mated and consequently are not included with the other farm expenses.
Thus for all farms, total annual farm expenses were under-estimated
(Table VI). The average net farm income for the farm operators includ-
ed in the study was SR. 47,736 and SR. 53,521 in the Hufuf and the
Kharj areas, respectively (Table VI). The variation in average net
farm income was mainly the result of the difference in the average
amount of farm land cultivated per farm in the two respective areas.

Off-Farm Income

Average off-farm income at SR. 90,071 per farm for the borrower
from the SAAB in the Kharj area was slightly over two times as large
as in the Hufuf area (SR. 38,719). Nearness of this area to a large
metropolitan area with greater off-farm employment opportunities was
the reason for higher off-farm income in the Kharj area. The average
off-farm income earned by farm families in Hufuf is 80 percent of
their net farm income versus 168 percent for farm families in Kharj
(Table VI).

TABLE VI

FARM INCOME, EXPENSES, AND OTHER CHARACTERISTICS
FARM A SAMPLE OF SAAB FARM OPERATOR BORROWERS
IN TWO AREAS OF SAUDI ARABIA, 1979

Item	Hufuf SR.	Kharj SR.	Both Areas SR.
Average Gross Farm Income:			
Receipts from Rotational Crops	29,405	35,738	32,571
Receipts from Permanent Crops	20,810	48,738	34,775
Receipts from Livestock	69,886	49,031	59,458
Average Value of Products Consumed on Farm	20,826	26,347	23,587
Total Gross Farm Income	140,927	159,854	150,391
Average Operating Expenses:			
Hired Labor	53,415	50,010	51,712
Repair and Maintenance	2,463	4,138	3,301
Fuel and Lubrication	3,233	16,458	9,846
Seeds	2,927	6,448	4,688
Fertilizer	21,803	15,227	18,515
Transportation (Marketing)	9,350	14,052	11,701
Total Operating Expenses	93,191	106,333	99,763
Average Net Farm Income	47,736	53,521	50,628
Average Off-Farm Income	38,719	90,071	64,395
Average Total Family Income	86,455	143,592	115,023
Average Family Living Expenses	47,117	52,971	50,044
Average Family Net Income After Living Expenses	39,338	90,621	64,979
Average Family Net Farm Income per Dunom Cultivated	1,224	1,849	1,477

Farm Loan Characteristics

Loans from SAAB

An average of 29 percent of the farm operators in the study areas had loans between SR 1,000 and Sr. 20,000, 38 percent had loans between SR. 20,001 and Sr. 50,000, and the remaining 33 percent had loans between SR. 50,001 and Sr. 300,000. Overall the average loan size per farm operator from the SAAB was SR. 44,163 (Table VII). The average amount borrowed from the SAAB varied from SR. 39,244 in the Kharj area to Sr. 49,082 in the Hufuf area. The average size of annual loan payments was SR. 15,605 in the Hufuf area and SR. 14,390 in the Kharj areas (Table VII).

The average amount of SAAB loans per dunom cultivated was SR. 1,409 and Sr. 934 in Hufuf and Kharj, respectively.

Time Lag for Loan Approval

An average of 57 days elapsed between the time loan application was made by the farm operator at the SAAB until the day the loan was obtained (Table VII). In contrast, it took only an average of two days to obtain loans from other sources such as merchants, dealers, brokers and individuals. Delay in the loan approval was the result of bureaucratic complications in processing loan applications and legal documents.

Loans from Other Sources

In addition to borrowing from SAAB, farm operators obtained credit from other sources such as dealers, merchants, brokers, and

TABLE VII

AMOUNT OF LOANS, TIME LAG FOR LOAN APPROVAL, AND OTHER CHARACTERISTICS
FROM A SAMPLE OF SAAB FARM OPERATOR BORROWERS
IN TWO AREAS OF SAUDI ARABIA, 1979

Item	Unit	Hufuf		Kharj		Total	
		No.	%	No.	%	No.	%
Distribution of Farms by Size of Intermediate-Term Loan (SR.):							
1,000-20,000	Farms	7	33	5		12	29
20,001-50,000	Farms	6	29	10		16	38
50,001-300,000	Farms	8	38	6		14	33
Average Size of Intermediate Term Loan	SR.	49,082	--	39,244	--	44,163	--
Distribution of Farms by Size of Short-Term Loan (SR.):							
0-10,000	Farms	18	86	19	90	37	83
10,001-30,000	Farms	3	14	2	10	5	12
Average Size of Short-Term Loan	SR.	5,883	--	6,542	--	6,213	--
Average Size of All Loans From SAAB	SR.	54,965	--	45,786	—	50,376	--
Average Size of Annual Loan Payment	SR.	15,605	--	14,390	--	14,998	--
Average Amount of All Loans From SAAB per Dunom Cultivated	SR.	1,409	--	934	--	1,145	--
Average Time Lag for Loan Approval	Days	57	--	58	--	57	--
Average Amount of Loans From Other Sources	SR.	45,100	--	55,095	--	50,098	--
Average Total Borrowing	SR.	100,000	--	100,881	--	100,474	--
Average Total Borrowing per Dunom Cultivated	SR.	2,566	--	2,059	--	2,284	--

individuals. The average amount borrowed from other lenders in the sample farm operators for the 1978 crop season was SR. 45,100 and SR. 55,095 in the Hufuf and the Kharj areas, respectively (Table VII). The cost of borrowed money from the merchants, dealers, brokers, and individuals ranged up to 30 percent annual interest charge whereas loans from the SAAB are interest free. This indicates that funds given by the SAAB were either not adequate or terms of the loans were not appropriate. As was indicated in the previous discussion, charging interest on borrowed funds is prohibited by Islam. However, merchants and dealers do charge interest on borrowed money for purchase of capital items such as machinery and equipment. Interest charged by merchants or dealers is frequently not stated in the agreement, but hidden in the purchase price of the item sold to farm operators. As an example, a farm operator borrows SR. 1,000 from a merchant. The farm operator will sign a note that he borrowed SR. 1,300. The merchant may also require real estate or personal property as collateral.

Advantages of private money lenders over SAAB frequently include unsecured loans, absence of red tape, funds readily available under flexible conditions, and private handling of transactions. The onerous nature of the credit terms frequently outweigh these advantages so that private credit, all things considered, is generally not a good credit source. Prohibition against making unlawful charges for interest is not enough to protect farm operators from possible exploitation by the private moneylenders.

Total Borrowing

The overall average total borrowing from SAAB and other sources

by farm operators in the study was SR. 100,474. Average total borrowing was SR. 100,065 in the Hufuf area and SR. 100,881 in the Kharj area (Table VII).

<div align="center">Loan Repayment and Loan Delinquency</div>

<div align="center">Characteristics</div>

Only 24 percent of the sample of farm operators who borrowed from the SAAB in the Hufuf area made their loan payments in full on the due dates in 1978-79. In the Kharj area, there were 28 percent who made the payments on time (Table VIII). The average size payment was SR. 31,364, and SR. 15,823 in the respective areas, Hufuf and Kharj (Table VIII). Farm operators as a percent of total operator borrowers who failed to make any partial loan payments on due dates were 76 percent in the Hufuf area and 72 percent in the Kharj area (Table VIII). The average loan payment due was SR. 10,680 and SR. 13,816 in Hufuf and Kharj respectively (Table VIII).

The average length of time payments was overdue for delinquent borrowers was 223 days for the two areas. This varied from an average of 281 days in the Hufuf area to 162 days in the Kharj area (Table VIII). One of the major reasons for overdue payments was loss of crops due to adverse weather conditions such as frost. A total of 23 farms was affected by bad weather conditions and the average value of crop loss was 52.5 percent.

To compare an average delinquent and nondelinquent farm operator, the average annual operating expenses per dunom cultivated was SR. 2,284 for the nondelinquent and SR. 2,024 for the delinquent farm operator borrowers from the SAAB (Table IX). Average investment in ma-

TABLE VIII

LOAN REPAYMENT AND LOAN DELINQUENCY CHARACTERISTICS FROM A SAMPLE
OF SAAB FARM OPERATOR BORROWERS IN TWO AREAS
OF SAUDI ARABIA, 1979

Item	Unit	Hufuf No.	Hufuf %	Kharj No.	Kharj %	Total No.	Total %
No. of Farmers who repaid Full Amount on or Before Due Dates	Farms	5	24	6	28	11	26
Average Size of Payment	SR.	31,364	--	15,823	--	22,890	--
No. of Farmers who Failed to Make Any Payment on Due Dates	Farms	16	76	15	72	31	74
Average Size of Payment Due	SR.	10,680	--	13,816	--	12,197	--
Distribution of Farms with Overdue Loans (Days):							
4-90	Farms	4	19	6	29	10	24
91-200	Farms	1	5	1	5	2	5
201-460	Farms	11	42	8	38	19	45
Average Length of Time Payment Was Overdue	Days	261	--	162	--	223	--
No. of Farms Affected by Adverse Weather Conditions	Farms	16	76	7	33	23	55
Average Value of Crop Loss Per Farm	Percent	53	--	52	--	52.5	--

TABLE IX

COMPARISON OF COST AND RETURN DATA FOR NONDELINQUENT AND DELINQUENT FARM OPERATOR BORROWERS FROM A SAMPLE OF SAAB BORROWERS IN TWO AREAS OF SAUDI ARABIA, 1979

		Nondelinquent Borrowers			Delinquent Borrowers		
		Hufuf	Kharj	Total	Hufuf	Kharj	Total
Average Variable Expenses per Dunom	SR.	2,652	1,958	2,284	2,312	1,836	2,024
Average Investment in Machinery and Equipment	SR.	4,299	2,103	3,056	3,011	3,803	3,539
Average Value of Crop Consumed on Farm per Dunom	SR.	335	766	495	633	437	539
Average Gross Farm Receipts per Dunom	SR.	5,844	2,677	4,502	352	558	487
Average Gross Farm Income Per Dunom	SR.	6,179	3,443	4,997	985	995	1,026
Average Net Farm Income per Dunom	SR.	3,527	1,485	2,712	-1,327	-841	-998
Average Land Utilized per Farm Dunom		50	66	68	35	43	38
Average Amount Borrowed from SAAB per Dunom	SR.	2,335	735	1,425	1,019	3,315	2,167
Average Amount Borrowed from Other Sources per Dunom	SR.	500	73	257	1,468	2,366	2,015
Average Total Borrowing per Dunom	SR.	2,835	808	1,682	2,487	5,681	3,070

chinery and equipment per dunom cultivated was SR. 3,056 and SR. 3,539 for nondelinquent and delinquent farm operator borrowers, respectively (Table IX). Nondelinquent borrowers had an average net farm income of SR. 2,712 versus an average net farm income of SR.-998 for delinquent borrowers. The lower average net farm income resulted from lower average gross farm income per dunom earned by the delinquent farm operators as compared to the nondelinquent borrowers. Nondelinquent borrowers had somewhat larger farms with an average of 68 dunoms versus 38 dunoms for the delinquent borrowers (Table IX). The average amount of funds borrowed per dunom from SAAB was larger for nondelinquent borrowers, SR. 1,425, than for delinquent borrowers SR. 1,055. However, the average total amount borrowed per dunom cultivated was larger for the delinquent borrowers, SR. 3,070, than for the nondelinquent borrowers, SR. 1,682 (Table IX).

CHAPTER VI

EMPIRICAL RESULTS AND ANALYSIS OF THE

LOAN DELINQUENCY MODEL

In a foregoing discussion, the most important factors hypothe-
sized to affect repayment of agricultural credit were enumerated.
This section will develop an analytical model to explore the delin-
quency problem faced by SAAB. Hypotheses connecting delinquency rate
and associated factors will be tested. Within the framework of this
analysis, only quantifiable variables will be used. The non quanti-
fiable variables such as misuse of funds, attitudinal conditions
favoring nonrepayment and variability of income caused by fortuitous
and seasonal factors will not be included in estimating the delin-
quency rate model due to the inavailability of sufficient information
in the survey data.

This section will model the behavior of the farm operator borrow-
ers who had production loans from SAAB using two different approaches:
(1) ordinary least squares and (2) an interdependent system approach
(two stage least squares). The specification of the postulated models
will be first applied to the Hufuf area and then tested on the Kharj
area. The two areas, Hufuf and Kharj, will be combined to test the
structural stability between the two areas. The structural stability
test will indicate whether the estimated delinquency rate model using

89

ordinary least squares and two stage least squares have the same intercepts and slopes.

<div align="center">
Loan Delinquency Ordinary Least

Squares (OLS) Model
</div>

In this section, the OLS model is used to predict and analyse the hypothesized relationships between delinquency rate and associated variables.

Source of Data

The analysis employs cross-section data including 42 farm operators who had loans from SAAB. The data was obtained from administered farm questionnaires and SAAB credit files from two regions in Saudi Arabia, Hufuf and Kharj area.

The Dependent and Related Explanatory
Variables

Delinquency rate, as measured by the number of days payments are past due, is hypothesized to be a function of net farm income per unit cultivated (dunom), size of annual payments, family living expenditures, off-farm income, amount borrowed from other sources, timeliness of credit and the size of farm. The hypothesized relationship can be summarized implicitly by the following functional relationship:

DELRATE = f(NFID, AP, FAMEXPC, OFINC, TCRED, TAREAC)

where DELRATE = Number of days payments past due;

NFID   = Net farm income (SR. 1,000): to be negatively

related to delinquency rate;

AP[1]   = Size of annual payments in SR. 1,000 (0.2 times

intermediate-term SAAB loan + 1.0 times short-

term SAAB loan + 0.5 times loans obtained from

other credit sources): to be positively related

to delinquency rate;

FAMEXPC = Family living expenditures plus value of farm

output consumed by the farm household (SR. 1,000):

to be positively related to delinquency rate;

OFINC   = Off-farm income (SR. 1,000): to be negatively re-

lated to delinquency rate;

TCRED   = Timeliness of credit, time consumed for loan appli-

cation processing and approval (days): to be

positively related to delinquency rate; and

TAREAC = Total crop land cultivated (Dunom): to be nega-

tively related to delinquency rate.

Criteria Used in Evaluating the
Regression Results

Three criteria are used in evaluating the regression equations:

1. Does the sign of the estimated regression coefficient tend to
support or reject the hypothesized effects.

---

[1]The weights 0.2, 1.0, and 0.5 indicate the expected annual pay-
ment of intermediate-term, short-term, and amount borrowed from other
sources respectively.

2. Is the magnitude of the regression coefficient large enough relative to its standard error to support the hypothesis that the regression coefficient is significantly different from zero.

3. Does the R^2, the overall F-test value, the standard error of the estimate and an examination of the residuals indicate that the model can be used for accurate prediction.

Empirical Results

The empirical results from the estimated delinquency rate model using "OLS" approach for Hufuf and Kharj areas are presented in Tables X and XI.

Hufuf. The results of the estimated regression indicate that the net farm income (NFID) (in SR. 1,000 per dunom) is inversely related to the delinquency rate (number of days payments are past due) and the regression coefficient is significantly different from zero at the 0.01 probability level. This implies that the higher the level of net farm income, the lower the delinquency rate. This result is consistent with that obtained from the tabular analysis discussed earlier in the study. The tabular results indicated that the average net farm income per dunom was SR. 1,448.00 and SR. -1,664.00 for nondelinquent and delinquent farm operator borrowers, respectively.

Size of annual payment is positively related to delinquency rate. The estimated coefficient of this variable is statistically significant at 0.01 probability level. The level of annual payment is related to the size of short-term, intermediate-term, and other borrowings. The higher the size of loan, the higher the size of annual payment.

Family living expenditures variable is positively related to the delinquency rate. However, the regression coefficient is not significant at the 0.10 probability level. The low income farmer with high family living expenditures will find it difficult to improve the well being of his family and at the same time be able to repay loan funds.

Off-farm income is negatively related to the delinquency rate and its regression coefficient is statistically different from zero at the 0.05 probability level. Farm operator borrowers who have off-farm employment or other sources of income such as rents from real estate are in better financial position to meet their repayment responsibilities. Income generated from off-farm activities is used to supplement farm income in meeting farm family needs, farm investment and loan repayment.

Timeliness of credit (number of days consumed in processing and approving the loan) is positively related to delinquency rate but its regression coefficient is not statistically different from zero at the 0.10 probability level. The result indicates that bureaucratic complications and red tape may be important factors contributing to delinquency rate. Results obtained from the tabulated analysis presented earlier in the study indicated that the average time lag for loan approval was 57 days.

Size of crop land cultivated is negatively related to delinquency rate and its regression coefficient is statistically different from zero at the 0.01 probability level. In essence, borrowers operating larger farms have higher income generating potential to repay their crop production loans than borrowers operating smaller units. The results indicate that economies of size may exist in the sense that

additional crop land provides more income for debt repayment, family consumption, and other needs.

Kharj. The same hypothesized model was also tested on the Kharj area. The results indicate that the level of net farm income per dunom is negatively related to delinquency rate and significantly different from zero at the 0.01 probability level (Table XI).

The results also indicate that family living expenditures plus value of farm output used up for farm family consumption, and timeliness of credit are positively related to delinquency rate (Table XI). Neither variable, however, is significant at the 10 percent probability level.

Off-farm income and total crop land cultivated are negatively related to delinquency rate and significantly different from zero at the 0.20 and 0.02 probability levels, respectively. The results obtained from estimating delinquency rate for the Kharj area are found to be consistent, in general, with those of the Hufuf area in terms of the hypothesized relationships. However, annual payment is negatively related to delinquency for the Kharj region although the coefficient is not significantly different from zero.

Other results of the delinquency rate model are noted by the magnitudes of the estimated regression coefficients. The results indicate that for a SR. 1,000 increase in net farm income per dunom, number of days payments past due will decrease by about 31 and 50 days for the Hufuf and the Kharj area, respectively. A SR. 1,000 increase in family living expenditures plus value of farm output consumed by the farm family will increase the delinquency rate by about 2.00 days for the Hufuf area and about 0.70 days for the Kharj area.

The coefficient of off-farm income is substantially higher for the Hufuf area than for the Kharj area. A SR. 1,000 increase in off-farm income decreases delinquency rate by about 2.7 days in the Hufuf area and about 0.14 for the Kharj area. The difference in the magnitude of the coefficients indicate that farmer borrowers in the Hufuf area are able to use larger portions of their off-farm income to supplement farm income in repaying SAAB loans than farmer borrowers in the Kharj area (Tables X and XI).

Farm size has a larger effect on delinquency rate in the Hufuf area than in the Kharj area. One dunom increase in crop land cultivated will decrease delinquency by about 2.6 days in Hufuf compared to 1.4 days in Kharj (Tables X and XI).

The hypothesized delinquency models explain 62 and 74 percent of the variation for the Hufuf and the Kharj areas, respectively.

Application of the Model to the Pooled Data

The postulated delinquency model was tested on the pooled data for the Hufuf and Kharj areas. But based on the structural stability test, results indicate that there is a significant difference between the two areas in terms of their characteristics that are related to the farms and the farm operator borrowers. Therefore, the farm and farm operator characteristics are apparently structurally different between the two areas. The results of the test imply that delinquency rate problems and lending policies for each area should be assessed and evaluated in different perspectives.

Up to this point, the relationship between delinquency and the hypothesized variables has been explored and empirically determined.

TABLE X

DELINQUENCY RATE MODEL FOR THE HUFUF AREA,
1978/79, USING OLS APPROACH

DELRATE = 219.5815 − 31.1699 NFID*** + 0.5392 AP* + 1.9631 FAMEXPC
$\quad\quad\quad$ (91.70)$\quad$(10.28)$\quad\quad\quad\quad$(0.27)$\quad\quad\quad$(1.47)

$\quad\quad\quad$ − 2.6847 OFINC** + 1.1783 TCRED − 2.5982 TAREAC***
$\quad\quad\quad\quad$ (0.91)$\quad\quad\quad\quad$(0.74)$\quad\quad\quad$(0.86)

$$R^2 = 0.6244$$

$$F(5, 16) = 3.88**$$

Note:$\quad$DELRATE = Delinquency rate measured in days payments past due.
$\quad\quad\quad$ NFID = Net farm income per dunom measured in SR. 1,000.
$\quad\quad\quad$ AP = Size of annual payment measured in SR. 1,000.
$\quad\quad\quad$ FAMEXPC = Farm family living expenditures measured in SR. 1,000.
$\quad\quad\quad$ OFINC = Income from off-farm employment and real estate meas-
$\quad\quad\quad\quad\quad$ ured in SR. 1,000.
$\quad\quad\quad$ TCRED = Timeliness of credit, time lag for processing and ap-
$\quad\quad\quad\quad\quad$ proving loans measured in days.
$\quad\quad\quad$ TAREAC = Total crop land cultivated measured in dunoms.

*Significance test at 10 percent probabiliyt level
**Significance test at 5 percent probability level
***Significance test at 1 percent probability level
Standard errors of the regression coefficients in parentheses.
The figures in parentheses beside the F-statistic are degrees of free-
$\quad$ dom of the F-statistics.

TABLE XI

DELINQUENCY RATE MODEL FOR THE KHARJ AREA,
1978/79, USING OLS APPROACH

DELRATE = 194.0479 - 49.5413 NFID*** - 0.4513 AP + 0.7022 FAMEXPC
       (53.13)   (11.17)   (0.48)   (0.49)

      - 0.1442 OFINC + 0.2382 TCRED - 1.3644 TAREAC**
       (0.10)   (0.45)   (0.53)

$$R^2 = 0.7385$$

$$F(6, 14) = 6.57***$$

Note: DELRATE = Delinquency rate measured in days payments past due.
       NFID = Net farm income per dunom measured in SR. 1,000.
       AP = Size of annual payment measured in SR. 1,000.
       FAMEXPC = Farm Family living expenditures measured in SR.
             1,000.
       OFINC = Income from off-farm employment and real estate meas-
           ured in SR. 1,000.
       TCRED = Timeliness of credit, time lag for processing and ap-
           proving loans measured in days.
       TAREAC = Total crop land cultivated measured in dunoms.

*Significance test at 10 percent probability level
**Significance test at 5 percent probability level
***Significance test at 1 percent probability level
Standard errors of the regression coefficients in parentheses.
The figures in parentheses beside the F-statistic are degrees of free-
  dom of the F-statistics.

The results are consistent with what was expected. However, delinquency in the foregoing dicsussion was analyzed by using a single equation multiple regression model and independent of the farm production activities. To provide further insight, a farm credit interdependent system is postulated to evaluate loan delinquency relative to farm production, farm and family financial management, and credit policies.

Farm Credit Interdependent System

The advantage of the farm credit interdependent system is that it links loan delinquency with the level and usage of the financial resources obtained through loans and the farm and family resource management and production processes. Credit given to farm operators is used to acquire farm resources which are combined in the production process to increase farm output and generate income. Part of the generated income is used to meet the farm family needs, part is used to repay loans and another part is either saved for unforeseen contingencies or reinvested in the farm enterprises. The following section will focus on developing the farm financial interdependent system means of a simultaneous equation system. Two Stage Least Square (2SLS) will be used to estimate the model.

The farm credit interdependent model consists of a system of eight equations:

1. Farm machinery and equipment demand,

2. Farm facilities demand,

3. Hired labor demand,

4. Farm variable capital demand,

5. Farm production function,

6. Loan delinquency,

7. An identity equation for net farm income, and

8. An identity equation for total farm durable capital.

Equations 1-4 permit the examination of the impact of credit on the demand for factor inputs by the farm operator borrowers.

The production function equation describes the technical relationship between the combined farm resources and the attainable level of output.

The loan delinquency equation reflects the management and financial ability of the producers in combining financial and physical resources to maximize production and improve farm income.

The identity equations are an accounting of net farm income and total farm durable capital.

The relationships stated above establish intuitively the simultaneous interaction between the financial management and production of farm output. Therefore, in the following section a more formal model is developed.

Classification of the Variables

1. The Endogenous Variables

a. Gross farm receipts (GFR): value of farm output. It includes receipts from the sale of cash crops such as vegetables and animal feeds; permanent crops such as dates and citrus fruits; livestock; and value of farm output consumed by the farm household. The value was measured in terms of Saudi Riyals (SR. 1,000).

b. Farm machinery and equipment (MACEQ): value of farm machinery and equipment such as irrigation engines, pumps, vehicles, etc. (SR. 1,000).

c. Farm facilities (FACIL): value of farm facilities such as irrigation canal systems, water storage, office space, and animal shelters (SR. 1,000).

d. Hired labor (LCOST): total value paid to hired labor on farms (SR. 1,000).

e. Farm variable capital (VCAP): includes all expenses for fertilizer, seeds, fuel and lubrication, and marketing and transportation costs (SR. 1,000).

f. Net farm income per dunom (NFID): equals gross farm receipts plus value of farm output consumed by the farm household minus current operating expenses and cost of hired labor (SR. 1,000).

g. Loan delinquency (DELRATE): number of days loan payments past due.

h. Total farm durable capital (TCAP): equals sum of farm machinery and equipment and facilities (SR. 1,000).

2. The Exogenous Variables

a. Total area cultivated (TAREAC): includes the total crop land cultivated for cash and permanent crops measured in terms of dunoms. Land resources are assumed exogenously determined by institutional and cultural factors. Government policies determine size of land parcel for new settlements and inheritance customs determine land distribution.

b. Intermediate-term credit (INTOB): includes the amount of

intermediate-term credit obtained from SAAB plus additional credit obtained from other credit sources (SR. 1,000).

    c. Short-term credit (SHOB): includes the amount of short-term credit obtained from SAAB plus additional funds obtained from other credit sources (SR. 1,000). Government policy also determines amount of short-term credit available.

The amount of funds obtained from other sources of credit was added to intermediate and short-term credit since the data do not permit distinguishing terms of the borrowed funds. There is no indication of the proportions of informal credit used for intermediate and short-term purposes.

    d. Family labor (FLAB): family members employed full time on the farm (work days per year).

    e. Wage rate (WAGE): wage rate paid by farm operators to farm hired labor and measured in terms of (SR. 1,000) per working day. Labor markets are assumed to be competitive with farm operators paying the opportunity cost of labor. Strong labor demand exists in the nonagricultural sectors, particularly in the petroleum sector.

    f. Family living expenditures (FAMEXP): farm family living expenditures per year plus farm output produced and consumed (SR. 1,000). FAMEXP is highly correlated with size of farm household and the latter is assumed to be exogenously determined.

    g. Off-farm income (NFINC): total annual earnings from off-farm employment and rent from real estate (SR. 1,000).

    h. Annual loan payment (AP): annual loan payment is com-

puted as one-fifth of the SAAB intermediate-term loans plus all of the SAAB short-term loans plus one-half of the total amount of funds farm operators obtained from other sources of credit. Government policy can be used to influence loan payment terms. The terms of credit obtained from SAAB are presently one and five years for short and intermediate-term credit, respectively. However, funds obtained from other sources are generally repaid within an average of two years.

i. Timeliness of credit (TCRED): number of days consumed to process, evaluate and approve the loans. Government procedures can be changed to improve timeliness of credit.

The Postulated Models

The following eight equations describe the farm credit interdependence system. Endogenous variables are underlined in the equations.

$$GFR = f (TCAP, LCOST, VCAP, TAREAC) \tag{1}$$

$$MACEQ = F (LCOST, FLAB, INTOB, TAREAC) \tag{2}$$

$$FACIL = f (NFID, INTOB, NFINC) \tag{3}$$

$$TCAP = MACEQ + FACIL \tag{4}$$

$$LCOST = f (FLAB, SHOB, WAGE, TAREAC) \tag{5}$$

$$VCAP = f (NFID, TCAP, SHOB, NFINC, TAREAC) \tag{6}$$

$$NFID = [GFR - LCOST - VCAP] \div TAREAC \tag{7}$$

$$DELRATE = f (NFID, AP, FAMEXPC, NFINC, TCRED, TAREAC) \tag{8}$$

By examining the six behavioral equations and the two identity equations making up the system, it can be seen that each equation in question contains a common explanatory variable with other equations in the system. Since the primary objective of the system is to

examine the impact of credit (short and intermediate-term credit) on farm production and hence on loan delinquency transmitted through the acquisition and use of factor inputs, then simultaneity exists in the system. In this case, the estimation procedure cannot be considered within the framework of single equations.

Heady and Dillon point out that if the production relationship is in fact a unilateral casual relation with output dependent upon a number of predetermined input variables, the single equation model is logically appropriate. Under such circumstances, the least squares multiple regression procedure provides the best estimates of the production function parameters. However, the production relationship may be but one of a number of simultaneously determined relationships involving output and inputs, and other variables, not as dependent and independent variables but as mutually determined variables. If the economic, biological, or physical relationships relevant to the production process dictate that such is the case, then ideally, the parameters of the production relationship should be estimated in terms of the complete set of simultaneous equations in which the production relation is embedded (22, pp. 137-138).

Recalling that one of the crucial assumptions of the method of OLS is that the explanatory variables are either non-stochastic or, if stochastic (random), should be distributed independently of the stochastic disturbance term. If neither of these conditions are met, then, the least-squares estimators are not only biased but also inconsistent. That is, as the sample size increases indefinitely, the estimators do not converge to their true (population) values. Thus, consider the following hypothetical system of equations:

$$y_{1i} = \beta_{10} + \beta_{12}\, y_{2i} + \gamma_{11}\, x_{1i} + u_{1i} \qquad (1)$$

$$y_{2i} = \beta_{20} + \beta_{21}\, y_{1i} + \gamma_{21}\, x_{1i} + u_{2i} \qquad (2)$$

where y_1 and y_2 are mutually dependent, or endogenous variables and x_1 an exogenous variable and where u_1 and u_2 are the stochastic disturbance terms. The variables y_1 and y_2 are both stochastic. Therefore, unless it can be shown that the stochastic explanatory variable y_2 in (1) is distributed independently of u_1 and the stochastic explanatory variable y_2 in (1) is distributed independently of u_1 and the stochastic explanatory variable y_1 in (2) is distributed independently of u_2, application of the classical OLS to those equations individually will lead to inconsistent estimates (9, p. 336).

The following section will describe the analytical procedures of the hypothesized model developed by means of the two stage least squares (2SLS) technique.

Estimating the Farm Credit Interdependent System by Means of (2SLS)

This section will present the 2SLS technique to estimate the hypothesized interdependent system described in the foregoing section.

Necessary Conditions for (2SLS). In order to estimate the system of equations using 2SLS, pre-estimation identification properties of the model are necessary to determine if (2) the system is complete, and (b) the system is overidentified.

By satisfying a and b, the use of 2SLS is justified. By completeness, it is meant that the endogenous variables can be determined uniquely if the errors, exogenous variables and structural paramenters

are known. In our interdependent system model, there are eight independent equations and eight endogenous variables. Therefore, the system is complete.

Identification by definition means that the structural parameters can be determined uniquely if the errors, exogenous variables and endogenous variables are known (42, p. 189).

For a system of G equations and G endogenous variables, the following rules of thumb can be used to decide whether a given equation is identified or not. Let D be the number of predetermined variables appearing in the system but not in the equation at hand; and H the number of endogenous variables that appear in the equation being studied. The given equation is over-identified if $D > H - 1$; just-identified if $D = H - 1$; and under-identified if $D < H - 1$ (22, p. 139).

Applying the identification to the hypothesized model in this study it can be determined whether the model is just-identified, over-identified or under-identified.

For the first equation:

$D^* = 8$, $H^* = 4$, $H^* - 1 = 3 \rightarrow D^* > H^* - 1$ (over-identified)

For the second equation:

$D^* = 6$, $H^* = 2$, $H^* - 1 = 1 \rightarrow D^* > H^* - 1$ (over-identified)

For the third equation:

$D^* = 7$, $H^* = 2$, $H^* - 1 = 1 \rightarrow D^* > H^* - 1$ (over-identified)

For the fourth equation:

$D^* = 9$, $H^* = 3$, $H^* - 1 = 2 \rightarrow D^* > H^* - 1$ (over-identified)

For the fifth equation:

$D^* = 5$, $H^* = 1$, $H^* - 1 = 0 \rightarrow D^* > H^* - 1$ (over-identified)

For the sixth equation:

$D^* = 6$, $H^* = 3$, $H^* - 1 = 2 \rightarrow D^* > H^* - 1$ (over-identified)

For the seventh equation:

$D^* = 7$, $H^* - 4$, $H^* - 1 - 3 \rightarrow D^* > H^* - 1$ (over-identified)

For the eighth equation:

$D^* - 4$, $H^* - 3$, $H^* - 1 = 1 \rightarrow D^* > H^* - 1$ (over-identified)

Since the pre-estimation identification properties of the model were examined and the system found to be over-identified, the structural coefficients can be estimated by two stage least squares (2SLS).

2. Assumptions of 2SLS (22, p. 139).

    a. No errors of observations in the variables.

    b. Only errors in the equations are permitted.

    c. The expected value of the error term in each equation should be zero, and

    d. The error term in a given equation should be independent of the predetermined variables in the equation and should not be autocorrelated.

The Production Function

The neoclassical production function will be applied to determine the technical relationship between the level of farm output and the associated factor inputs used by farm operator borrowers. Economic theory is used to identify the important variables in explaining the allocation of factor inputs used in the farm production process. For the SAAB farm operator borrowers it is hypothesized that total farm durable capital (TCAP), hired labor (LCOST), farm variable capital (VCAP) and total area cultivated (TAREAC) are important in deter-

mining farm production:

$$\underline{GRF} = f\ (\underline{TCAP},\ \underline{LCOST},\ \underline{VCAP},\ \underline{TAREAC})$$

1. <u>Assumptions of the Production Function</u>

    a.   Output, capital, land and labor are all perfectly homogeneous units.

    b.   Capital and labor are fully employed, i.e. there is no slackness in the production process, and all the factors of production are effective in production.

    c.   The most efficient technology is employed, i.e. greatest output is obtained from given factor inputs.

    d.   Other regional characteristics such as agglomeration and spatial dimensions are assumed to be non-existent or unimportant.

These assumptions are very restrictive. While output and capital can usually be evaluated in terms of their real values, farm labor force is usually measured in terms of the number of people available to work. This simple count generally does not adequately measure the actual labor input nor the quality of the labor force (21, p. 59). Cost of hired labor is used in this study to more nearly reflect actual quantity and quality of labor inputs. The following section addresses the problem of using values rather than physical units of output and input.

2. <u>Limitations from Using Values Rather than Physical Quantities</u>. The main difficulty faced in this analysis is the lack of appropriate quantity data for farm output and some of the explanatory input vari-

ables. The use of value rather than quantity data leads to little bias in the results if cross sectional relative price differences are not "too large" (20, p. 420).

For this study, these differences are expected to be small for most of the commodity prices. These differences are expected to be limited to transportation costs which are relatively low within each area included in this study since all farm operators have access to the same local market. Distance to market can be used as a proxy for price differences due to transportation costs and will be tested in the empirical models.

Cost of hired labor is used as a proxy variable for actual labor inputs in the production function. It is felt that this measure more nearly reflects actual quantity of labor and quality of labor inputs. The study areas are relatively small regions with highly competitive labor markets. Family labor inputs are small relative to hired labor and are indirectly accounted for in the hired labor demand function.

Input Demand Functions

In this section demand equations for factor inputs will be presented. The demand functions in question include: (1) farm machinery and equipment, (2) farm facilities, (3) farm hired labor, and (4) farm variable capital.

Farm Machinery and Equipment Demand. It is hypothesized that demand for farm machinery and equipment is a function of hired farm labor, family labor, amount of intermediate-term credit available from the financial sector, and amount of crop land at the producers

disposal. The relationship can be expressed by the following functional form:

MACEQ = F (LCOST, FLAB, INTOB, TAREAC)

Farm Facilities Demand. It is hypothesized that demand for farm facilities is a function of internal investment made out of farm income, amount of intermediate-term credit obtained from the financial sector, and off-farm income. The relationship is expressed by the following functional form:

FACIL = f (NFID, INTOB, NFINC)

Farm Hired Labor Demand. It is hypothesized that farm hired labor demand is a function of the amount of short-term credit available from the financial sector, farm family labor, wage rate, and total crop land cultivated. The relation is expressed by the following functional form:

LCOST = f (SHOB, FLAB, WAGE, TAREAC)

Farm Variable Capital Demand. It is hypothesized that the demand for variable capital is a function of internal investment made out of farm income, short-term credit available from the financial sector, off-farm income, total farm durable capital, and total crop land cultivated. The relationship is expressed by the following functional form:

VCAP = f (NFID, SHOB, NFINC, TCAP, TAREAC)

Loan Delinquency Function

The same functional relationship is hypothesized for loan delinquency in the farm credit interdependent model as hypothesized for

the OLS model discussed previously. However, net farm income is now considered an endogenous variable along with loan delinquency in the following functional form:

DELRATE = f (NFID, AP, FAMEXPC, NFINC, TCRED, TAREAC)

Empirical Results by Means of (2SLS)

It was hypothesized that loan delinquency is directly linked to the production processes of the farm enterprise and the farm operators financial management. This is to be evaluated in a farm credit inter-dependent system by means of two stage least squares. The postulated model is expressed by a system of eight jointly determined equations: six behavioral equations determining input demands, farm production and loan delinquency, and two identity equations determining total durable farm capital and net farm income.

In this section, the estimated equations of the interdependent system will be presented. Results of the 2SLS estimates of the model applied to the Hufuf area will be discussed, followed by the discussion of the results obtained by applying the model to the Kharj area.

Results for the Hufuf Area

Empirical results for the six behavioral equations of the system for the Hufuf area are presented in Table XII.

Machinery and Equipment Demand. The formulation of this model was based upon hypothesized negative relationships with hired farm labor and family labor and positive relationships with intermediate term credit and total crop land cultivated. The results of the 2SLS model estimation tend to bear out these hypothesized relationships.

TABLE XII

ESTIMATED INPUT DEMANDS, PRODUCTION FUNCTION AND DELIQUENCY RATE
EQUATIONS OF THE FARM CREDIT INTERDEPENDENCE SYSTEM (2SLS),
HUFUF AREA, 1978/79

MACEQ = 9.4592 - 1.8068LCOST* - 0.0977FLAB + 1.2615 INTOB***
(0.79)   (0.94)   (0.24)   (0.68)

$+$ 1.1501TAREAC*
(0.68)

R^2 = 0.6312
$F(4, 16)$ = 5.93***

FACIL = -33.1981 + 10.6828NFID*** + 0.6866INTOB*** + 2.0856NFINC***
(30.24)   (0.91)   (0.22)   (0.48)

R^2 = 0.8077
$F(3, 17)$ + 17.23***

LCOST = 39.8984 + 0.0318SHOB - 0.0230FLAB** + 178.2744WAGE**
(11.37)   (0.04)   (0.01)   (70.72)

+ 0.2722TAREAC**
(0.12)

R^2 = 0.6102
$F(4, 16)$ = 5.48***

VCAP = 22.7348 + 9.4892NFID*** - 0.0659TCAP** + 0.2016SHOB***
(9.02)   (1.94)   (0.03)   (0.07)

+ 0.2149NFINC + 0.3101TAREAC**
(0.12)   (0.12)

R^2 = 0.8052
$F(5, 15)$ = 9.01***

GFR = -94.6372 + 0.0276TCAP + 0.7350LCOST** + 2.6361VCAP***
(25.57)   (0.04)   (0.31)   (0.37)

+ 3.3970TAREAC*** - 0.0213TAREAC^2***
(1.07)   (0.01)

R^2 = 0.9186
$F(5, 15)$ = 23.08***

DELRATE = 218.9346 - 30.4354NFID** + 0.5183AP + 1.0745FAMEXPC*
(82.88)   (12.56)   (0.57)   (1.23)

- 2.6722NFINC*** + 1.1681TCRED* - 2.5927TAREAC***
(0.82)   (0.60)   (0.77)

R^2 = 0.6597
$F(6, 14)$ = 3.61**

TABLE XII (Continued)

NOTE: MACEQ = Farm machinery and equipment measured in SR. 1,000.00
    FACIL = Farm facilities measured in SR. 1,000.00
    LCOST = Cost of farm hired labor measured in SR. 1,000.00 per man-day per year.
    VCAP = Farm variable capital measured in SR. 1,000.00
    GFR = Total farm output measured in SR., 1,000.00
    DELRATE = Delinquency rate measured in number of days loan paymens past due
    INTOB = Amount of intermediate term credit from SAAB plus loans obtained from other sources of credit measured in SR. 1,000.00
    TAREAC = Total crop land cultivated measured in dunoms.
    NFID = Net farm income per dunom measured in SR. 1,000.00
    NFINC = Income from off-farm employment and real estate measured in SR. 1,000.00
    SHOB = Amount of short-term credit from SAAB plus loans obtained from other sources of credit measured in SR. 1,000.00
    FLAB = Farm family labor measured in man-days per year.
    VCAP = Total farm variable capital measured in SR. 1,000.00
    WAGE = Wage rate paid to farm hired labor measured in SR. 1,000.00 per man-day
    TCAP = Total farm durable capital items measured in SR. 1,000.00
    TCRED = Timeliness of credit, time lag for processing and approving loans measured in days.
    AP = Size of annual payments in SR. 1,000.00 (0.2 times intermediate-term SAAB loan + 1.0 times short-term SAAB loan + 0.5 times loans obtained from other credit sources

*Significance test at 10 percent probability level
**Significance test at 5 percent probability level
***Significance test at 1 percent probability level

The figures in parentheses beside the F-statistic are degree of freedom of the F-statistics.

The procedures used for computing the corrected standard errors, F and R^2 are presented in Appendix C.

The coefficient for hired farm labor indicates that a SR. 1.00 increase in value of hired labor will decrease investment in farm machinery and equipment an average of SR. 1.81. Similarly, a one dunom increase in total crop land cultivated (TAREAC) will increase the investment in farm machinery and equipment by an average of SR. 1,150. The results are consistent with the hypothesized relationships. Both value of hired labor and total crop land cultivated are significant at the ten percent probability level (Table XII).

The coefficient for the intermediate-term credit (INTOB) indicates that at SR. 1.00 increase in INTOB will increase the investment in farm machinery and equipment by SR. 1.26. The estimated partial coefficient is statistically significant at the 0.01 probability level (Table XII). The corrected R^2 is 0.63 and the F- statistic has a significance level at the one percent probability level.

Farm Facilities Demand. Farm facilities demand (FACIL) specifies hypothesized positive relationships with net farm income per dunom (NFID), intermediate-term credit, and off-farm income (NFINC) (Table XII).

The coefficient for NFID indicates that a SR. 1.00 increase in net farm income per dunom on the average will increase the level of investment in farm facilities by SR. 10.68 (Table XII). The coefficient is significantly different from zero at the one percent probability level.

The coefficient for intermediate-term credit indicates that a SR. 1.00 increase in INTOB will increase investment in facilities by SR. 0.69. The coefficient is significant at the one percent probability level.

The coefficient for off-farm income has a significant coefficient at the one percent probability level. The result indicates that a SR. 1.00 increase in NFINC will increase investment in facilities by SR. 2.09. The result indicates that NFINC is an important source for financing farm facilities (Table XII).

The corrected R^2 is 0.82 and the F-statistic has a significance level at the one percent level.

Hired Farm Labor Demand. The hypothesized relationships are that hired farm labor is positively related to level of short-term credit and total crop land cultivated (TAREAC). LCOST is expected to be negatively related to family labor (FLAB) since as the number of family farm workers increase they substitute for hired labor. An increase in the wage rate (WAGE) would be expected to decrease the demand for hired labor. However, since labor demand is measured in value of labor used, an increase in the wage rate can be interpreted as an increase in cost of labor. The final result is an empirical question to be answered by the data.

The coefficient on SHOB is positive but not significant at the five percent probability level. However, the result indicates that a SR. 1.00 increase in SHOB is associated with an increase in value of labor used by SR. 0.03. This would indicate that SHOB is not an important means for financing hired labor (Table XII).

The coefficient on FLAB confirms the hypothesized negative relationship between CLOST and FLAB and with a coefficient statistically significant at the five percent probability level. The result indicates that an increase of one man-day per year of FLAB will de-

crease the value of hired labor employed by about SR. 23.00.

The coefficient for WAGE variable is positively related to the value of hired labor used and is significant at the five percent probability level. The results indicate that a SR. 10.00 increase in WAGE will increase the value of hired labor employed by SR. 1,783 (Table XII).

The coefficient for total crop land cultivated (TAREAC) indicates that the larger the size of farm, the more labor is needed for crop production and the higher the value of hired labor. A one dunom increase in cultivated crop land increases the value of hired labor by SR.272. The TAREAC coefficient is significant at the five percent probability level.

The corrected R^2 is 0.61 and the F-statistic has a significance level at the one percent level.

Farm Variable Capital Demand. It is hypothesized that the demand for farm variable capital is positively related to net farm income (NFID), short-term credit (SHOB), and off-farm income (NFINC). All of these variables are associated with financing variable capital needs. The coefficient for NFID is very significant at the one percent level of probability. The result indicates that a SR. 1.00 increase in NFID is associated with an increase in variable capital equal to SR. 9.49. The magnitude of the estimated coefficient and the high significance level indicate the apparent importance of NFID in financing farm variable capital (Table XII). The estimated coefficient for SHOB is significant at the one percent probability level. The result indicates that a SR. 1.00 increase in SHOB will increase VCAP by SR. 0.20 (Table XII). Although the NFINC coefficient is positive it is not

significant at the 10 percent probability level.

It is hypothesized that VCAP is negatively related to total farm durable capital (TCAP) which includes farm machinery and equipment plus facilities and thus is a substitute for variable capital. The coefficient for TCAP is negative and significant at the five percent level of probability. The result indicates that a SR. 1.00 increase in the amount of TCAP will decrease the amount of variable capital by SR. 0.07. This implies that the higher the level of investment in farm machinery and equipment and facility, the lower the current farm expenses (Table XII).

The corrected R^2 is 0.805 and the F-statistic has a significance at the one percent probability level.

Production Function. In the estimated production function equation, the result indicates that total farm capital (TCAP) is positively related to the level of farm output measured in terms of value (SR. 1,000). However, the coefficient is not significant. An increase of SR. 1.00 in LCOST will increase the value of output (GRF) by an average of SR. 0.74. This implies that farm operators with enough cash to hire more labor may be able to increase farm production and hence income (Table XII).

The coefficients for cultivated crop land (TAREAC) and its squared term (TAREAC^2) are significant at the one percent and five percent probability level, respectively. The results indicate that a one dunom increase in total cultivated crop land will increase the value of farm outputs by SR. 3.40. However, this increase will be smaller the larger the increment of land added (diminishing return to land) due to the

negative sign of the TAREAC^2 coefficient (Table XII). The corrected R^2 is 0.92 and the F-statistic is significance at the one percent probability level.

Loan Delinquency. Before presenting the results for the 2SLS loan delinquency model, it is worthwhile to recall that the same formulation was used for the OLS model presented earlier. The parameter estimates for both estimation procedures are similar and, in general, conform to a prior expectation.

For the 2SLS model, the coefficient of the net farm income per dunom (NFID) has the expected sign and is significant at the five percent probability level. The association is still strong, although the significance is slightly less than for the OLS model. An increase of SR. 1,000 in NFID will decrease the delinquency rate by an average of 30.44 days. The coefficient is very comparable to that obtained by OLS method discussed previously in the study. The estimated coefficients for NFID are 30.44 and 31.17 using 2SLS and OLS, respectively. For comparison purposes see Tables X and XII.

The relationship between the delinquency rate and farm family living expenditures is as hypothesized. FAMEXPC is positively related to DELRATE. A SR. 1,000 increase in farm family living expenditures will increase DELRATE by about 1.1 days. The FAMEXPC coefficient is significant at the ten percent level of probability. The result implies that FAMEXPC is an important variable affecting the delinquency rate. The FAMEXPC variable should not be ignored when appraising the farm operator borrowers' repayment capacity (Table XII).

The coefficient for off-farm income conforms with the expected

relationship. NFINC is negatively related to DELRATE. The result indicates that a SR. 1,000 increase in NFINC will decrease DELRATE by about 2.67 days. The estimated coefficient is significant at the one percent probability level.

The variable for annual payment (AP) is positively related to DELRATE. However, it is not significant at the ten percent probability level. The result indicates that a SR. 1,000 increase in annual payment is associated with an increase in DELRATE of about 0.52 days. AP as a policy instrument variable should be further scrutinized with the farm operators' income earning potential.

Timeliness of credit, TCRED, is another policy instrument variable. The relationship is consistent with what was expected. The coefficient for TCRED indicates that a one day delay in obtaining credit due to red tape and bureaucratic complications is associated with an increase in DELRATE by about 1.17 days. The TCRED coefficient is significant at the ten percent probability level.

The coefficient for total crop land cultivated (TAREAC) indicates that a one dunom increase in TAREAC will decrease DELRATE by about 2.59 days. The relationship is as expected. The variable is significant at the one percent probability level. The TAREAC variable and its associated coefficient indicates the importance of economies of farm size in increasing the farm operators' income and hence repayment capacity (Table XII).

Results for the Kharj Area

Before discussing the empirical results for the Kharj area, it should be pointed out that the same interdependent model applied to

the Hufuf area was tested on the Kharj area. However, the hypothesized explanatory variables for the input demand functions and the production function did not adequately explain the Kharj farm credit interdependent system. Although most of the hypothesized relationships held true, there were some inconsistencies in signs and a general reduction in statistical significance for the individual coefficients and the overall regression statistics compared to the Hufuf system. Results of that application are presented in Appendix B.

Since the Hufuf area farm credit interdependence model cannot be applied to the Kharj area, an alternative model is developed. The postulated Kharj interdependent system equations are presented below:

Production Function

GFR = f(TCAP, FLAB, VCAP, TAREAC, WEATH)

Input Demand Functions

MACEQ = F (LCOST, FLAB, INTOB)

FACIL = f(NFID, LCOST, NFINC, TAREAC)

LCOST = f(TCAP, WAGE, TAREAC)

VCAP = f(TCAP, SHOB, NFINC, TAREAC)

Identity Equations

NFID = (GFR - VCAP - LCOST) ÷ TAREAC

TCAP = MACEQ + FACIL

Loan Delinquency

DELRATE = f(NFID, AP, FAMEXPC, NFINC, TRED, TAREAC)

where the endogenous and the exogenous variables are as defined in the previous section. The endogenous variables in the system have been underlined.

The pre-estimation identification properties of the models were

examined and the system is found to be overidentified. The above post-
ulated system for the Kharj area is estimated by two stage least
squares (2SLS) discussed previously.

For presenting the results of the estimated models for the Kharj
area, input demand functions will be discussed first, then followed
by the discussion of the production function and the loan delinquency.
The results of these models are presented in Table XIII.

Machinery and Equipment Demand. It is hypothesized that the
level of MACEQ is negatively related to value of hired labor (LCOST)
and farm family labor (FLAB) and positively related with land size
(TAREAC).

The coefficient for LCOST indicates a negative relationship but
the coefficient is not significant. These results do indicate, how-
ever, that FLAB and LCOST may substitute for MACEQ. One day of FLAB
may substitute for SR. 96 of MACEQ and Sr. 1.00 of LCOST may substitute
for SR. 0.38 of MACEQ.

The coefficient for INTOB indicates that there is a positive
relationship between INTOB and the level of MACEQ. The result indi-
cates that a SR. 1.00 increase in INTOB will increase MACEQ by SR.
0.88. The estimated coefficient is significant at the one percent
probability level. This implies that INTOB is an important variable
for the acquisition of farm machinery and equipment. The positive
relationship between MACEQ and INTOB is also consistent with what was
expected (Table XIII).

The R^2 is 0.32 and the F-statistic is not significant at the ten
percent probability level.

TABLE XIII

ESTIMATED INPUT DEMANDS, PRODUCTION FUNCTION AND DELINQUENCY RATE
EQUATIONS OF THE FARM CREDIT INTERDEPENDENCE SYSTEM (2SLS),
KHARJ AREA, 1978/79

MACEQ = 104.4013** - 0.3837LCOST - 0.0962FLAB + 0.8822INTOB***
$\quad$ (47.88) $\qquad$ (0.79) $\qquad$ (0.07) $\qquad$ (0.25)

$$R^2 = 0.3165$$
$$F(3, 17) = 2.97$$

FACIL = -44.4609 + 23.6926NFID** + 3.2275LCOST*** + 0.057NFINC
$\quad$ (28.84) $\quad$ (8.72) $\qquad$ (0.55) $\qquad$ (0.05)

$\quad$ + 1.2332 TAREAC***
$\quad$ (0.33)

$$R^2 = 0.7031$$
$$F(4, 16) + 7.80***$$

LCOST = -24.9821* + 0.0882TCAP** + 785.8267WAGE*** + 0.4535TAREAC***
$\quad$ (14.37) $\quad$ (0.03) $\qquad$ (224.43) $\qquad$ (0.09)

$$R^2 = 0.7219$$
$$F(3, 17) = 11.36***$$

VCAP = -13.7368 + 0.0408TCAP + 0.2588 SHOB*** + 0.0303NFINC
$\quad$ (13.74) $\quad$ (0.04) $\quad$ (0.07) $\qquad$ (0.02)

$\quad$ + 0.8037TAREAC***
$\quad$ (0.13)

$$R^2 = 0.8305$$
$$F(4, 16) = 16.64***$$

GFR = 45.4738** + 0.0766TCAP - 0.0625FLAB*** + 0.5388VCAP**
$\quad$ (20.22) $\quad$ (0.07) $\qquad$ (0.02) $\qquad$ (0.41)

$\quad$ + 1.9016TAREAC*** - 0.00013TAREAC^2 - 100.4501WEATH**
$\quad$ (0.18) $\qquad$ (0.002) $\qquad$ ( )

$$R^2 = 0.9171$$
$$F(6, 14) = 30.41***$$

DELRATE = 219.6408*** - 61.0628NFID*** - 0.4847AP + 0.5879 FAMEXPC***
$\quad$ (51.22) $\qquad$ (13.55) $\qquad$ (0.41) $\quad$ (0.18)

$\quad$ - 0.176NFINC** + 0.1352TCRED** - 1.2729TAREAC**
$\quad$ (0.08) $\qquad$ (0.06) $\qquad$ (0.51)

$$R^2 = 0.7350$$
$$F(6, 14) = 6.05***$$

TABLE XIII (Continued)

NOTE: MACEQ = Farm machinery and equipment measured in SR. 1,000.00

FACIL = Farm facilities measured in SR. 1,000.00

LCOST = Cost of farm hired labor measured in SR., 1,000.00 per man-day per year

VCAP = Farm variable capital measured in SR. 1,000.00

GFR = Total farm output measured in SR. 1,000.00

DELRATE = Delinquency rate measured in number of days loan payments past due

INTOB = Amount of intermediate-term credit from SAAB plus loans detained from other sources of credit

TAREAC = Total crop land cultivated measured in dunom.

NFID = Net farm income per dunom measured in SR. 1,000.00

NFINC = Income from off-farm employment and real estate measured in SR. 1,000.00

SHOB = Amount of short-term credit from SAAB plus loans obtained from other sources of credit measured in SR. 1,000.00

FLAB = Farm family labor measured in man-days per year

VCAP = Total farm variable capital measured in SR. 1,000.00

WAGE = Wage rate paid to farm hired labor measured in SR. 1,000.00 per man-day

TCAP = Total farm durable capital items measured in SR. 1,000.00

TCRED = Timeliness of credit, time lay for processing and approving loans measured in days

WEATH = Percentage of value of crops loss due to adverse weather conditions such as damage to crops from frost

AP = Size of annual payments in SR. 1,000.00 (0.2 times intermediate-term SAAB loans + 1.0 times short-term SAAB loan + 0.5 times loans obtained from other credit sources

*Significance test at 10 percent probability level
**Significance test at 5 percent probability level
***Significance test at 1 percent probability level

Corrected standard errors of the coefficients in parenthesis.[1]

The figures in parenthesis beside the F-statistic are degree of freedom of the F-statistics

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[1]The procedures used for computing the corrected standard errors, F and R^2 are presented in Appendix C.

Farm Facilities Demand. It is hypothesized that the level of farm facilities is positively related to the level of NFID, LCOST, NFINC, and TAREAC. The results of the estimated coefficients are consistent with the hypothesized relationships.

The coefficient of NFID has the expected positive sign and is significant at the five percent probability level. The results indicate that a SR. 1.00 increase in NFID will increase value of FACIL by about SR. 23.69 (Table XIII).

The coefficient for LCOST is positive and highly significant at the one percent probability level. A SR. 1.00 increase in LCOST will increase the value of FACIL by SR. 3.23. The result indicates that farm facilities and hired labor are complements. Hired labor is important for building farm facilities such as irrigation systems and other facilities that cannot be built by machinery power (Table XIII).

The coefficient for NFINC indicates the hypothesized positive relationship with FACIL. The coefficient is not significant at the ten percent probability level. However, the result indicates that income generated from off-farm sources is having some impact in financing farm facilities (Table XIII).

The coefficient for TAREAC indicates that a one dunom increase in TAREAC will increase FACIL by about SR. 1.233. The coefficient is significant at the one percent probability level. Farmers who operate large units need more facilities for irrigating additional cultivable land and storage facilities to store their farm products before transporting them to the market (Table XIII).

The corrected R^2 is 0.70 and the F-statistic is significant at the one percent probability level.

Hired Farm Labor Demand. The coefficient for TCAP indicates the unexpected positive relationship between TCAP and LCOST. It is significant at the five percent probability level. The result indicates that a SR. 1.00 increase in TCAP is associated with an increase of SR. 0.09 in LCOST. The positive relationship is probably due to the strong association between LCOST and the level of FACIL since TCAP is the sum of MACEQ and FACIL (Table XIII).

The coefficient of WAGE has a positive sign and is consistent with the result for Hufuf. A SR. 10.00 increase in WAGE will increase LCOST by about SR. 7.859. The coefficient is highly significant at the one percent level.

The coefficient of TAREAC has the expected sign and indicates a strong positive association between TAREAC and the amount of LCOST. It is significant at the one percent probability level. This implies that the larger the size of farm the more labor the farm operators employ (Table XIII).

The corrected R^2 is 0.72 and the F-statistic is significant at the one percent probability level.

Farm Variable Capital Demand. The coefficient for TCAP indicates a complementary relationship with VCAP. The result indicates that a SR. 1.00 increase in TCAP is associated with a SR. 0.04 increase in VCAP. However, the coefficient is not significant at the ten percent probability level (Table XIII).

The estimated coefficient for SHOB indicates a positive relationship with VCAP and is highly significant at the one percent probability level. The result indicates that SHOB is a very important external means for financing variable capital (Table XIII).

The coefficient of TAREAC is another important variable in explaining the variation in VCAP. The result indicates a positive association between VCAP and TAREAC and a coefficient that is statistically different from zero at the one percent probability level. A one dunom increase in TAREAC is associated with a SR. 8.04 increase in VCAP (Table XIV). The corrected R^2 is 0.83 and the F-statistic is significant at the one percent probability level.

Production Function. In the production function equation, the coefficient for TCAP has the expected positive sign. It is not significant, however, at the ten percent probability level. The result indicates that as TCAP increases by SR. 1.00, GFR will increase by about SR. 0.08. This shows that TCAP has no statistical effect on the level of GFR (Table XIII).

The coefficient for VCAP has the expected sign and is significant at the five percent probability level. The result indicates that a SR. 1.00 increase in VCAP is associated with a SR. 0.54 increase in GFR. Again, the significance of the estimated coefficient indicates the importance of variable capital in the farm production process (Table XIII).

FLAB is a highly statistically significant coefficient in the KHARJ production function. However, the negative sign of the coefficient is contrary to expectations. One plausible explanation is that farms with more family labor tend to represent subsistence farming emphasizing low value food crops relative to higher value cash crops.

The coefficient of TAREAC has the expected sign and is significant at the one percent probability level. The result indicates that

the size of farm is important for increasing farm income (Table XIII).

The weather variable (WEATH) is defined as the percentage of crop loss due to adverse weather conditions such as damage to crops from frost. The coefficient is negatively associated with the level of farm output and is significant at the five percent probability level. A ten percent estimated loss of crops due to adverse weather conditions is associated with a loss of SR. 10.05 in gross farm receipts.

The corrected R^2 is 0.92 and the F-statistic is significant at the one percent probability level.

Loan Delinquency. The relationship between loan delinquency and the hypothesized associated variables generally conform to prior ex-pectations with the exception of the annual payment (AP) variable. The negative sign is not expected but the coefficient is not statis-tically different from zero at the 20 percent probability level.

The most important variable explaining loan delinquency rate is the NFID variable. The NFID coefficient is negative and highly sig-nificant at the one percent probability level. The relationship in-dicates that as NFID increases by SR. 1,000, DELRATE will decrease by about 61.06 days (Table XIII).

The coefficient for FAMEXPC indicates a positive relationship with DELRATE and is highly significant at the one percent probability level. The result indicates that an increase of SR. 1,000 in farm family living expenditures is associated with an increase in DELRATE by about 0.59 days (Table XIII).

Off-farm income (NFINC) is negatively associated with DELRATE. The coefficient is significant at the five percent probability level.

The result indicates that farm operator borrowers may use part of their off-farm income to repay their loans (Table XIII).

The coefficient for timeliness of credit (TCRED) shows a positive relationship with DELRATE. The coefficient is significant at the five percent probability level. The result indicates that the importance of TCRED in influencing DELRATE cannot be ignored. Because each working day the farm operator spends off his farm may affect the level of farm production. The result indicates that a one day delay in obtaining credit will increase loan delinquency by about 0.14 days (Table XIII).

Total crop land cultivated, TAREAC, is negatively associated with DELRATE. The TAREAC coefficient is significant at the five percent probability level. The result indicates that as TAREAC increases by one dunom, DELRATE will decrease by about 1.3 days. The negative relationship also indicates the importance of economies of farm size in decreasing DELRATE (Table XIII).

The corrected R^2 is 0.74 and the F-statistic is significant at the one percent probability level.

Before concluding the analysis of the farm credit interdependence system as estimated by means of 2SLS, it is important to indicate that the parameter estimates (Tables XII and XIII) in general conform to a priori expectations. Not all of the estimated coefficient are statistically acceptable relative to their standard error. Further, some of the demand equations, especially for the Kharj area, have few significant coefficients but very significant F-statistics and high corrected R^2. This may indicate that multicollinearity is still present.

Multicollinearity is a phenomenon in which one column of the data

is highly correlated with another column or a linear combination of several columns of data. This would render the matrix $(x'x)$ very small (where x is the observation matrix), and hence the inverse $(x'x)^{-1}$ very large. Since the t-statistics are directly proportional to the estimated coefficients and inversely proportional to the matrix $(x'x)^{-1}$, the t-statistics will be exceptionally small.[2]

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[2] Intrilligator, Econometric models, Techniques and Applications, pp. 151-156.

CHAPTER VII

FURTHER ANALYSIS OF LOAN DELINQUENCY

Farm and farmer characteristics from a sample of SAAB delinquent and non-delinquent operator borrowers were analyzed by tabular means in Chapter V. A simultaneous equation (2SLS) approach was also used to analyze loan delinquency within a farm credit interdependent system. The empirical results and their economic implications were presented in Chapter VI. To provide further insights about loan delinquency and to provide for policy implications, a more complete analysis pertaining to the SAAB operator borrowers' characteristics is needed. To meet this objective, the reduced form of the estimated farm credit interdependent system developed in Chapter IV together with a discriminant analysis classifying operator borrowers are presented.

The reduced form of the estimated farm credit interdependent system is useful for determining the direct and indirect impact of the exogenous variables upon the endogenous variables. In other words, the reduced form indicates the unit change expected in an endogenous variable for a one-unit increase in the exogenous variable.

Discriminant analysis is also applied to derive a linear combination of delinquent and non-delinquent farm operator borrowers who obtained crop production loans from SAAB. The discriminant analysis will provide a method to determine credit quality and the farm operator borrowers' credit worthiness given their financial, social, and

129

farm resource characteristics.

Reduced Form of the Farm Credit
Interdependent System

The reduced form to be presented in this section is developed using the structural coefficients estimated by the means of 2SLS in the farm credit interdependent system. The reduced form of the model is computed by reordering the structural models, isolating the endogenous variables from the constants and the exogenous variables and solving the system simultaneously for the endogenous variables in terms of the exogenous variables and constants.

Reduced Form Model

The reduced form model can be expressed symbolically as:

$$AW = C + BX$$

where A = matrix of the endogenous variable coefficients

W = column vector of the endogenous variables

C = column vector of constant terms

B = matrix of the exogenous variable coefficients

X = column vector of exogenous variables

To express W as a function of the remaining variables, the A matrix is inverted, and then postmultiplied by the corresponding matrices:

$$(A)^{-1} (A) W = (A)^{-1} C + (A)^{-1} BX$$

This matrix equation reduces to:

$$W = (A)^{-1} C + (A)^{-1} BX$$

In drawing implications from the empirical results obtained from

the reduced form of the farm credit interdependent system, data from the Hufuf and Kharj areas will be presented and analyzed. The analysis will parallel the dichotomy of economic understanding on the one hand and direct policy information on the other.

The impact multipliers provide a basis for determining the expected direct and indirect impact on the endogenous variable from a one-unit increase in the exogenous variable (i.e. , $\frac{\Delta W}{\Delta X} = A^{-1} B$). This provides insight into the important economic factors affecting the farm operator borrower's financial and farm management decisions, and hence, the delinquency problem.

Because net farm income per dunom (NFID) enters the reduced form in a non-linear fashion, the interdependent system model for both the Hufuf and the Kharj areas are developed by fixing the amount of cropland cultivated at three levels: the mean value, a high value, and a low value. The effects of farm size are, thus, entered in the analysis in this fashion. The reduced form models for the Hufuf and the Kharj areas are presented in Appendix B.

Empirical Results of the Reduced Form

Results of the impact multipliers are presented in Tables XIV through XIX. These results are in terms of the impacts on the endogenous variables listed to the left of the table for a one-unit change in the exogenous variables listed across the top of the table. For example, a SR. 1.0 change in short-term credit from SAAB (SACRED) is associated directly and indirectly with a SR. 0.8771 change in gross farm receipts (GFR) for farm operator borrowers in the Hufuf area with land holdings at the mean level of 39.07 dunoms (Table XIV).

TABLE XIV

IMPACT MULTIPLIERS FROM THE REDUCED FORM OF THE FARM CREDIT INTERDEPENDENT SYSTEM,
WITH LAND FIXED AT THE MEAN VALUE (TAREAC = 39.07 DUNOMS),
HUFUF AREA, 1978/79

Endogenous Variables	Units	Exogenous Variables									Constant Terms
		SHCRED SR. (1000)	INTCRED SR. (1000)	OBOR SR. (1000)	AP SR. (1000)	TCRED (days)	FLAB (days)	FAMEXPC SR. (1000)	NFINC SR. (1000)	WAGE SR. (1000)	
GFR	SR. (1000)	0.8771	-0.4349	0.4422	0	0	0.0015	0	0.4393	157.5259	104.0359
NFI	SR. (1000)	0.5223	-0.2502	0.2720	0	0	0.0170	0	0.2954	-34.2697	16.0966
TCAP	SR. (1000)	0.0851	1.8797	1.9648	0	0	-0.0515	0	2.1664	-331.4934	20.5612
MACEQ	SR. (1000)	-0.0567	1.2615	1.2039	0	0	-0.0561	0	0	-322.1240	49.3584
FACIL	SR. (1000)	0.1428	0.6182	0.7610	0	0	0.0046	0	2.1664	-9.3693	-28.7973
LCOST	SR. (1000)	0.0319	0	0.0319	0	0	-0.0230	0	0	178.2744	50.5336
VCAP	SR. (1000)	0.3229	-0.1847	0.1383	0	0	0.0075	0	0.1440	13.5213	37.4057
DELRATE	(days)	-0.4068	0.1949	-0.2119	0.5184	1.1682	-0.0132	1.9745	-2.9023	26.6927	105.0965

TABLE XV

IMPACT MULTIPLIERS FROM THE REDUCED FORM OF THE FARM CREDIT INTERDEPENDENT SYSTEM
WITH LAND FIXED AT THE HIGHEST VALUE (TAREAC = 167.00 DUNOMS),
HUFUF AREA, 1978/79

Endogenous Variables	Units	Exogenous Variables									Constant Terms
		SCHRED SR. (1000)	INTCRED SR. (1000)	OBOR SR. (1000)	AP SR. (1000)	TCRED (days)	FLAB (days)	FAMEXPC SR. (1000)	NFINC SR. (1000)	WAGE SR. (1000)	
GFR	SR. (1000)	0.6398	-0.3087	0.3311	0	0	-0.0071	0	0.2904	174.8065	398.0676
NFI	SR. (1000)	0.3737	-0.1713	0.2024	0	0	0.0116	0	0.2022	-23.4621	232.7935
TCAP	SR. (1000)	-0.0337	1.9371	1.9034	0	0	-0.0554	0	2.0986	-323.6256	119.0073
MACEQ	SR. (1000)	-0.0576	1.2615	1.2039	0	0	-0.0561	0	0	-322.1240	137.3066
FACIL	SR. (1000)	0.0139	0.6756	0.696	0	0	0.0007	0	2.0986	-1.5016	-18.2993
LCOST	SR. (1000)	0.0319	0	0.0319	0	0	-0.0230	0	0	178.2744	85.3558
VCAP	SR. (1000)	0.2341	-0.1574	0.0968	0	0	0.0043	0	0.0883	19.9943	179.9183
DELRATE	SR. (days)	-0.0681	0.1312	-0.0369	0.5134	1.1682	-0.0021	1.9745	-2.7091	4.2771	171.6080

133

TABLE XVI

IMPACT MULTIPLIERS FROM THE REDUCED FORM OF THE FARM CREDIT INTERDEPENDENT SYSTEM WITH LAND FIXED AT THE LOWEST VALUE (TAREAC = 6.00 DUNOMS), HUFUF AREA, 1978/79

Endogenous Variables	Units	Exogenous Variables									Constant Terms
		SCHRED SR. (1000)	INTCRED SR. (1000)	OBOR SR. (1000)	AP SR. (1000)	TCRED (days)	FLAB (days)	FAMEXPC SR. (1000)	NFINC SR. (1000)	WAGE SR. (1000)	
GFR	SR. (1000)	-0.3189	0.1382	-0.1808	0	0	-0.0374	0	-0.2370	236.0056	143.7395
NFI	SR. (1000)	-0.2258	0.1082	-0.1176	0	0	-0.0073	0	-0.1277	14.8130	31.3160
TCAP	SR. (1000)	-0.4596	2.1407	1.6811	0	0	-0.0692	0	1.8584	-295.7494	49.0565
MACEQ	SR. (1000)	-0.0576	1.2615	1.2039	0	0	-0.0561	0	0	-322.1240	26.4965
FACIL	SR. (1000)	-0.4028	0.8792	0.4778	0	0	-0.0131	0	1.8584	26.3746	22.5600
LCOST	SR. (1000)	0.0319	0	0.0319	0	0	-0.0230	0	0	178.2744	41.5316
VCAP	SR. (1000)	-0.1251	0.0300	-0.0951	0	0	-0.0070	0	1.9745	42.9182	70.8919
DELRATE	SR. (days)	1.1451	-0.5487	0.5965	0.5184	1.1682	0.0372	1.9745	-2.0246	-75.1406	44.5249

TABLE XVII

IMPACT MULTIPLIERS FROM THE REDUCED FORM OF THE FARM CREDIT INTERDEPENDENT SYSTEM WITH LAND FIXED AT THE MEAN VALUE (TAREAC = 48.36 DUNOMS), KHARJ AREA, 1978/79

Endogenous Variables	Units	Exogenous Variables SHCRED SR. (1000)	INTCRED SR. (1000)	OBOR SR. (1000)	AP SR. (1000)	TCRED (days)	FLAP (days)	FAMEXPC SR. (1000)	NFINC SR. (1000)	WAGE SR. (1000)	WEATH (%)	Constant Terms
GFR	SR. (1000)	0.1319	0.2457	0.1138	0	0	-0.0789	0	0.0226	238.6767	-98.3437	147.9488
NFI	SR. (1000)	-0.1170	-0.1522	-0.0351	0	0	-0.0575	0	-0.0159	-859.5025	-103.0175	129.3867
TCAP	SR. (1000)	-0.0765	1.0781	1.1546	0	0	-0.1660	0	0.0639	2521.0119	-14.1633	96.5931
MACEQ	SR. (1000)	0.0026	0.8457	0.8431	0	0	-0.0906	0	-0.0022	-383.4682	0.4793	99.9618
FACIL	SR. (1000)	-0.0791	0.2323	0.3115	0	0	-0.0754	0	0.0661	2804.4801	-14.6426	-3.3687
LCOST	SR. (1000)	-0.0067	0.0951	0.1018	0	0	-0.0146	0	0.0056	999.3960	-1.2492	11.5703
VCAP	SR. (1000)	0.2557	0.3028	0.0471	0	0	-0.0068	0	0.0329	98.7773	5.9229	6.9918
DELRATE	(days)	0.1478	0.1921	0.0443	-0.4847	0.1352	0.0725	0.5879	-0.1560	1085.2936	27.3511	-321.4600

TABLE XVIII

IMPACT MULTIPLIERS FROM THE REDUCED FORM OF THE FARM CREDIT INTERDEPENDENT SYSTEM
WITH LAND FIXED AT THE HIGHEST VALUE (TAREAC = 230.00 DUNOMS),
KHARJ AREA, 1978/79

Endogenous Variables	Units	Exogenous Variables										Constant Terms
		SHCRED SR. (1000)	INTCRED SR. (1000)	OBOR SR. (1000)	AP SR. (1000)	TCRED (days)	FLAB (days)	FAMEXPC SR. (1000)	NFINC SR. (1000)	WAGE SR. (1000)	WEATHER (%)	
GFR	SR. (1000)	0.1378	0.2534	0.1156	0	0	-0.0759	0	0.0234	282.2471	-103.4862	609.7974
NFI	SR. (1000)	0.1189	-0.1545	-0.0357	0	0	-0.0584	0	-0.0162	-872.9477	-101.4308	331.9508
TCAP	SR. (1000)	-0.0163	1.1563	1.1727	0	0	-0.1364	0	0.0721	2863.0393	-66.3274	924.0376
MACH	SR. (1000)	0.0006	0.8431	0.8425	0	0	-0.0916	0	-0.0024	-398.4275	2.2447	42.6935
FACIL	SR. (1000)	-0.0169	0.3132	0.3301	0	0	-0.0448	0	0.0746	3261.4668	-68.5721	881.3441
LCOST	SR. (1000)	-0.0014	0.1020	0.1034	0	0	-0.0120	0	0.0064	1038.3828	-5.8501	160.8230
VCAP	SR. (1000)	0.2581	0.3060	0.0478	0	0	-0.0056	0	0.6332	116.8120	3.7946	117.0236
DELRATE	(days)	0.0316	0.0410	0.095	-0.4847	0.1352	0.0155	0.5879	-0.1718	231.7676	128.0767	-161.2591

TABLE XIX

IMPACT MULTIPLIERS FROM THE REDUCED FORM OF THE FARM CREDIT INTERDEPENDENT SYSTEM WITH LAND FIXED AT THE LOWEST VALUE (TAREAC = 9.00 DUNOMS), KHARJ AREA, 1978/79

Endogenous Variables	Units	Exogenous Variables										
		SCHRED SR. (1000)	INTCRED SR. (1000)	OBOR SR. (1000)	AP SR. (1000)	TCRED (days)	FLAB (days)	FAMEXPC SR. (1000)	NFINC SR. (1000)	WAGE SR. (1000)	WEATHER (%)	Constant Terms
GFR	SR. (1000)	0.1021	0.2070	0.1049	0	0	-0.0935	0	0.0186	19.7407	92.4069	92.4069
NFI	SR. (1000)	-0.1078	-0.1402	-0.1324	0	0	-0.0529	0	-0.0147	-791.9535	80.4376	80.4376
TCAP	SR. (1000)	-0.3739	0.6849	1.0639	0	0	-0.3144	0	0.0228	200.2447	416.8253	416.8253
MACH	SR. (1000)	0.0128	0.8590	0.8462	0	0	-0.0856	0	-0.0008	-303.3123	98.3145	98.3145
FACIL	SR. (1000)	-0.3917	-0.1714	0.2177	0	0	-0.2289	0	0.0236	508.5569	318.5108	318.5108
LCOST	SR. (1000)	-0.0334	0.0604	0.0938	0	0	-0.0277	0	0.0020	803.5243	15.8634	15.8634
VCAP	SR. (1000)	0.2433	0.2867	0.0434	0	0	-0.0128	0	0.0312	8.1700	-3.8941	-3.8941
DELRATE	(days)	0.7316	0.9502	0.2196	-0.4847	0.1352	0.3592	0.5879	-0.0766	5373.2463	-337.5683	-337.5683

For the analysis which follows, credit obtained and used for farm production by the farm operator borrowers is separated in two categories: intermediate-term credit (INTCRED) and short-term credit obtained from SAAB, and credit from other sources (OBOR). The objective of separating credit by source and purpose is to determine the policy impact of each type of credit on the factor inputs acquired and hence on the value of all endogenous variables.

Hufuf

Results of the impact multipliers for the Hufuf area are presented in Tables XIV through XVI.

SAAB Short-term Credit. The short-term SAAB credit (SHORED) as was indicated earlier in the study is obtained by the farm operator for the purpose of financing farm variable capital and hired labor. In the input demand functions for hired labor cost (LCOST) and variable capital (VCAP), short-term SAAB credit was combined with the amount of credit borrowed from other sources (OBOR). The amount of SHORED and OBOR combined were designated as SHOB. The SHOB in the input demand functions for LCOST and VCAP were positively associated with the level of hired labor cost and variable control. The variable SHOB was significant in explaining the variation in VCAP but was not significant in the LCOST model.

Based on the results of the reduced form with land holdings at the mean value, the direct and indirect impact of SHORED on LCOST and VCAP is positive. Accordingly, its impact on GFR and NFI is also positive. The direct and indirect impact of SHORED on DELRATE is

negative and hence consistent since the SHORED impact on NFI is positive.

In terms of the magnitude of the impact multipliers, a SR. 1,000 change in SHORED is associated directly and indirectly with a SR. 877.1 change in GFR.

The magnitudes and direction of the impact multipliers changed somewhat due to decreasing or increasing farm size. The most interesting result is that the SHORED impact on the endogenous variables is highest with land holdings at the mean value. Changes of the direct and indirect multipliers in terms of magnitudes and direction can be determined from Tables XIV and XVI.

SAAB Intermediate-term Credit. Intermediate-term credit from SAAB (INTCRED) was obtained by the farm operators for the purposes of financing and acquiring farm capital items such as machinery and equipment (MACEQ) and facilities (FACIL). The INTCRED was combined with credit from other sources as an explanatory variable in the MACEQ and the FACIL demand functions. The INTOB was positively associated with the level of MACEQ and FACIL and significantly different from zero at the one percent probability level in the input demand functions.

However, the results of the reduced form indicate that the direct and indirect impact multipliers of INTCRED, excluding credit obtained from other sources, has positive impacts on MACEQ and FACIL of SR. 1.2615 and SR. 0.6182 respectively. But its impact on GFR and NFI is negative and hence positive on DELRATE. The positive and negative impacts of INTCRED on capital items and gross farm receipts can

possibly be explained in the following manner. Total capital items
(TCAP) which is the sum of MACEQ and FACIL used as an explanatory
variable in the production function, GFR, was not significant at the
10 percent probability level although the association was positive.
This result may indicate over-capitalization of the farm operation
due to over-extending intermediate-term credit from SAAB and other
sources to the operator borrowers in the study. Therefore, the
negative direct and indirect impacts of the INTCRED on GFR and NFI
and hence positive impact on DELRATE are logical and consistent with
the previous results indicated above.

When the land holdings increase from the mean to the higher value,
it indicates that the larger the farm size the less impact INTCRED
has on most of the endogenous variables (Tables XIV and XV).

Other Borrowings (OBOR). The OBOR impact multipliers with land
holdings fixed at the mean value are the largest for TCAP and GFR
(excluding MACEQ and FACIL which sum to TCAP). A SR. 1,000 change in
OBOR is associated with SR. 1,1965 and SR. 442 changes in TCAP and
GFR, respectively. In the proceeding section, the combined effect
of INTCRED plus OBOR (INTOB) in the TCAP demand function was positive.
However, TCAP was not important in explaining the variation in the
production function model. Therefore, since the direct and indirect
impact of INTCRED on GFR was negative but that of OBOR is positive,
this may indicate that the positive association of TCAP with GFR in
the production function was due mainly to the effect of OBOR on
financing TCAP.

One interesting result is that the direct and indirect impact

multiplier of OBOR on DELRATE is negative. The result indicates that a SR. 1,000 change in OBOR is associated with a -0.2119 day change in DELRATE. This negative impact of OBOR on DELRATE can perhaps be explained in that operator borrowers may repay their loans to SAAB in part from funds obtained from other sources of credit in cases of low farm income.

Annual Payment (AP). In the estimated DELRATE models using both OLS and 2SLS, AP was positively associated with the DELRATE for the Hufuf area indicating that the higher the level of AP, the higher the delinquency. It was significant at the 10 percent probability level.

The results of the reduced form indicates that the direct and indirect impact of AP on DELRATE is still positive and comparable in terms of magnitude with the partial regression coefficient in the OLS DELRATE model. However, the results show that AP has no effect on other endogenous variables in the reduced form model.

The significance level and positive association of AP with DELRATE indicate the potential importance of AP in determining DELRATE and that AP should be closely linked with the income generating potential of the farm operations.

Timeliness of Credit (TCRED). The TCRED direct and indirect impact multiplier indicates no effect on the endogenous variables in the present model except for DELRATE. For a one day change in TCRED, DELRATE will change by about 1.17 days (Table XIV). In the DELRATE regression models, TCRED is positively associated with the number of days payments were past due. However, the coefficients were not significantly different from zero at the 10 percent probability level.

The effect of TCRED on DELRATE should not be ignored, however, when processing and evaluating the borrowers' loan applications since there is some effect on DELRATE. To minimize any impact of TCRED upon DELRATE, SAAB may need to improve its operational efficiency in processing and approval of loans.

Family Labor (FLAB). Farm family labor measured in terms of man days has a positive direct and indirect impact upon GFR and NFI. A one day change in FLAB is associated directly and indirectly with SR. 1.5 and SR. 17 changes in gross farm receipts (GFR) and net farm income (NFI), respectively, when land holdings are held at the mean level of 39.07 (Table XIV).

FLAB was deleted from the GFR production function because of very low level of significance. However, the positive direct and indirect impact upon GFR and NFI may be due to substitution effects between hired labor and family labor in the farm production process.

FLAB direct and indirect impact upon MACEQ is negative whereas the impact is positive for FACIL. A one man-day change in FLAB is associated directly and indirectly with a SR. -56.1 and SR. 4.6 change in MACEQ and FACIL, respectively. The FLAB negative impact upon MACEQ indicates the substitution between family labor and the level of investment in machinery and equipment. The positive impact of FLAB upon FACIL indicates a complementary relationship in that operator borrowers may employ family labor for improving and/or constructing irrigation systems and facilities for storing farm products.

The FLAB multiplier indicates that a one man-day change in FLAB is associated with a SR. 23 change in hired labor costs (LCOST). The negative multiplier indicates the substitution effect between hired

and family labor. Operator borrowers with a large number of family members working on the farm may save labor costs by utilizing farm family labor for agricultural production and increase income by labor cost savings. FLAB also has a negative impact on DELRATE which is mainly the result of higher net farm income due to labor cost savings. A one man-day change in FLAB is associated with a -0.0132 day change in DELRATE.

The impacts of FLAB on the endogenous variables in the model at the lowest and the highest levels of land holdings are presented in Tables XV and XVI. In general, the results indicate that the larger the size of farm, the less effect the FLAB has in increasing the value of farm output due to substituting machinery for labor.

Family Expenditures Plus Home Produced and Consumed (FAMEXPC)

The results of the direct and indirect impact multipliers of FAMEXPC indicate that a SR. 1,000 change in FAMEXPC is associated with a positive change of 1.98 days in DELRATE (Table XIV).

It was indicated previously in this study that FAMEXPC is positively related to DELRATE and the partial regression coefficient is significantly different from zero at the 10 percent probability level. The magnitude of the FAMEXPC partial regression coefficient and the impact multiplier indicate the importance of FAMEXPC in determining delinquency rate. Therefore, family living expenditures and home produced and consumed farm output should be accounted for when evaluating operator borrowers' repayment capacities. SAAB may have to consider providing operator borrowers with consumption credit when it is necessary to help in minimizing the delinquency problem.

The change of the effect of FAMEXPC on the endogenous variables in the model at the lowest and the highest levels of land holdings as compared with the effect when land holdings are fixed at the mean is presented in Tables XV and XVI.

Non-Farm Income (NFINC). The NFINC has its greatest positive impact on FACIL. The result indicates that a SR. 1,000 change in NFINC is associated with a change of SR. 2,166 in FACIL with land holdings fixed at the mean value.

It was indicated previously that the average NFINC in the Hufuf area is SR. 38,719 (Table VI). Furthermore, the NFINC variable in the FACIL demand equation is positively related to FACIL and its partial regression coefficient is significantly different from zero at the one percent probability level. Recall that FACIL and MACEQ were combined and entered the production function as one variable (TCAP). The combined effect, however, was not significant in explaining the variation in GFR. But the results of the impact multipliers indicate that the effects of NFINC on GFR and NFI are positive and hence its effect on DELRATE is negative.

The positive effect of NFINC on NFI is due in part to its positive contribution in financing farm facilities and, hence, indirectly influences the level of GFR.

The negative direct and indirect impact of NFINC on DELRATE is due to the indirect affect of NFINC on NFI and hence on DELRATE and the direct effect of NFINC on DELRATE as a source of SAAB loan repayment.

The results of the NFINC direct and indirect impact multipliers

with land holdings at the highest and lowest levels are presented in Tables XV and XVI. The results indicate the competitive relationship between farm and non-farm income at the low land holdings level whereas this relationship may eventually change to complementary with land holdings approaching the mean level. Similarly, the complementary relationship decreases in terms of magnitude as the size of land holdings moves upward above the mean level.

Based on these results, it may be stated that non-farm employment may subsidize the farm operation up to certain limits. But as the size of farm increases, operator borrowers devote more time to manage their farms in order to increase farm output. Failing to allocate sufficient time for management, farm production is likely to decrease at the expense of non-farm employment.

Therefore, to minimize operator borrowers dependence on non-farm employment, farm productivity should be improved by providing adequate and effective credit with highly coordinated technical assistance oriented toward better financial and farm management skills.

Kharj

Results of the direct and indirect impact multipliers for the Kharj area are presented in Tables XVII through XIX.

Short-term Credit (SHCRED). With land holdings fixed at the mean value, the results indicate that SHCRED has positive and negative direct and indirect impacts on GFR and NFI, respectively. A SR. 1,000 change in SHCRED is associated with SR. 131.9 and SR. -117.0 changes in GFR and NFI, respectively (Table XVII). The negative impact of

SHCRED is due mainly to over financing of the hired labor costs by SHCRED which has a negative effect on NFI.

The results also indicate that SHCRED has a positive effect on DELRATE. A SR. 1,000 change in SHCRED is associated with 0.15 days change in DELRATE. The positive effect on DELRATE may be attributed in part to the negative effect of SHCRED on NFI since NFI is negatively associated with DELRATE, and possibly to misuse of SHCRED. The term misused refers to using SHCRED for consumption rather than farm production purposes.

Changes in the impact multipliers due to varying land holdings can be noted in Tables XVIII and XIX.

Intermediate-term Credit (INTCRED). In the input demand functions for MACEQ and FACIL, INTOB which is the sum of INTCRED plus OBOR, was positively associated with the level of investment in farm machinery and equipment and facilities. The partial regression coefficient was statistically significant at the one percent probability level (Table XIII). Furthermore, the results of the production function indicated the positive association between GFR and TCAP, but was not significant at the 10 percent probability level. Based on the regression results outlined above, the negative direct and indirect effect of INTCRED in NFI is not surprising. MACEQ and FACIL may be adding more to the costs of production than to gross receipts.

The direct and indirect impact of INTCRED on the remaining endogenous variables in the models at different levels of land holdings can be detected by comparing the INTCRED columns in Tables XVII through XIX. In general, the magnitude of the impact multipliers of

of INTCRED increase with increasing land holdings with the exceptions of the multipliers associated with NFI and DELRATE.

Other Borrowing (OBOR). Farm operator borrowers obtain additional funds from other sources of credit mainly for two purposes: financing factors of farm production, and to meet family requirements. The OBOR joint effect with SHCRED and INTCRED on factors of production was discussed in the previous sections in this study.

However, the direct and indirect impact multipliers of OBOR indicate that the largest effect is on MACEQ and FACIL. A SR. 1,000 change in OBOR is associated with SR. 843.1 and SR. 311.5 changes in MACEQ and FACIL, respectively, with land holdings fixed at the mean level (Table XVII). The impact of OBOR on GFR is positive with a SR. 113.8 change in GFR for a SR. 1,000 change in OBOR. However, its impact on NFI is negative and consequently its positive impact on DELRATE becomes smaller the larger the size of land holdings (Tables XVII through XIX).

It is also important to point out that operator borrowers who borrow from other credit sources may give first priority to repaying these sources before SAAB. This may have a direct positive effect on the delinquency problem.

Annual Payment (AP). The results of the reduced form model indicates that AP has no effect on the endogenous variables except DELRATE. The direct and indirect effect of AP on DELRATE is negative. A SR. 1,000 change in AP is associated with -0.49 days change in DELRATE. Change in land holding levels did not have any effect on the impact multiplier of AP on DELRATE in terms of sign or magnitude.

Timeliness of Credit (TCRED). The results of the TCRED multi-
plier indicates that a one day consumed for processing and approval
of loans is associated with 0.1352 days change in DELRATE. The results
from the previous analysis indicated that the average number of days
consumed to process and approve the loan due to bureaucratic compli-
cation and red tape is 58 days in the Kharj area. The positive asso-
ciation between TCRED and DELRATE indicates the need for simplifying
loan procedures for the operator borrowers so they may obtain the
loans at the time they need them.

Farm Family Labor (FLAB) The direct and indirect FLAB multipliers
indicate that a one man-day change in FLAB is negatively associated
with GFR, NFI, TCAP, MACEQ, FACIL, LCOST, and VCAP and positively asso-
ciated with DELRATE. However, the magnitudes of the impact multipliers
decrease in magnitudes the larger the size of land holdings (Tables
XVII through XIX.

The decrease of the impact multipliers of FLAB on the endogenous
variables included in the model may be due to substituting machinery
for labor the larger the farm size.

Family Expenditures Plus Home Produced and Consumed (FAMEXPC).
The direct and indirect impact multiplier of FAMEXPC indicates that a
SR. 1,000 change in FAMEXPC is associated with 0.5879 days change in
DELRATE with land holdings fixed at the mean value of 48.36 dunoms.
It was previously indicated that to minimize the positive impact of
FAMEXPC on DELRATE, it may be necessary for SAAB to provide operator
borrowers with a full line of credit to meet the needs for purchasing
operating inputs as well as family consumption.

Non-farm Income (NFINC). The direct and indirect impact of NFINC on GFR is positive and on NFI is negative. A SR. 1.00 change in OFINC is associated with changes of SR. 0.0226 and SR. -0.0159 in GFR and NFI, respectively, with land holdings fixed at the mean level of 48.36 dunoms. The largest NFINC direct and indirect effect is on FACIL. A SR. 1.00 change in NFINC is associated with SR. 0.0661 change in FACIL (Table XVII). However, the results of the FACIL demand equation discussed previously indicate a positive relationship between FACIL and NFINC but the partial regression coefficient is not significant at the 10 percent probability level.

As the size of land holdings increases from lowest to highest level, the magnitude of the impact multipliers of NFINC on all the endogenous variables in the model increases. This result may indicate that the larger the farm size the more the farm operator borrower invests out of income generated from off-farm employment. The results also indicate the importance of NFINC for decreasing DELRATE since operator borrowers may make their loan payment out of non-farm income whenever necessary.

Wage Rate (WAGE). WAGE impact multipliers indicate that a SR. 1.00 change in WAGE is associated with SR. 238.7 and SR. -859.5 changes in GFR and NFI, respectively (Table XVII). This result indicates that WAGE adds more to current operating expenses than to GFR which is reflected in the negative association between WAGE and NFI.

In general, by changing the level of land holdings, the magnitudes of the impact multipliers increase. This result may indicate that operator borrowers with large land holdings substitute machinery in place of labor in order to increase production and improve income.

<u>Adverse Weather Conditions (WEATH)</u>. The direct and indirect WEATH multipliers indicate that a one percent change in farm output due to adverse conditions such as frost or other natural factors is associated with changes of SR. -98.3437 and SR. -103.0175 in GFR and NFI, respectively. The result from the previous analysis indicated that about 33 percent of the operator borrowers' farms were effected and 52 percent of the total farm output lost due to adverse weather conditions, mainly frost (Table XVIII).

In this regard, it is important to indicate that SAAB, with joint cooperation of the extension agents, should provide operator borrowers with adequate information concerning crops that have resistance against such weather conditions or develop a crop insurance program for the operator to insure crops against risks.

<div align="center">

Evaluating Loan Repayment Capacity

Using Discriminant Analysis

</div>

Currently, analysis of the farm operator borrowers' financial position and credit worthiness is conducted via examinations of individual credit files by credit analysts and loan officers at the SAAB's branches and sub-branches. Considerable time and costs are required for a credit analyst and a loan officer to examine a borrower's loan record and accurately determine his financial performance rating and credit worthiness.

The results obtained from the loan delinquency analysis indicate that timeliness of credit is an important factor influencing delinquency. Questionnaire results also indicated that red tape and bureaucratic complications in processing and approval of loans influence

delinquency. The average time lag from loan application until the loan is obtained by the applicant is 57 days (Table VII). Therefore, delays in loan processing and approval result in costs to SAAB and the farmer borrowers.

Since the credit analysts and the loan officers determine the farm operator credit worthiness by relying only on the individuals credit files, their decisions are often, if not always, based on subjective value judgments. This method of evaluation ignores many economic and non-economic factors which affect the borrower's ability to repay loans and thus contribute to the delinquency problem.

Therefore, it is important to develop a method by which the farm operator borrowers can be distinguished according to their financial positions and capacity to repay crop production loans obtained from SAAB. Discriminant analysis has proven useful in classifying farm operator borrowers into two classes: those with potential to repay and those without potential, given their financial, social and farm resource characteristics.

Moreover, analysis of each borrower's financial performance establishes the basis for extending, limiting or withdrawing the present line of credit and for determining the amount and kind of supervision needed.

If the evaluation of the borrower's application puts him in the non-delinquent borrower group, this implies that the likelihood of loan repayment is high and only normal supervision is required. However, if the borrower's application falls into the potential delinquent category, this indicates that the loan possesses serious credit deficiencies and requires more than normal supervision. This provides

the basis for working closely with the borrower applicant to improve his farm operation efficiency and financial performance instead of denying him credit services. This is because if the borrower applicant is turned away, it will not be consistent with achieving the SAAB main objective of helping the small farm operators to increase farm production, improve income, and repay the government loans.

Previous Application of the Discriminant
Model on Financial Data

The discriminant model was intensively tested on financial data of borrowers of Production Credit Associations (PCA's) in Missouri, Illinois, and Arkansas. The purpose was to identify and classify a large percentage of the "acceptable" loans in order to achieve the following benefits:

a. Reduce credit examination costs.

b. Reduce the man hours needed to classify the obviously acceptable loans, thereby allowing more time for those loans requiring more attention and in-depth analysis.

c. Create greater opportunity for credit representatives to assist the associations in credit training and specialized credit handling.

d. Provide credit scoring index information that will be useful to the PCA's in their credit administration.

Staff members of the Federal Intermediate Credit Bank of the above indicated states report that these objectives are being achieved and that they are pleased with the performance of the new credit scoring program. Since initiating the program, credit representatives in the

three-state district, Missouri, Illinois, and Arkansas, now have more
time to assist association personnel with the improvement of lending
procedures (25, p. 62).

Conceptual Framework of the Discriminant
Analysis Model

Discriminant analysis is a statistical tool which lends itself
to classifying items into predetermined populations. The linear dis-
criminant model has been used previously to quantify the credit rating
of both consumer and agricultural loan applicants. The technique of
discriminant analysis is based on the assumption that a linear func-
tion,

$$y = \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n$$

exists which will distinguish between elements of a population. The
discriminant model utilizes coefficients β_1, β_2, $\ldots$, β_n chosen in
such a way that the ratio of between group sum of squares is maximized.
Factors x_1, $X_2 \ldots, X_n$ represent the quantitative characteristics of the
loans, the farm, and the farm operator borrowers (25, p. 57).

For example, let factors X_1, X_2, $\ldots$, X_n be n characteristics of
persons, and let these persons constitute loan groups, each group hav-
ing N_k (k = 1, 2,..., g) members. Let a particular characteristic of
a particular person in a particular group be identified by X_{ijk}, where
i = 1, 2, ..., n identifies the characteristics, j = 1, 2, ..., N_k
identifies a person in a particular group, and k = 1, 2, ..., g iden-
tifies the group to which the person belongs. For a given group then,
say k = 1, there would be N_1 members of the group, each person having
n measurements (42, p. 11).

Assumptions of the Linear Discriminant Function

There are certain assumptions which discriminant analysis re-
quires. The most important assumptions include:

a. The data vector is assumed to be multivariate-normal in
distribution to facilitate tests of hypotheses and classification
routines. The covariance structure among the variables in the data
vector is assumed to be constant within each category (25, p. 58).

b. The discriminant coefficients are chosen to maximize the
ratio of among to within group variance in discriminate score. These
coefficients are dimensionless and their ratio is important, not
their value (25, p. 58). Diagram denotes the situation where there
are two populations and only one variable, i.e., M = 2 and n = 1,
where M is number of population and n is number of variables. The
figure assumes samples large enough that all the population para-
meters can be regarded as known. Since the variance of y (which is
assumed to be the same in the two populations) and the population
means are known, the likelihood of an observation being classified
into either population 1 or population 2 is determined by consulting
a table of normal distributions. The likelihood of an observation
receiving a classification into either population 1 or population 2
are equal at y_c. One would classify all cases where $y > y_c$ in popu-
lation 2. Conversely, all observations where $y < y_c$ in population 1.
The shaded area in Figure 1 represents the expected proportion of
the misclassified cases (25, p. 58).
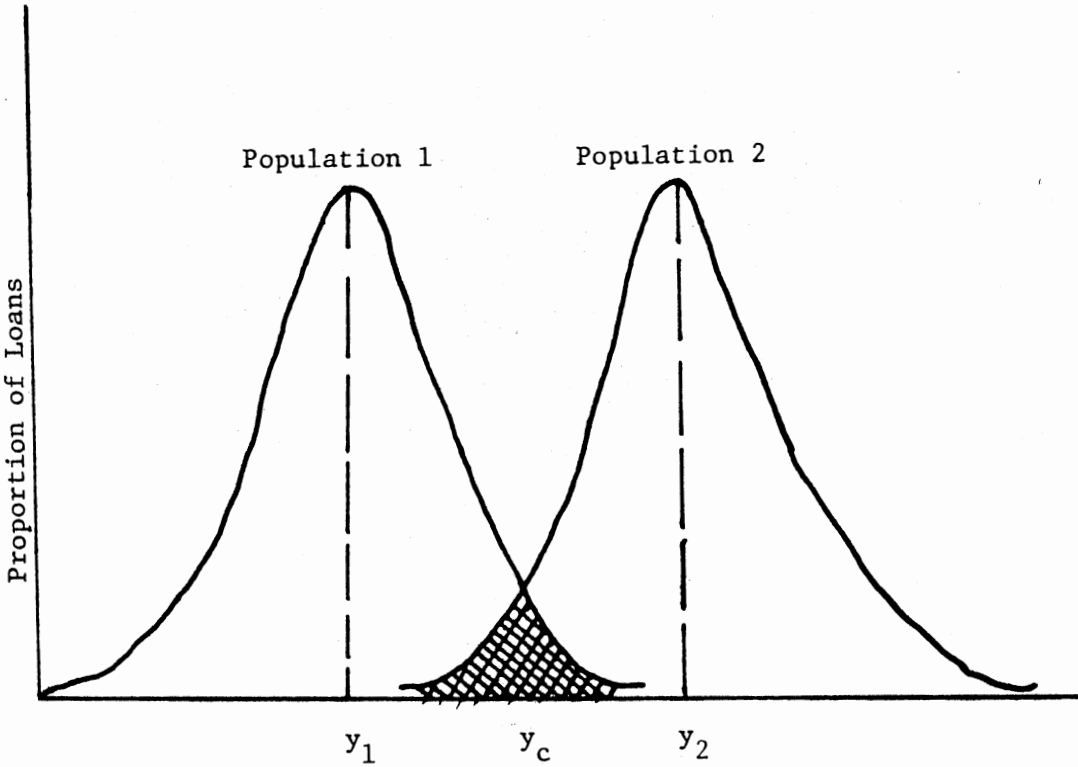
Figure 5: Classification For Two Populations and One Variable: Population Parameters Known

The Cut-off Point

If one assumed that the two kinds of errors, that is, classifying an acceptable loan in the problem group and classifying a problem loan as acceptable, are of equal significance, the cut-off point would be y_c in Figure 1. This point can be determined algebraically:

$$y_c = \frac{b'n\ \overline{Y}d - b'd\ \overline{Y}n}{b'n + b'd}$$

where

      $b'n$ = the standard deviation of the y values for the acceptable loan group

      $b'd$ = the standard deviation of the y values for the problem loan group

      $\overline{Y}n$ = the mean y value for the acceptable loan group

      $\overline{Y}d$ = the mean y value for the problem loan group

After determining the cut-off point (y_c), a Z statistic can be computed for both $\overline{Y}n$ and $\overline{Y}d$. The letter Z denotes a random variable from a normal density function with zero mean, $M = 0$, and unit standard deviation, $\sigma = 1$.

The Z statistic is determined according to the following formula:

$$Z_n = \frac{y_c - \overline{Y}n}{b'n} \quad ; \quad Z = \frac{y_c - \overline{Y}d}{b'd}$$

Referring to a Z table, we can determine what percent of acceptable and problem loans will be misclassified (25, p. 58).

Loan Delinquency Linear Discriminant Function

The linear discriminant function is equivalent to a linear probability function and is simply a type of linear regression. If, when

estimating a regression function, values of zero and one are used as a dummy dependent variable, the estimated function will be linear probability function. The expected value of the dependent variable between zero and one would then be generated when a given set of N measurements are substituted into the estimated equation. The estimated value of the dependent variable could then be interpreted as the probability that the event would occur, given the values of the N independent variables (42, pp. 14-15). However, in this study $-1/N_n$ will be used for Y instead of 0 and 1.

The Model

The loan delinquency linear discriminant model is presented as follows:

$$Y = B_1 \text{ VCOSGIN} + B_2\text{FEXGIN} + B_3\text{APNFI} + B_4\text{LABCAP} + B_5\text{IBASSET}$$
$$+ B_6\text{ACSHTAR} + B_7\text{TEXCBOR}$$

where $Y = 1/N_d$ for delinquent; and $-1/N_n$ for non-delinquent; N_d and N_n are numbers of observation.

VCOSGIN = Ratio of total current farm expenses to gross farm receipts (SR. 1000)

FEXGIN = Ratio of farm family living expenses to gross farm receipts (SR. 1000)

APNFI = Ratio of size of annual payment to net farm income (SR. 1000)

LABCAP = Ratio of total farm labor to total farm capital (Man-day/SR. 1000)

TBASSET = Ratio of total current borrowings to total value of farm assets (SR. 1000)

ACASHTAR = Percent of cropland cultivated for cash crops (dunom)

TEXCBOR = Ratio of total current farm expenses to current

borrowings (SR. 1000)

The independent variables used in the delinquency rate model were
tested in the linear discriminant model. However, they were deleted
from the model due to inconsistency in terms of the empirical signs.

Empirical Results

The discriminant model in this study is developed on the basis of
the application of the discriminant analysis to the data obtained from
the administered questionnaires used for interviewing operator borrow-
ers who have current production loans from SAAB in the Hufuf and the
Kharj areas. These discriminant models are presented in this section:

Hufuf. Y = -0.26577910 VCOSGIN + 0.34823531 FEXGIN -0.00721323
APNFI + 0.00127481 LABCAP + 0.05673530 TBASSET -0.06091127 ACASHTAR
-0.00088654 TEXCBOR

$F_{(7, 13)}$ = 2.47 is significant at the 10 percent probability
level

The results of the estimated discriminant linear function indi-
cate that VCOSGIN is negatively associated with delinquency rate. The
higher the ratios of variable capital to gross receipts, the lower the
delinquency. This is reasonable at least to a certain level, since
the result of the estimated production function model indicated the
importance of variable capital in contributing to gross farm receipts.
The positive sign of the FEXGIN coefficient indicates that the higher
the ratio of family living expenditures plus home produced and consum-
ed to gross receipts, the higher the likelihood of non-repayment of

SAAB loans. This result is also reasonable and consistent with the results of the delinquency rate model discussed earlier where FAMEXPC is positively associated with delinquency rate.

The negative sign of APNFI coefficient was not expected. The negative sign indicates that as the ratio of annual payment to net farm income increases, likelihood of loan repayment decreases. This inconsistency may probably be resolved by adding a squared term for APNFI.

Ratio of total labor employed on farm to total capital (LABCAP) is positively associated with delinquency. The higher the magnitude of this ratio, the higher the likelihood of loan non-repayment. This result is reasonable since production is likely to increase if more capital is substituted for labor.

The TBASSET coefficient indicates that the higher the ratio of total borrowings to total farm assets, the higher the likelihood of non-repayment of SAAB loans. This result may be reasonable for the Hufuf area if operators are borrowing more than they need and consequently over capitalizing their farm operation resulting in lower net farm income.

The ACASHTAR coefficient indicates that the higher the proportion of crop land cultivated for cash crops, the higher the likelihood of loan repayment. This result is reasonable and consistent with the results of the calculated analysis. The result of the tabulated analysis indicates that receipts from cash crops are about 1.4 times the receipts from permanent crops in the Hufuf area.

The mean values of the discriminant variables for the delinquent and non-delinquent farm operator borrowers in the Hufuf area are presented in Table XX.

TABLE XX

MEAN VALUES FOR THE DELINQUENT AND NON-DELINQUENT FARM OPERATOR
CHARACTERISTICS INCLUDED IN THE DISCRIMINANT MODEL,
HUFUF AREA, 1979

Variable	Unit	Mean Values	
		Delinquent	Non-Delinquent
VCOSGIN	(SR. 1000)	0.5567	0.3989
FEXGIN	(SR. 1000)	1.3333	0.426
APNFI	(SR. 1000)	2.4810	0.8549
LABCAP	(Man-day/SR. 1000)	52.3883	8.2007
TBASSET	(SR. 1000)	1.1333	0.3789
ACASHTAR	(DUNOM)	0.3550	0.5378
TEXCBOR	(SR. 1000)	9.1018	24.5636

The Critical Value for Y. If it is assumed that the two kinds of errors in misclassification are of equal significance, the critical or cut-off value can be calculated as described previously.

$$Y_c = \frac{b'n\overline{Y}d + b'd\overline{Y}n}{b'_n + b'_d}$$

$$= \frac{(0.04157628)\,(.052970611) + (0.08144260)\,(0.02111978)}{(0.04157628 + 0.08144260)} = 0.1930$$

Z_n and Z_d are:

$$Z_n = \frac{Y_c - \overline{Y}_n}{b'_b}$$

$$= \frac{0.1930 - 0.02112}{0.0416} = 4.13$$

$$Z_d = \frac{Y_c - \overline{Y}_d}{b'_d}$$

$$= \frac{0.1930 - 0.5297}{0.0830} = -4.06$$

Referring to a table of values for "cumulative normal frequency distribution", the computed Z values indicate that the discriminant function would correctly classify 100 percent of the operator borrowers in the Hufuf area. When comparing the cut-off scores to computed Y values for operator borrowers in the Hufuf area, those with Y values equal to or greater than 0.1930 would be classified as delinquent while those with Y values less than 0.1930 would be classified into the non-delinquent borrowers group. The means and their standard errors are presented in Table XXI.

TABLE XXI

THE MEANS AND STANDARD ERRORS OF MEANS FOR THE DISCRIMINANT MODEL,
HUFUF AREA, 1979

Farm Operator Borrowers Classification Group	Code	Sample Size	Mean Discriminant Value	Standard Error of Means
Non-delinquent borrowers	-0.1111	9	0.0211	0.0416
Delinquent borrowers	0.0833	12	0.5297	0.0814

Kharj. The specific linear discriminant function for the 21 operator borrowers in the Kharj area is the following:

Y = 0.10085642 VCOSGIN + 0.27317093 FEXGIN + 0.10492432 APNFI + 0.02880426 LABCAP -0.47609876 TBASSET + 0.14135500 ACASHTAR -0.02571778 TEXCBOR

$F_{(3, 17)}$ = 2.30 is significant at 10 percent probability level.

The results of the Kharj discriminant model indicate that as the ratio of variable capital to gross income increases the likelihood of loan repayment decreases. This result may be reasonable for the Kharj area since operators may be employing more variable capital than required given limited crop land area and poor management. The positive sign of the FEXGIN coefficient indicates the higher the ratio of family living expenditures plus home produced and consumed to gross recepits, the lower the likelihood of loan repayment.

The ratio of annual payment to net farm income is associated with delinquency rate. The result is reasonable because as annual payment exceeds operator borrower's repayment capacity, the likelihood of loan repayment decreases.

The coefficient of TBASSET carries a negative sign indicating that as the ratio of total borrowings, intermediate SAAB credit plus borrowings from other sources, increases the likelihood of loan repayment increases (delinquency decreases). This result may be reasonable for the Kharj area if these borrowings finance farm capital formation and increase the operator borrower's equity.

Proportion of crop land cultivated for cash crop in the Kharj area is positively associated with delinquency. The higher this proportion, the lower the likelihood of loan repayment. This result is reasonable since the Kharj area is subject to variation in weather conditions such as frost which has adverse effects on cash crops as pointed out earlier in the study.

The TEXCBOR coefficient indicates a negative relationship with nonrepayment of loans. As current farm expenses to current borrowings (short-term SAAB plus other borrowings) increases the higher the likelihood of loan repayment.

The mean value of the discriminant variables for the delinquent and non-delinquent operator borrowers in the Kharj area are presented in Table XXII.

The critical value or cut-off point for the Kharj area is calculated as discussed in the previous section:

$$Y_c = \frac{b'_n \overline{Y}_d + b'_d + \overline{Y}_n}{b'_n + b'_d}$$

$$= \frac{(0.05633466)(.049404213) + (0.07260177)(-0.01582131)}{(0.05633466 + 0.07260177)} = 0.2026$$

TABLE XXII

MEAN VALUES FOR THE DELINQUENT AND NON-DELINQUENT FARM OPERATORS CHARACTERISTICS INCLUDED IN THE DISCRIMINANT MODEL, KHARJ AREA, 1979

Variable	Unit	Mean Values	
		Delinquent	Non-Delinquent
VCOSGIN	(SR. 1000)	0.4651	0.2613
FEXGIN	(SR. 1000)	1.2285	0.2900
APNFI	(SR. 1000)	1.1038	0.2163
LABCAP	(Man-day/SR. 1000)	8.8246	7.2363
TBASSET	(SR. 1000)	0.5585	0.4300
ACASHTAR	(DUNOM)	0.3254	0.3010
TEXCBOR	(SR. 1000)	2.3777	7.2512

Z_n and Z_d are:

$$Z_n = \frac{\overline{Y}_c - \overline{Y}_n}{b'_n}$$

$$= \frac{0.2026 - (-0.0158)}{0.060} = 3.64$$

$$Z_d = \frac{\overline{Y}_c - \overline{Y}_d}{b'_d}$$

$$= \frac{0.2026 - 0.4840}{0.073} = -3.85$$

Referring to a table of values for "cumulative normal frequency distribution", the computed Z values indicate that the discriminant function would correctly classify 100 percent of the operator borrowers in the Kharj area when comparing the cut-off scores to computed Y values for operator borrowers. Those with Y values equal to or greater than 0.2026 would be classified as non-delinquent while those with Y values less than 0.2026 would be classified into the delinquent borrowers group.

The means and the standard errors of the means are presented in Table XXIII.

Alternative Cut-off Points

Based on the results obtained above it is indicated that none of the farm operator borrowers in this study who had loans from the SAAB would be misclassified. However, since the above computer scoring model will supplement the credit analysts' personal examination, a more reasonable classification scheme within a more tolerable level than zero percent of misclassification may be needed.

TABLE XXIII

THE MEANS AND STANDARD ERRORS OF MEANS FOR THE DISCRIMINANT MODEL,
KHARJ AREA, 1979

Farm Operator Borrowers Classification Group	Code	Sample Size	Mean Discriminant Value	Standard Error of Means
Non-delinquent borrowers	-0.20	8	-0.0158	0.0563
Delinquent borrowers	0.0625	13	0.4840	0.0726

Therefore, a 0.01 probability of misclassification of the potential delinquent may be considered a more acceptable level and can be calculated. The alternative cut-off score is specified as the critical Y value (CV) for classifying farm operator borrowers (25, p. 61).

Consulting a table of cumulative normal frequency distribution, the appropriate critical value is derived through the following calculation:

$$Y_{cv} = \overline{Y}_d + (Z) b'_d$$

Where:

Y_{cv} = critical Y value

Y_d = mean value for the delinquent loan group

Z = standard measure, and

b'_d = standard deviation of Y_d

The appropriate value of Z which allows a one percent misclassification tolerance is 2.33. Thus, multiplying the standard measure times the standard deviation of the sample mean (b'_d) and adding this product to the mean $(\overline{Y}_d)$ results in a critical Y value. Assuming the

sample mean ($\overline{Y}_d$) score approximates the population mean, there is only one chance out of 100 of misclassifying a delinquent loan into the non-delinquent loan group (25, p. 61).

In order to test the discriminant function on operator borrowers data, the following critical Y values are calculated:

(i) <u>Critical Y value for Hufuf area</u>

Y_{cv} = 0.5297 + (2.33) (0.0814)

= 0.7194

(ii) <u>Critical Y value for Kharj area</u>

Y_{cv} = 0.4840 + (2.33) (0.0726)

= 0.6532

The results indicate that all farm operator borrowers receiving Y scores equal to or greater than 0.7194 and 0.6532 in the Hufuf and the Kharj areas, respectively, will be classified into the delinquent borrowers group. Conversely, farm operator borrowers with Y scores less than Y_{cv} will be categorized into the delinquent borrowers group.

It was indicated previously in this study that some of the major problems facing the SAAB are the following:

1. Need for well trained personnel with enough skills to improve the quality of the SAAB portifolio of loans and efficiency in appraising, processing, and approval of loans.

2. Need for a grading system differentiating clients according to their loan risk at any given point in time.

In addition, delay in evaluating and processing loan applications increases credit examination costs and man hours needed for evaluating personal and financial attributes of the borrowers. There are also other costs associated with loan default such as collection and social costs that could be very high if the borrower applicants' repayment capacity is not accurately appraised.

Therefore, discriminant analysis may be an effective, efficient and appropriate tool to use by the SAAB's credit analysts to improve the SAAB portifolio and efficiency in providing agricultural production loans. This will also reduce the time and social costs involved in extending and collecting loans.

Before closing the discussion in this section, it is necessary to point out that the estimation procedures of the discriminant models discussed so far were based on small sample sizes of large populations in the two study areas. To provide reasonable assurance that the estimated discriminant model will classify the operator borrower groups with more precision, larger sample size may be needed. The results should improve as the number of observations increase since they contain more information relevant to the parent populations.

The selection of the variables used for estimating the discriminate function models in this study was limited to the available information in the administered farm questionnaires of the operator borrowers. Therefore, SAAB's credit analysts may consider adding other variables that may be important in relation to evaluating the operator borrowers loan repayment capacities and determining the likelihood of repaying loans obtained from SAAB.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

Summary

The main objective for establishing SAAB was to provide interest-
free loans to farm operators, individuals and/or groups of persons en-
gaged in agricultural production and agricultural allied industries.
The loans extended by SAAB are to be used for acquiring farm capital
needed by the farm operators to increase production and improve income.
Increased income should be sufficient to cover farm prcduction expen-
ses, meet family needs and repay the government loans.

SAAB has been in full operation for 16 years, however, the credit
program is far from achieving its objective of reaching all of the
Saudi Arabian farmers. Only three percent of the total number of
farmers have obtained agricultural loans from SAAB. Limited SAAB activ-
ity in the agricultural financial market is attributed mainly to the
farms' and operator borrowers' characteristics and SAAB's low opera-
tional efficiency. Farm characteristics refer to low productivity of
farm units due to small amount of crop land cultivated and consequently
low income earning potential. The results of the study indicate that
only 50 percent and 26 percent of the total crop land is utilized for
crop production in the Hufuf and the Kharj area, respectively (Table
III). The average size of farm in the Hufuf and the Kharj area is 78
dunoms and 188 dunoms respectively. Operator borrowers' characteris-

tics refer to the farm and farm financial management which include
the ability of the operator borrowers to make the best use of credit
and allocate the scarce farm resources to maximize production and
increase farm income. The results of the analysis indicate that none
of operator borrowers in the study kept written records and only 28
percent and 33 percent of operator borrowers in the Hufuf and Kharj
areas, respectively, can read and write. SAAB's low operation effi-
ciency refers to slowness in processing and approval of loans when
they are submitted. The low efficiency is mainly attributed to lack
of well trained field representatives and credit analysts to gather
and assimilate information pertaining to farms and operator applicants
and to evaluate the actual credit needs, farm income earning potential,
operator credit worthiness and repayment capacity.

The overall objective of this study is to systematically explore,
evaluate and determine the important factors contributing to the loan
delinquency rate. Two approaches were used to model the delinquency
rate: ordinary least squares techniques and 2SLS in a farm interdepen-
dent system. The models were estimated using technical and economic
data obtained from personal surveys of 42 farm operators with current
production loans from SAAB in the Hufuf and the Kharj areas.

The delinquency model using OLS approach was postulated with
delinquency as a function of net farm income, size of annual payment,
farm family living expenditures, non-farm income, timeliness of credit,
and amount of crop land cultivated. To give further insights, loan
delinquency was determined within the framework of a farm credit
interdependent system using the 2SLS approach. The purpose of using
simultaneity is to evaluate the impact of short-term credit on hired

labor and variable capital and the impact of intermediate-term credit on farm machinery and facilities. The impact of credit on the indicated factors is translated to delinquency rate through the farm production function and net farm income. The specification of the four input demand functions for the Hufuf area are: (1) farm machinery and equipment (SR. 1000) as a function of hired labor costs (SR. 1000), family labor (man-days), intermediate-term credit from SAAB plus borrowings from other sources (SR. 1000) and total crop land cultivated (dunom); (2) facilities as a function of net farm income (SR. 1000), and non-farm income (SR. 1000); (3) cost of hired farm labor (SR. 1000) as a function of short-term credit from SAAB plus borrowings from other sources (SR. 1000), family labor (man-days per year), wage rate (SR. 1000), and total crop land cultivated (dunom); and (4) variable capital as a function of net farm income (SR. 1000), total farm capital (SR. 1000), short-term credit from SAAB plus borrowings from other sources (SR. 1000), and non-farm income (SR. 1000). The postulated production function is specified to be a function of total farm capital (SR. 1000), cost of hired labor (SR. 1000), variable capital (SR. 1000), and total crop land cultivated (dunom).

Two identity equations were included in the system: (1) net farm income (SR. 1000) equal to gross farm receipts minus cost of hired labor and cost of variable capital used up in the current production period; and (2) total farm capital (SR. 100) equal to value of machinery and equipment (SR. 1000) plus value of facilities (SR. 1000).

The postulated delinquency rate in the system has the same functional specification as the model estimated by using OLS approach.

The above indicated interdependent system was also tested on the Kharj area. However, examination of structural stability between the Hufuf and the Kharj areas indicated structural difference. Therefore, an alternative credit interdependence model was developed for the Kharj area.

The differences between the credit interdependent systems for the two areas are in the specification of the input demand functions and the production function. The postulated input demand equations for the Kharj area are: (1) value of farm machinery and equipment as a function of cost of hired labor, family labor, intermediate-term credit from SAAB plus borrowings from other sources; (2) value of facilities as a function of net farm income, costs of hired labor, non-farm income, and total crop land cultivated; (3) costs of hired labor as a function of value of total capital, wage rate and total crop land cultivated; and (4) cost of hired labor as a function of value of total capital, short-term credit from SAAB plus borrowings from other sources, non-farm income and total crop land cultivated.

The postulated production function model is the value of farm output is a function of value of total capital, family labor, value of variable capital total crop land cultivated, and a variable reflecting loss of crops due to adverse weather conditions (percent loss of crop value).

Furthermore, for policy implication purposes, reduced forms were developed and the results evaluated using three different levels of farm size; lowest, mean, and highest farm sizes included in the study. This was to determine the direct and indirect impact of credit on the endogenous variables affecting the level of production such as farm

machinery and equipment, facilities, cost of hired labor, and variable capital inputs.

For improving SAAB operation efficiency for evaluating operator applicant credit needs and repayment capacity, a linear discriminant model was introduced. Operator borrowers in this study were classified into delinquent and non-delinquent for each study area. The dependent variable in the linear discriminant model Y ($Y=1/N_d$ for delinquent; $Y=-1/N_n$ for non-delinquent) represents the optimum discriminator between the two groups and the explanatory variables represent the quantifiable characteristics of the operator borrowers, where N_d and N_n are the number of delinquent and non-delinquent borrowers.

For developing the linear discriminant model, a number of variables were used. The selection and use of these variables in question were limited to the information available in the personal interview questionnaires administered in this study. However, the credit analysts do not have to limit their evaluation of credit worthiness of the farm operator applicants to the variables used in this study. The credit analysts may use additional variables that they consider to be important determinants for loan repayment capacity.

Policy Implications

Farm Income

In this study farm income is one of the most important determinants of the delinquency problem. The impact of credit on income, however, cannot be directly measured because credit does not directly generate output and income.

Short-term credit facilitates the purchase and acquisition of im-
proved production factors such as improved seeds and fertilizers. In-
termediate-term credit facilitates the acquisition of lumpy inputs such
machinery and equipment and farm facilities for irrigation that are
difficult to finance internally by the farm operator borrowers. These
lumpy inputs contribute to a greater extent to increasing farm pro-
duction and hence income. Examples are: increasing farm size intro-
duces scale economies; expanding irrigated area raises the productivity
of fertilizers, land and improved varieties; and mechanization changes
land-labor relations (10, p. 15).

Input-output Relationships

In this study farm production functions for the Hufuf and the
Kharj areas were estimated by means of multiple linear regression with
interdependent credit system (2SLS). In the model, the intermediate-
term credit was assumed to shift the production coefficients for
machinery and equipment and facilities, and short-term credit shifts
the coefficients of variable capital and cost of labor used as a proxy
for amount of labor employed.

Total Capital

Total capital is directly influenced by intermediate-term credit
and was found to be positively related with the level of gross farm
receipts in the production function for the Hufuf and the Kharj areas.
However, the estimated partial regression coefficients were not signif-
icant at the 10 percent probability level. Results of the tabulated
analysis indicated the average investment in machinery and equipment

plus facilities was SR. 3,056 for the non-delinquent and SR. 3,539

for the delinquent operator borrowers for the two study area. The

average gross farm income for the non-delinquent and the delinquent

operator borrowers were SR. 4,052 and SR. 487, respectively. These

results may indicate that non-delinquent operator borrowers with less

capital investment relative to the delinquent operator borrowers are

more able to generate higher incomes. These results may also indicate

that the delinquent operator borrowers use more capital than they need

to increase production and income given their limited management capa-

bility to allocate scarce resources among competing farm enterprises.

Since the availability of capital items is closely related to in-

termediate-term credit from SAAB and borrowings from other sources,

intermediate credit should be provided based on the actual need and

the extent of its effectiveness in increasing farm production and in-

come. Failure to scrutinize credit against the operators' actual need

may result in over-capitalization of the farm production processes

and burden the operator borrowers with debts which may eventually lead

to worsening the operator borrowers' financial position and in turn

influence loan repayment capacity.

Variable Capital

Variable capital regression coefficients in the production func-

tions for the Hufuf and the Kharj areas were positive and significantly

different from zero at the one and five percent probability levels,

respectively. The results obtained from the tabulated analysis indica-

ted the average value of variable capital for the non-delinquent

borrowers was SR. 2,284 for Hufuf and SR. 2,024 for Kharj per unit of

crop land cultivated (dunom). Based on the strong positive relation-
ships between the level of gross farm receipts and the level of vari-
able capital is a very important variable contributing to increases in
income. Therefore, short-term credit for financing variable capital
should be adequate and be given after accurately evaluating the actual
credit needs for increasing farm production.

A large proportion of short-term credit is given to the operator
borrowers in cash. This may increase the likelihood of using part of
the short-term credit for consumption purposes rather than farm pro-
duction. This problem of misuse of credit may be solved if farm
family consumption needs are accounted for in the short-term credit
package since farm family requirements are as important as the require-
ments of the farm enterprises. A full line of credit may also lessen
the operator borrowers' dependence on the other non-institutional
credit sources.

Borrowing from other credit sources may in fact unfavorably
influence loan repayment. Farm operator borrowers who borrow addi-
tional funds from credit sources other than SAAB may find it necessary
to repay these sources before repaying SAAB in order not to jeopardize
this important source of consumption credit. The analysis indicates
that the average amount of funds per dunom obtained from other sources
of credit was SR. 257 and SR. 2,015 for the non-delinquent and the
delinquent borrowers, respectively. Based on these results, borrowing
from other sources of credit may be an important factor contributing
to the delinquency rate problem.

The Cost of Hired Farm Labor

Cost of hired farm labor was used as an explanatory variable in the farm production function. It was used as a proxi for the amount of hired farm labor employed for farm production. Cost of hired labor was positively associated with level of gross receipts and significantly different from zero at the five percent probability level for the Hufuf area. However, this variable was dropped from the Kharj area production function due to insignificance of its estimated partial regression coefficient. But farm family labor in the Kharj area production function was negatively related to the level of gross receipts and statistically significant at the one percent probability level. The negative sign of the partial regression coefficient and its high significance level indicates that to increase farm production in the Kharj area less labor should be employed so surplus labor can be freed for other uses in the non-agricultural sector where the demand for labor and its marginal productivity are higher.

Total Crop Land Cultivated

Throughout the analysis land was assumed to be of constant quality in each area of the study and exogenously determined by government program policies and social factors such as inheritance. Land was used as an explanatory variable to capture the economy of size in the farm production process. Its partial regression coefficient indicates a positive relationship with gross farm income in the Hufuf and Kharj production function models. The partial regression coefficients for the two respective areas were very significant at the one percent probability level.

The results obtained from the tabulated analysis indicate farm
size in the Hufuf and the Kharj areas was 78 and 188 dunoms, respectiv-
ely, but that only 50 and 74 percent of the total land was cultivated
in the respective areas. The information included in the administered
questionnaire did not provide any indication whether the remaining
farm land was not utilized because of lack of capital, irrigation water
or management.

Since land is one of the most important factors in contributing
to increases in farm production and income, more of the unused land
should be brought under cultivation by means of providing operator
borrowers with the necessary factor inputs.

Adverse Weather Conditions

Adverse weather conditions, mainly frost, was one of the important
factors affecting level of farm output and income in the Kharj area.
A weather condition variable in the Kharj production function model
was negatively associated with the level of gross farm receipts. The
partial regression coefficient was statistically significant at the
five percent probability level. This calls attention to the need for
implementing a crop insurance program so that the operator borrowers
can insure their crops against risk, increase farm production and in-
come, and hence improve loan repayment capacity.

Distance From the Market Center

Distance from the farms to the local market center was tested as
an explanatory variable in the Hufuf and the Kharj production function
models as proxis for prices of farm output. The signs of the estimated

partial regression coefficients were negative as expected. However, the variable was dropped from the production function due to low levels of statistical significance. Regardless of low significance of the distance variable in the production function, the results may still indicate the necessity of developing an efficient transportation network so the farm operators can transport their perishable farm products to the markets on time and with lower transportation costs. Results obtained from the tabulated analysis indicate that marketing costs make up about 10 and 13 percent of the total current operating expenses in the Hufuf and the Kharj areas, respectively.

Net Farm Income

Net farm income in this study was computed as total gross receipts minus costs of variable capital and hired labor. The results of the tabulated analysis indicate that the average net farm income per dunom for the non-delinquent and delinquent operator borrowers was SR. 1,768 and SR. -1,537, respectively. This great variation in the level of net farm income between the non-delinquent and the delinquent borrowers was due in part to the low level of gross farm receipts for the delinquent compared to the non-delinquent borrowers. Other factors that may have contributed to low net farm income was the level of capital items employed by the delinquent operator borrowers. The average investment in farm machinery and equipment was SR. 3,056 and SR. 3,539 for the non-delinquent and the delinquent operator borrowers respectively. A third factor that may have contributed to the difference in net farm income between the two groups is the low level of variable capital employed with an average of SR. 2,024 for the delinquent

borrowers compared to an average of SR. 2,284 for the non-delinquent borrowers.

Net farm income was assumed to be an important measure of loan repayment capacity and as a means of internal financing of farm facilities, cost of labor and variable capital.

For the delinquency rate determination, it was hypothesized that net farm income per dunom is negatively associated with the delinquency rate. The results of the delinquency rate models estimated by OLS and 2SLS were consistent and conformed to the hypothesized relationships. The partial regression coefficients estimated by both approaches were very significant at the one percent probability level. Therefore, to improve the operator borrowers' loan repayment capacity and well being which are the main objectives of the credit program, much more effort is needed by SAAB and the supporting institutions to help operator borrowers make the best use of credit to increase production and income.

Farm Credit

It was pointed out earlier in the study that SAAB provides interest-free short and intermediate-term credit to the farm operators.

Short-term SAAB Credit

Since short-term credit is provided to the operator borrowers for acquisition of factor inputs such as variable capital and hired labor, its impact on farm production and income was measured through its impact on these factor inputs. The results of the input demand functions indicate that short-term credit from SAAB plus borrowings

from other sources was positively associated with the level of labor costs but not significant at the ten percent probability level, and positively associated with the level of variable capital and statistically significant at the one percent probability level for the Hufuf area.

For the Kharj area, short-term credit from SAAB plus borrowings from other sources was positively associated with the level of variable capital and significant at the one percent probability level. However, the partial regression of this variable was positively associated with the level of hired labor cost but not significant at the ten percent probability level. These results indicate the importance of short-term credit plus borrowings from other sources for financing variable capital in the Hufuf and the Kharj areas.

The farm credit interdependent system estimated in this study shows the direct and indirect impact of short-term credit multipliers on gross farm income, net farm income, and delinquency rate. The magnitudes of the impact multipliers increase as the size of the land holdings increase from the lowest level of 6.00 dunom to the mean of 39.07 dunom and then decrease again as the land size exceeds the mean level. This may indicate that operator borrowers with farm size below and above the mean obtain more short-term credit than needed for farm production and the possibility of diverting short-term credit for consumption rather than for farm production does exist.

Intermediate-term SAAB Credit

The average amount of intermediate-term SAAB credit obtained by the operator borrowers was SR. 49,082 and SR. 39,244 in the Hufuf and

the Kharj areas, respectively (Table VIII). Intermediate-term SAAB
credit was included in the input demand functions for farm machinery
and equipment and facilities. Intermediate-term SAAB credit was com-
bined with funds borrowed from other sources since part of these funds
are used by the operator borrowers to finance durable farm capital.
These combined credit sources (INTOB) are positively associated with
the level of investment in farm machinery and equipment (MACEQ) and
the level of investment in farm facilities (FACIL) in the Hufuf and
the Kharj areas. The INTOB partial regression coefficients in the
MACEQ and FACIL demand functions were significant at the one percent
probability level and indicate the importance of credit in financing
MACEQ and FACIL.

However, total capital (TCAP) was positively associated with the
level of gross farm receipts in the production function but was not
significant at the ten percent probability level.

The impact multipliers derived from the reduced form indicate
intermediate-term SAAB credit has a positive impact on gross farm
receipts and net farm income when land holdings are fixed at the low-
est level but negative impacts at the mean and higher levels for
the Hufuf area. For the Kharj area, its impact on gross receipts
is positive but negative on net farm income at the lowest, mean and
highest levels of land holdings. The impact on loan delinquency is
positive for both areas.

Examination reveals that if credit is not closely scrutinized
and linked with income generating potential of the farm enterprises,
operator borrowers' financial management ability, and repayment capac-
ity, credit may have a negative impact on production and income and in

turn, on the delinquency rate. Therefore, for more effective use of credit, actual credit needs for each operator applicant should be carefully evaluated in order to avoid the problem of overfinancing and overburdening operator borrowers with debts that may make them worse off with credit than without it.

Borrowings From Other Sources of Credit

The average amount of additional funds operator borrowers obtained from other credit sources (OBOR) was SR. 45,100 and SR. 55,095 in the Hufuf and the Kharj areas respectively, whereas the average amount of short and intermediate-term credit from SAAB was SR. 54,965 and SR. 45,786 in the two respective areas.

The impact of OBOR on farm capital items and facilities was jointly determined with that of intermediate-term SAAB credit already discussed in the preceding section. However, the results of the reduced form indicate that OBOR has negative impacts on GFR and NFI at the lowest level of land holding but the impact is positive with land holding at the mean in the Hufuf area. Its impact on GFR is positive but negative on NFI at the three levels of land holdings in the Kharj area.

The direct and indirect impact of OBOR on delinquency rate is positive with land holdings fixed at the lowest level but negative with land holdings at the mean and the highest levels in the Hufuf area, whereas its impact on delinquency rate in the Kharj area is positive at the three levels of land holdings.

Operator borrowers seek out additional financing from other non-institutional sources of credit for several reasons: purchasing

production inputs, meeting farm family requirements, and repaying SAAB loans in the case of default due to inavailability of cash when payments are due. Furthermore, OBOR may increase the SAAB delinquency rate in that operator borrowers may give first priority to repaying other credit sources before SAAB in order not to jeopardize this line of credit. Therefore, provision of a full line of credit by SAAB may be necessary to minimize operator borrowers dependence on non-institutional credit sources.

Credit Policies

Two credit policy variables were included in this study: timeliness of credit and size of annual payment.

Timeliness of Credit

Timeliness of credit (TCRED) as defined in this study is the number of days from the day loan request was made until the loan was approved by SAAB. The results of the tabulated analysis indicate that the average days consumed for loan processing and approval was 57 and 58 days for the Hufuf and the Kharj areas, respectively. Also, the partial regression coefficient of timeliness of credit in the delinquency rate models using OLS and 2SLS for the respective areas indicate a positive association with loan delinquency. These coefficients are significantly different from zero at the ten and five percent probability levels in Hufuf and Kharj areas, respectively.

Based on these results, to minimize the unfavorable impact of timeliness of credit on delinquency rate, operational efficiency of SAAB for evaluating operator borrowers' credit worthiness, repayment capacity, and loan approval should be improved. It can be improved

by increasing the skills of the field representatives and the credit
analysts in the area of agricultural finance. It may also be neces-
sary for SAAB to make use of computerized programs presently in use
by other credit institutions saving time and operation costs.

Size of Annual Payments

It was hypothesized that size of annual payment (AP) is one of
the factors influencing loan repayment. The average size of annual
payment for the loans obtained from SAAB is SR. 15,605 and SR. 14,390
in the Hufuf and the Kharj areas, respectively. AP in the delinquency
rate model is positively associated with DELRATE for the Hufuf area
but negatively associated with DELRATE for the Kharj area. However,
the AP variable in the delinquency rate models for the two areas is
not significant at the ten percent probability level. Therefore, the
insignificance of the partial regression coefficients indicates that
the size of the annual payment as specified is not an important factor
influencing loan repayment.

Family Financial Management

Family financial management is an important factor determining
the level of investment in farm machinery and equipment, facilities
and other operating inputs for agricultural production. Farm finan-
cial management becomes relatively crucial the larger the farm oper-
ation. As farms develop into substantial business units, need will
arise for astute handling of financial affairs. The larger the farm
firm becomes, the larger the capital requirements and hence the great-
er the need for farm income and borrowed funds to finance purchased
inputs.

Internal Savings and Investment

It was stated previously that a primary reason for implementing an agricultural credit program in the Kingdom of Saudi Arabia was the low farm income constraining operator investment in farm capital items and improvement of farm facilities. Other factors that may discourage farm operators to save is the lack of well developed financial markets to mobilize rural savings. Since charging interest on borrowed funds is prohibited by Islam, the government should take the initiative in implementing appropriate rural saving schemes not conflicting with Islam guidelines but encouraging farm savings and investment.

In the context of rural savings, SAAB may develop rural savings programs where members deposit money in their saving accounts at the branches and offices. The money deposited can be mobilized and channeled for investment in the farming or industrial sector. Part of the profit can be divided among the participants and the remaining portion be allocated for reinvestment and covering operation costs.

Off-farm Income

The average off-farm income is SR. 38,719 and SR. 90,071 in the Hufuf and the Kharj areas, respectively. Nearness to a large metropolitan area with greater off-farm employment opportunities was the reason for higher off-farm income in Kharj relative to Hufuf. Off-farm income was assumed to be one of the means for financing farm production inputs. The results of the study indicate that off-farm is an important means of financing farm facilities in the Hufuf area. Partial regression coefficients indicate positive associations between off-farm income and VCAP in the Hufuf area and FACIL and VCAP in the

Kharj area. However, the coefficients were not significant at the ten percent probability level.

Results of the study indicate off-farm income is negatively associated with delinquency rate for both areas. The partial regression coefficients are statistically significant at the one and five percent probability level for Hufuf and Kharj, respectively. Based on these results, operator borrowers with low farm income may be using their off-farm income to repay SAAB loans.

But the interesting results in relation to off-farm income is the direct and indirect impact of off-farm income on gross receipts and net farm income as the size of land holdings increase. The results indicate that farm income and off-farm income may be competitive at the small farm size. Low farm productivity could be the primary reason for low farm income operators seeking off-farm employment.

Family Living Expenses

The average family living expenses for the operator borrowers was SR. 47,117 and SR. 52,971 in the Hufuf and the Kharj areas, respectively. The level of family living expenditures are directly related to size of family. The average size of family in the Hufuf and the Kharj areas is 15 and 10 persons respectively with only an average of 1.8 and 0.8 persons contributing to farm production in the two respective areas. The remaining family members are either children still in school, elderly, disabled, or working off the farm.

The family living expenditure (FAMEXPC) variable is positively associated with loan delinquency and is significant at the ten and one percent probability levels in the Hufuf and Kharj areas,

respectively. These results indicate the importance of FAMEXPC in determining loan delinquency and should not be ignored when evaluating operator borrowers' repayment capacity.

Loan Repayment Capacity

Repayment capacity of operator borrowers should be carefully and accurately analyzed by the SAAB credit analysts. Average production costs, yields, prices and income should be estimated with reasonable accuracy and analyzed before approval of loans.

SAAB Operational Efficiency

It was indicated in the previous sections that timeliness of credit and the accuracy in evaluating and determining operator borrowers repayment capacity are among the important factors contributing to the delinquency rate. But since SAAB is short of skilled manpower, a computerized system may be the answer to this problem. The use of such systems should help in increasing the credit analysts' efficiency in determining the applicants' credit worthiness and, in turn, reducing credit examination costs and saving time of the farmers. In the context of this study, the discriminant model proved to be useful and effective tool to utilize for credit scoring. Therefore, a credit scoring program using the discriminant model, should be considered by SAAB for categorizing borrowers into respective loan classification groups.

Limitations of the Study

In this study, an attempt was made to systematically explore,

examine, and evaluate the important factors affecting the level of farm output and hence influencing the loan delinquency rate within the framework of farm credit interdependence system. Because of the structural differences in terms of characteristics of farm and operator borrowers between the two areas included in the study, different interdependence systems were developed for each area.

The inapplicability of one interdependence system to both areas is one of the limitations of the model applied in this study. Therefore, there is some question whether the model developed should be applied to all agricultural areas in Saudi Arabia. The SAAB may have to develop lending policies that are suited to individual or groups of major agricultural areas with similar farms and farm operator characteristics in order to provide more effective credit services.

Further Research

Further research on providing farm operators with adequate credit to meet their needs for capital inputs to increase agricultural production and improve the farm operators' well being will improve as researchers develop greater appreciation for the issues raised in this study: interdependence of farm and household decision-making, awareness for the need of teaching farm operators better farm and financial management, and improving the capability of loan analysts in helping farmers with credit needs. The farm financial interdependent systems that include econometric models illustrate potential analytical approaches for measuring credit impact upon farm production and hence upon loan delinquency rate problems.

The immediate priority is to develop a data base by SAAB for a

better and more detailed analysis of agricultural credit needs. The characteristics of farm and farm operator borrowers and the financial needs that influence farm-household decision-making, indicate the need for collecting comprehensive data to be utilized for determining actual and potential credit needs of the farm-household and for the provision of better and more productive credit services. Careful monitoring of production expenses, farm investments, consumption and nonfarm activites as well as borrowing additional funds from sources of credit other than SAAB are necessary to accurately describe when to provide credit and how it is to be allocated. Once described, more rigorous analysis can be used to identify the important factors ex-plaining allocation and impact of credit.

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APPENDIXES

APPENDIX A

ESTIMATED EQUATIONS OF THE FARM CREDIT

INTERDEPENDENT SYSTEM-<u>KHARJ AREA</u>,

1978/79

ALTERNATIVE MODEL

MACEQ = 105.5951 − 0.563LCOST − 0.0970FLAB + 0.8726UBTIB***
       (52.69)   (1.09)   (0.08)   (0.29)

    + 0.1305TAREAC
     (0.68)

$$R^2 = 0.3557$$
$$F_{(4, 15)} = 2.10$$

FACIL = 77.5357 + 6.5561NFID + 0.0286INTOB − 0.0201OFINC
     (44.34)   (16.31)   (0.26)   (0.12)

$$R^2 = 0.0132$$
$$F_{(3,17)} = 0.06$$

LCOST = 012.1111 + 0.0709SHB + 0.0098FLAB + 808.4611 WAGE**
     (17.38)   (0.06)   (0.02)   (308.58)

    + 0.4620TAREAC***
     (4.12)

$$R^2 = 0.5658$$
$$F_{(4, 16)} = 4.68**$$

VCAP = −7.7767 − 3.6511NFID** + 0.0326TCAP + 0.2515SHOB***
     (15.25) (1.26)   (0.05)   (0.08)

    + 0.0224OFINC + 0.8193TAREAC***
     (0.03)   (0.13)

$$R^2 = 0.8233$$
$$F_{(5,15)} = 12.81**$$

GFR = 33.5349 − 0.0222TCAP − 0.3416LCOST + 0.6887VCOST**
    (27.85)   (0.09)   (0.51)   (0.32)

  + 1.4509TAREAC** + 0.0011TAREAC^2
   (0.69)   (0.002)

$$R^2 = 0.8495$$
$$F_{(5, 15)} = 23.76***$$

DELRATE = 219.6408 − 61.0628NFID*** − 0.4847AP + 0.5879FAMEXPC***
     (51.22)   (13.55)   (0.41)   (10.18)

  − 0.1761OFINC** + 0.1352TCRED** − 1.2730TAREAC**
    (0.08)   (0.06)   (0.51)

$$R^2 = 0.7350$$
$$F_{(6, 14)} = 6.05**$$

APPENDIX B

REDUCED FORM MODELS FOR THE

HUFUF AND THE KHARJ AREA

Hufuf

1. Cropland cultivated at the mean (TAREAC = 39.07 dunom).

$$
A = \begin{bmatrix}
1.0 & 0 & -0.0276 & 0 & 0 & -0.7350 & -2.6361 & 0 \\
-1 & 1.0 & 0 & 0 & 0 & 1.0 & 1.0 & 0 \\
0 & 0 & 1.0 & -1.0 & -1.0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1.0 & 0 & 1.8069 & 0 & 0 \\
0 & -0.2734 & 0 & 0 & 1.0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1.0 & 0 & 0 \\
0 & -0.2429 & 0.0659 & 0 & 0 & 0 & 1.0 & 0 \\
0 & 0.7789 & 0 & 0 & 0 & 0 & 0 & 1.0
\end{bmatrix}
$$

$$
A^{-1} = \begin{bmatrix}
1.9613 & 0.9613 & -0.2232 & -0.2232 & 0.8836 & 4.2089 & 0 \\
1.6012 & 1.6012 & -0.1284 & -0.1284 & -0.1922 & 2.6198 & 0 \\
0.4378 & 0.4378 & 0.9649 & 0.9649 & -1.8595 & 0.7162 & 0 \\
0 & 0 & 0 & 1.00 & -1.8069 & 0 & 0 \\
0.4378 & 0.4378 & -0.0351 & -0.0351 & -0.0526 & 0.7162 & 0 \\
0 & 0 & 0 & 0 & 1.00 & 0 & 0 \\
0.3601 & 0.3601 & -0.0948 & -0.0948 & 0.0758 & 1.5891 & 0 \\
-1.2472 & -1.2472 & 0.1000 & 0.10 & 0.1497 & -2.0405 & 1.00
\end{bmatrix}
$$

$$
B = \begin{bmatrix}
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
-0.0977 & 0 & 0 & 0 & 1.2615 & 1.2615 & 0 & 0 & -0.0977 \\
0 & 0 & 2.0856 & 0 & 0.6866 & 0.6866 & 0 & 0 & 0 \\
-0.0230 & 0 & 0 & 0.0319 & 0 & 0.0319 & 0 & 178.2744 & -0.0230 \\
0 & 0 & 0.2150 & 0.2017 & 0 & 0.2017 & 0 & 0 & 0 \\
0 & 1.9745 & -2.6722 & 0 & 0 & 0 & 0.5184 & 0 & 1.1682
\end{bmatrix}
$$

APPENDIX B (Continued)

$$
C = \begin{bmatrix}
-32.2789 \\
0 \\
0 \\
140.6676 \\
-33.1981 \\
50.5336 \\
34.8508 \\
117.6342
\end{bmatrix}
\qquad
W = \begin{bmatrix}
GFR \\
NFI \\
TCAP \\
MACEQ \\
FACIL \\
LCOST \\
VCAP \\
DELRATE
\end{bmatrix}
\qquad
X = \begin{bmatrix}
FLAB \\
FAMEXPC \\
OFINC \\
SHCRED \\
INTCRED \\
OBOR \\
AP \\
WAGE \\
TCRED
\end{bmatrix}
$$

Where: A = matrix of the endogenous variables coefficients

A^{-1} = inverse matrix of the endogenous variable coefficients

W = vector of the endogenous variables

B = matrix of the exogenous variable coefficients

X = vector of the exogenous variables

C = vector of constant terms

The reduced form of the model: $W = (A^{-1}) C + (A)^{-1} BX$ is presented in Table 15.

2. Cropland cultivated at highest value (TARLAC = 48.36 dunom)

$$
A = \begin{bmatrix}
1.0 & 0 & -0.0276 & 0 & 0 & -0.735 & -2.6371 & 0 \\
-1.0 & 1.0 & 0 & 0 & 0 & 1.0 & 1.0 & 0 \\
0 & 0 & 1.0 & -1.0 & -1.0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1.0 & 0 & 1.8069 & 0 & 0 \\
0 & -0.0640 & 0 & 0 & 1.0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1.0 & 0 & 0 \\
0 & -0.0568 & 0.0659 & 0 & 0 & 0 & 1.0 & 0 \\
0 & 0.1823 & 0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix}
$$

APPENDIX B (Continued)

$$
A^{-1} = \begin{bmatrix}
1.1539 & 0.1539 & -0.1585 & -0.1585 & -0.1585 & 0.9805 & 2.8879 & 0 \\
1.0962 & 1.0962 & -0.0879 & -0.0879 & -0.0879 & -0.1316 & 1.7936 & 0 \\
0.0702 & 0.0702 & 0.9944 & 0.9944 & 0.9944 & -1.8153 & 0.1148 & 0 \\
0 & 0 & 0 & 1.0 & 0 & -1.8064 & 0 & 0 \\
0.0702 & 0.0702 & -0.0056 & -0.0056 & 0.9944 & -0.0084 & 0.1148 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0.0576 & 0.0576 & -0.0705 & -0.0705 & -0.0705 & -0.1122 & 1.0443 & 0 \\
-0.1998 & -0.1998 & 0.0160 & 0.0160 & 0.0160 & 0.0240 & -0.3270 & 1.0
\end{bmatrix}
$$

$$
B = \begin{bmatrix}
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
-0.0977 & 0 & 0 & 0 & 1.2615 & 1.2615 & 0 & 0 & -0.0977 \\
0 & 0 & 2.0857 & 0 & 0.6866 & 0.6866 & 0 & 0 & 0 \\
-0.0230 & 0 & 0 & 0.0319 & 0 & 0.0319 & 0 & 178.2744 & -0.0230 \\
0 & 0 & 2.2150 & 0.2107 & 0 & 0.2107 & 0 & 0 & 0 \\
0 & 1.9745 & -26722 & 0 & 0 & 0 & 0.5184 & 0 & 1.1682
\end{bmatrix}
$$

$$
C = \begin{bmatrix}
121.3739 \\
0 \\
0 \\
291.5360 \\
-33.1981 \\
85.3558 \\
74.5382 \\
214.0463
\end{bmatrix}
\qquad
W = \begin{bmatrix}
GFR \\
NFI \\
TCAP \\
MACEQ \\
FACIL \\
LCOST \\
VCAP \\
DELRATE
\end{bmatrix}
\qquad
X = \begin{bmatrix}
FLAB \\
FAMEXPC \\
OFINC \\
SHCRED \\
INTCRED \\
OBOR \\
AP \\
WAGE \\
TCRED
\end{bmatrix}
$$

The reduced form of the model is presented in Table 16.

APPENDIX B (Continued)

3. Cropland cultivated at lowest value (TAREAC = 6.00 dunom)

$$A = \begin{bmatrix}
1.0 & 0 & -0.0276 & 0 & 0 & -0.7350 & -2.6361 & 0 \\
-1.0 & 1.0 & 0 & 0 & 0 & 1.0 & 1.0 & 0 \\
0 & 0 & 1.0 & -1.0 & -1.0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1.0 & 0 & 1.8069 & 0 & \bullet \\
0 & -1.7805 & 0 & 0 & 1.0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1.0 & 0 & 0 \\
0 & -1.5816 & 0.0659 & 0 & 0 & 0 & 1.0 & 0 \\
0 & 5.0726 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}$$

$$A^{-1} = \begin{bmatrix}
-1.7056 & -2.7056 & 0.0709 & 0.0709 & 0.0709 & 1.3238 & -1.7905 & 0 \\
-0.6921 & -0.6921 & 0.0555 & 0.0555 & 0.0555 & 0.0831 & -1.1324 & 0 \\
-1.2323 & -1.2323 & 1.0989 & 1.0989 & 1.0989 & -1.6590 & -2.0162 & 0 \\
0 & 0 & 0 & 1.0 & 0 & -1.8069 & 0 & 0 \\
-1.2323 & -1.2323 & 0.0989 & 0.0989 & 1.0989 & 0.1479 & -2.0162 & 0 \\
0 & 0 & 0 & 0 & 0 & 1.0 & 0 & 0 \\
-1.0135 & -1.0135 & 0.0154 & 0.0154 & 0.0154 & 0.2407 & -0.6581 & 0 \\
3.5109 & 3.5109 & -0.2816 & -0.2816 & -0.2816 & -0.4215 & 5.744 & 1.0
\end{bmatrix}$$

$$B = \begin{bmatrix}
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
-0.0977 & 0 & 0 & 0 & 1.2615 & 1.2615 & 0 & 0 & -0.0977 \\
0 & 0 & 2.0857 & 0 & 0.6866 & 0.6866 & 0 & 0 & 0 \\
-0.0230 & 0 & 0 & 0.0319 & 0 & 0.0319 & 0 & 178.2744 & -0.0230 \\
0 & 0 & 0.2150 & 0.2017 & 0 & 0.2017 & 0 & 0 & 0
\end{bmatrix}$$

APPENDIX B (Continued)

$$
C = \begin{bmatrix} -75.0184 \\ 0 \\ 0 \\ 101.5399 \\ -33.1981 \\ 41.5316 \\ 24.5954 \\ 203.3784 \end{bmatrix}
\qquad
W = \begin{bmatrix} GFR \\ NFI \\ TCAP \\ MACEQ \\ FACIL \\ LCOST \\ VCAP \\ DELRATE \end{bmatrix}
\qquad
X = \begin{bmatrix} FLAB \\ FAMEXPC \\ OFINC \\ SHCRED \\ INTCRED \\ OROR \\ AP \\ WAGE \\ TCRED \end{bmatrix}
$$

The reduced form of the model is presented in Table 17.

Kharj

1. Cropland cultivated at the mean (TAREAC = 48.36 dunom).

$$
A = \begin{bmatrix}
1.0 & 0 & -0.0766 & 0 & 0 & 0 & -0.5388 & 0 \\
-1.0 & 1.0 & 0 & 0 & 0 & 1.0 & 1.0 & 0 \\
0 & 0 & 1.0 & -1.0 & -1.0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1.0 & 0 & 0.3837 & 0 & 0 \\
0 & -0.4899 & 0 & 0 & 1.0 & -3.2275 & 0 & 0 \\
0 & 0 & -0.0882 & 0 & 0 & 1.0 & 0 & 0 \\
0 & 0 & -0.0408 & 0 & 0 & 0 & 1.0 & 0 \\
0 & 1.2627 & 0 & 0 & 0 & 0 & 0 & 1.0
\end{bmatrix}
$$

$$
A^{-1} = \begin{bmatrix}
1.0632 & 0.0632 & 0.1290 & 0.1290 & 0.1290 & 0.3037 & 0.5096 & 0 \\
0.9805 & 0.9805 & -0.0398 & -0.0398 & -0.0398 & -1.0937 & -0.4522 & 0 \\
0.6412 & 0.6412 & 1.3088 & 1.3088 & 1.3088 & 3.0807 & -0.2957 & 0 \\
-0.0217 & -0.0217 & -0.0443 & 0.9557 & -0.0443 & -0.4880 & 0.0100 & 0 \\
0.6629 & 0.6629 & 0.3531 & 0.3531 & 1.3531 & 3.5687 & -0.3057 & 0 \\
0.0566 & 0.0566 & 0.1154 & 0.1154 & 0.1154 & 1.2717 & -0.0261 & 0 \\
0.0262 & -0.0262 & 0.0534 & 0.0534 & 0.0534 & 0.1257 & 0.9879 & 0 \\
-1.2381 & -1.2381 & 0.0503 & 0.0503 & 0.0503 & 1.3810 & 0.5710 & 1.0
\end{bmatrix}
$$

APPENDIX B (Continued)

b =

$$\begin{bmatrix} -0.0625 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -100.4501 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -0.0962 & 0 & 0 & 0 & 0.8822 & 0.8822 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.0557 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 785.8627 & 0 & 0 \\ 0 & 0 & 0.0303 & 0.2588 & 0.2588 & 0 & 0 & 0 & 0 & 6.5008 \\ 0 & 0.5879 & -0.1761 & 0 & 0 & 0 & -0.4847 & 0 & 0.1352 & 0 \end{bmatrix}$$

$$C = \begin{bmatrix} 136.7826 \\ 0 \\ 0 \\ 104.4013 \\ 104.0984 \\ 3.0508 \\ 3.0508 \\ -158.034 \end{bmatrix} \qquad W = \begin{bmatrix} GFR \\ NFI \\ TCAP \\ MACEQ \\ FACIL \\ LCOST \\ VCAP \\ DELRATE \end{bmatrix} \qquad X = \begin{bmatrix} FLAB \\ FAMEXPC \\ OFINC \\ SHCRED \\ INTCRED \\ OBOR \\ AP \\ WAGE \\ TCRED \\ WEATH \end{bmatrix}$$

The reduced from of the model is presented in Table 18.

2. Cropland cultivated at highest value (TAREAC = 230.00 dunom).

$$A = \begin{bmatrix} 1.0 & 0 & -0.0766 & 0 & 0 & 0 & -0.5388 & 0 \\ -1.0 & 1.0 & 0 & 0 & 0 & 1.0 & 1.0 & 0 \\ 0 & 0 & 1.0 & -1.0 & -1.0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1.0 & 0 & 0.3837 & 0 & 0 \\ 0 & -0.1030 & 0 & 0 & 1.0 & -3.2275 & 0 & 0 \\ 0 & 0 & -0.0882 & 0 & 0 & 1.0 & 0 & 0 \\ 0 & 0 & -0.0408 & 0 & 0 & 0 & 1.0 & 0 \\ 0 & 0.2655 & 0 & 0 & 0 & 0 & 0 & 1.0 \end{bmatrix}$$

APPENDIX B (Continued)

$A^{-1} =$

$$
\begin{bmatrix}
1.0135 & 0.0135 & 0.1310 & 0.1310 & 0.1310 & 0.3592 & 0.5326 & 0 \\
0.9958 & 0.9958 & -0.0404 & -0.0404 & -0.0404 & -1.1108 & -0.4593 & 0 \\
0.1369 & 0.1369 & 1.3292 & 1.3292 & 1.3292 & 3.6432 & -0.0631 & 0 \\
-0.0046 & -0.0046 & -0.0450 & 0.9550 & -0.0450 & -0.5070 & 0.0021 & 0 \\
0.1415 & 0.1415 & 0.3742 & 0.3742 & 1.3742 & 4.1502 & -0.0653 & 0 \\
0.0121 & 0.0121 & 0.1172 & 0.1172 & 0.1172 & 1.3213 & -0.0056 & 0 \\
0.0056 & 0.0056 & 0.0542 & 0.0542 & 0.0542 & 0.1486 & 0.9974 & 0 \\
-0.2644 & -0.2644 & 0.0107 & 0.0107 & 0.0107 & 0.2949 & 0.1219 & 1.0
\end{bmatrix}
$$

$b =$

$$
\begin{bmatrix}
-0.0625 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -100.4501 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
-0.0963 & 0 & 0 & 0 & 0.8822 & 0.8822 & 0 & 0 & 0 & 0 \\
0 & 0 & 0.0557 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 785.8627 & 0 & 0 \\
0 & 0 & 0.0303 & 0.2588 & 0.2588 & 0 & 0 & 0 & 0 & 0.5879 \\
0 & 0.5879 & -0.1751 & 0 & 0 & 0 & -0.4847 & 0 & 0.1352 & 0
\end{bmatrix}
$$

$$
C = \begin{bmatrix}
475.9638 \\
0 \\
0 \\
104.4013 \\
328.0969 \\
79.3229 \\
79.3229 \\
-73.1262
\end{bmatrix}
\qquad
W = \begin{bmatrix}
CFR \\
NFI \\
TCAP \\
MACEQ \\
FACIL \\
LCOST \\
VCAP \\
DELRATE
\end{bmatrix}
\qquad
X = \begin{bmatrix}
FLAB \\
FAMEXPC \\
OFINC \\
SHCRED \\
VTCRED \\
OBOR \\
AP \\
WAGE \\
TCRED \\
WEATH
\end{bmatrix}
$$

The reduced form of the model is presented in Table 19.

APPENDIX B (Continued)

3. Cropland cultivated at lowest value (TAREAC = 9.00 dunom).

$$
A = \begin{bmatrix}
1.0 & 0 & -0.0766 & 0 & 0 & 0 & -0.5788 & 0 \\
-1.0 & 1.0 & 0 & 0 & 0 & 1.0 & 1.0 & 0 \\
0 & 0 & 1.0 & -1.0 & -1.0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1.0 & 0 & 0.3837 & 0 & 0 \\
0 & -0.4899 & 0 & 0 & 1.0 & -3.2275 & 0 & 0 \\
0 & 0 & -0.0882 & 0 & 0 & 1.0 & 0 & 0 \\
0 & 0 & -0.0408 & 0 & 0 & 0 & 1.0 & 0 \\
0 & 1.2627 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
$$

$$
A^{-1} = \begin{bmatrix}
1.0632 & 0.0632 & 0.1290 & 0.7290 & 0.1290 & 0.3037 & 0.5096 & 0 \\
0.9805 & 0.9805 & -0.398 & -0.0398 & -0.0398 & -1.1937 & -0.4522 & 0 \\
0.6412 & 0.6412 & 1.3088 & 1.3088 & 1.3088 & 3.0807 & -0.2957 & 0 \\
-0.0217 & -0.0217 & -0.0443 & 0.9557 & -0.0443 & -0.4880 & 0.0100 & 0 \\
0.6629 & 0.6629 & 0.3531 & 0.3531 & 1.3531 & 3.5687 & -0.3057 & 0 \\
0.0566 & 0.0566 & 0.1154 & 0.1154 & 0.1154 & 1.2717 & -0.0261 & 0 \\
0.0262 & 0.0262 & 0.0634 & 0.0534 & 0.0534 & 0.1257 & 0.9879 & 0 \\
-1.2381 & -1.2381 & 0.0503 & 0.0503 & 0.0503 & 1.3810 & 0.5710 & 1.0
\end{bmatrix}
$$

$$
b = \begin{bmatrix}
-0.0625 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
-0.092 & 0 & 0 & 0 & 0.8822 & 0.8822 & 0 & 0 & 0 & 0 \\
0 & 0 & 0.0557 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 785.8627 & 0 & 0 \\
0 & 0 & 0.0303 & 0.2588 & 0.2588 & 0 & 0 & 0 & 0 & 6.5008 \\
0 & 0.5879 & -0.1761 & 0 & 0 & 0 & -0.4847 & 0 & 0.1352 & 0
\end{bmatrix}
$$

APPENDIX B (Continued)

$$
C = \begin{bmatrix} 136.7826 \\ 0 \\ 0 \\ 104.4013 \\ -104.0984 \\ 3.0508 \\ 3.0508 \\ -158.0834 \end{bmatrix}
\qquad
W = \begin{bmatrix} GFR \\ NFI \\ TCAP \\ MACEQ \\ FACIL \\ LCOST \\ VCAP \\ DELRATE \end{bmatrix}
\qquad
X = \begin{bmatrix} FLAB \\ FAMEXPC \\ OFINC \\ SHCRED \\ INTCRED \\ OBOR \\ AP \\ WAGE \\ TCRED \\ WEATH \end{bmatrix}
$$

The reduced form of the model is presented in Table 20.

APPENDIX C

PROCEDURES FOR COMPUTING THE CORRECTED

STANDARD ERRORS, F AND R^2 FOR

THE 2SLS MODELS

APPENDIX C

PROCEDURES FOR COMPUTING THE CORRECTED STANDARD ERRORS, F AND R^2 FOR THE 2SLS MODELS

Consider the hypothetical equation of the model:

$$Y_1 = Y_2 \gamma_1 + X_1 \beta_1 + U_1$$

Where Y_1 = nx1 vector of the observations on the dependent variable,

Y_2 = nxL matrix of deservations of the other endogenous variables included in the equation,

X_1 = nxk matrix of observations of the predetermined variables,

β_1 = Lx1 vector of coefficient associated with Y_1,

γ_1 = kx1 vector of coefficient associated with X_1,

U_1 = nx1 vector of error terms.

The problem is that Y_2 is correlated with U_1. This is solved by replacing Y_2 with its estimates $\hat{Y}_2$ which is uncorrelated with U_1. This is done by 2SLS in the following stages:

First Stage: Obtain unbiased estimates of Y_2 by regressing Y_2 on all X's (all the exogenous variables in the system).

If the theoritical solution is: $Y_2 = X \pi_1 + V_1$

where π_1 is the coefficient vector associated with X and V_1 is the error vector. Let the OLS estimate by $\hat{Y}_2 = X \hat{\pi}_1$

Second Stage: Replacement of Y_2 by $\hat{Y}_2$ and apply OLS to the equation: $Y_1 = \hat{Y}_2 \gamma_1 + X \beta_1 + U_1$

The 2SLS solves the over supply of exogenous variable problem by linear combinations of the original exogenous variable in the form of:

$\hat{Y}_2 = X \hat{\Pi}_1$ This reduces the number of exogenous variables to the desired number.

The estimate obtained by the 2SLS has also proved to be unbiased and consistent. This is because in the second stage of $\hat{Y}_2$, the estimator of Y_1, the endogenous vector is uncorrelated with U_1 (21, P. 96).

However, the standard errors associated with π_1, β_1, t's, F-statistics, and R^2 are not valid and how to be corrected by the following procedures:

$$Y_1 = \hat{Y}_2 \Pi_1 + X \beta_1 \qquad (1)$$

substituting the observed values for Y_1 and $\hat{Y}_1$ in (1) to compute the new error terms (residuals) $\hat{U}_n$:

$$Y_1 - Y_2 \pi_1 - X \beta_1 = \hat{U}_1 \qquad (2)$$

where $\hat{Y}_2 \pi + X \beta_1 = \hat{Y}_1$

Then $ESS_n = \hat{U}'_n \hat{U}_n$; $s^2_n = \dfrac{ESS_n}{T-K}$

The corrected standard error of the coefficients (SE_n) is computed as:

$$SE_n = \dfrac{\sqrt{s^2_n}}{\sqrt{s^2_o}} \quad x \quad SE_o$$

Then:

$$t_c = \dfrac{\text{Estimated coefficients from the Second Stage}}{SE_n}$$

$$F_c = \dfrac{RSS_n/k-1}{ESS_n/T-k} \quad ; \quad RSS_n = TSS - ESS_n$$
$$TSS = Y'_1 Y_1 - T\bar{Y}^2_1$$

$$R^2_c = \dfrac{RSS_n}{TSS}$$

where ESS_n = Error sum of squares

s^2_n = New variance

SE_o = Old standard error (from the second stage, equation 1),

RSS_n = New sum of squares due to legression,

Tss = Total corrected sum of squares,

S^2_o = Old variance (from second stage, equation 1),

T = Number of observation on the dependent variable,

K = Number of predetermined variables included in the model.

VITA

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