BARD

FINAL REPORT

PROJECT No. US-446-81

Economic Development and Changing Structure of the Family Farm

W. Peterson, Y. Kislev

1986

Standard BARD Cover Page for Scientific Reports

Date 1-30-86

BARD
P.O. Box 6
Bet Dagan, ISRAEL

BARD Project No. US-446-81

Title of Research Project:

Economic Development and Changing Structure of the Family Farm

Names of Investigators:

Principal Investigator: Willis Peterson

Cooperating Investigator(s): Yoav Kislev

Name and Address of Affiliated Institutions:

Principal Institution: University of Minnesota

St. Paul, Minnesota

Cooperating Institution(s): Hebrew University

Rehovot, Israel

Project's starting date: October 1, 1982

Type of Report: 1st Annual _____ 2nd Annual _____ Final x

Signatures:

Principal Investigator

Willis Peterson

Institution's Authorizing Official

Marilyn Surbey

Marilyn Surbey, Asst. Director
Office of Research Administration

Table of Contents

Abstract

Objective of Original Research Proposal

An Investigation into the Structure of Agriculture

Description of Cooperation

Research Achievements

Benefit to Agriculture

List of Publications

Appendix

Abstract

The research on this BARD project can be divided into three categories. 1. work done primarily in the U.S. 2. work done jointly in the u.S. and Israel, and 3. work done primarily in Israel. Research in category 1 focused mainly on the family farm in the U.S. and how it responds to economic forces acting upon it. The second category of research was stated under our previous BARD project and completed under this project. It attempted to determine whether labor was pushed out of agriculture by new mechanical technology, or pulled out by rising real wages in nonfarm occupations. The third category of work centered mainly on the family farm in the Israeli moshav. Since the economic environment in which these farms operate is quite complex, the analysis had to cover many aspects including agricultural settlement, the impact of economy-wide policy and development, the role of regional cooperatives, and tax policy.

The project generated 11 papers during its 3-year duration. Their titles are given in the list of publications and a copy of each is included in the Appendix of this report. The first 5 papers stem from the U.S. research, number 6 is from our joint efforts, and papers 7-11 stem from work in Israel. Paper 6 is scheduled to be published in the March 1986 issue of the Journal of Economic History. Paper No. 10 is being published in the Economic Quarterly (in Hebrew). The other papers should be considered to be in preliminary form. The project turned out to be larger and more complicated than expected and was not completed in the allotted time. Work continues and will be reported to BARD upon completion. Much of the material in category 1 will be part of a Ph.D thesis by John

Rodgers. We anticipate that several journal articles will be forthcoming after the thesis is completed later this year.

The body of the report entitled "An Investigation into the Structure of Agriculture" contains three parts, corresponding to the three categories of work mentioned above. Major emphasis in the paper is given to category I.

Objectives of Original Research Proposal

The study was composed of two related but distinct parts:

1. Dynamics of adjustments in the family farms in Israel
2. Farm size and specialization in American agriculture

The following objectives were planned:

- a. Describe structural changes in terms of product composition, farm size, capital intensification, and part-time employment
- b. Analyze the relations between these changes and internal and external economic and social factors such as development in manufacturing, nonfarm income, changing technology, introduction of new crops, human capital of the farm family, and investment in agricultural research.
- c. Analyze the effect of growth and development on the structure of the cooperative in the moshav in Israel.

The original proposal called for an international comparison of growth in agriculture and other sectors. This part was not funded and is therefore not included in the work. The empirical part of the U.S. work remains to be done but will be included in Rodger's Ph.D. thesis.

AN INVESTIGATION INTO THE STRUCTURE OF AGRICULTURE

I. In this research, an approach to modeling the agricultural sector has been developed which facilitates an investigation of various aspects of the structure of agriculture. The analysis has been specifically directed at the behavior of the family farm and how it responds to the economic forces acting upon it. The view was taken that a satisfactory theoretical framework for the analyzing the structure of agriculture does not exist. Most previous analyses are based, usually implicitly, on partial equilibrium approaches to modeling the behavior of the sector, or of firms within it, and most empirical work has lacked an adequate theoretical framework. The view adopted here is that before fruitful empirical work can be undertaken, a satisfactory theoretical foundation is necessary. Accordingly, this research has primarily been of a theoretical nature.

In the next section of this paper, a brief description of the theoretical approach adopted in this research is given, and in the third section a summary of some of the results of our research to date will be given. Research into the structure of agriculture is continuing at the University of Minnesota, building upon the work already undertaken under BARD funding.

The Theoretical Framework

The agricultural sectors of most, if not all, economies are continually being modified by forces which are both internal and external to the sector. Because aggregate economic activity does not always follow the same logic as economic activity at the individual agent level, it is not possible to

always correctly infer sector level change on the basis of behavior of individual firms and/or households within the sector. It is necessary to take a wider view. However, structural change at the sector level is partially determined by the behavior of individual agents, and so such behavior is an essential consideration in investigating structural change at the industry level.

Accordingly, it is suggested that the appropriate framework is provided by general equilibrium analysis. Unfortunately, general equilibrium analysis applied to agriculture does not promise to be a very fruitful exercise. The commonly held view is that the perfectly competitive model is adequate and all of the important results are known. The view taken in this research is that the perfectly competitive model is not an adequate representation of an agricultural economy particularly in the way the managerial input is, or is not, incorporated into the model. Most models of the agricultural firm do not explicitly specify the managerial input. The implicit assumption is that the managerial input is homogeneous across firms. Management may, or may not, be a limiting input as a firm attempts to expand. Models that do attempt to incorporate the managerial input, usually do so in ways which indicate that its level can be controlled in some way.

The view taken here is that: (a) management is a necessary input into the farm firm, (b) the supply of the managerial input to each firm is perfectly inelastic, and (c) the quality of the managerial input varies between firms. The easiest way to envisage this is to regard every human being as possessing or embodying some level of managerial ability. Such

ability varies among the population. A necessary condition for the existence of a farm firm is the presence of one, and only one, manager. The managerial input cannot be traded, nor can it be substituted for other inputs within the firm. While this is a somewhat rigid specification, it is more consistent with reality than most previous approaches. The implications of this view of the farm firm will be shown below.

The various models of the agricultural sector which have been developed in this research are essentially variants, or extensions, of the following basic model. We view the economy as consisting of two sectors: agriculture which produces output A, and manufacturing which produces output M. The agricultural sector is assumed to be much smaller than the other sector. The economy is composed of a large number of agents who are alike in all respects except that they have different levels of farm management ability. (We could consider agents who have an aversion to being farmers, as having low farm management ability irrespective of their actual talent for farming). Let the farm management ability of each agent be measured by an index, x , drawn from a fixed distribution $T: R^+ \rightarrow [0,1]$. Because of the relative sizes of the two sectors, most agents will work in the manufacturing sector and only those agents with relatively high farm management talent levels will be occupied in the agricultural sector.

In addition to farm management ability, each agent is endowed with a unit of labor. The other productive resources in the economy are land and capital. Land has a mean availability of $\bar{l}$ (that is the land per agent is $\bar{l}$), and the mean availability of capital is $\bar{k}$. There are two outputs: food from the

agricultural sector all of which is consumed by agents, and a manufactured good which can be consumed by agents or used as an input into agricultural production as a *purchased input*.

The technology employed in the agricultural sector involves a *production technology* and a *managerial technology*. Even though this construction is somewhat artificial, it is convenient for our purpose here. For the production technology, let $F(a,b)$ be the output produced with a units of land and b units of purchased input using *normal* management. $F(a,b)$ is assumed to linear homogeneous, so that $F(a,b)=af(r)$, where $r=a/b$. $F:R^+ \times R^+$ is assumed twice differentiable, increasing and strictly concave.

The managerial technology is assumed to have two elements: the first associated with the management input and the second involving a "span of control" limitation or decreasing return to scale property. As previously discussed, each agent is endowed with a managerial talent level. The output of a farm firm managed by an agent with a talent level of x is assumed to be given by: $x \alpha [F(a,b)]^\beta$ where $\alpha > 0$ and $0 < \beta < 1$. This implies that each firm consists of one manager who supplies his managerial talent, x , and his unit of labor to the firm which also uses a units of land and b units of the manufactured good. The span of control limitation is captured by the assumption that $0 < \beta < 1$, which means that a proportional increase in the land and manufactured inputs will result in a less than proportional increase in output of the firm.

The multiplicative way in which the managerial input enters the firms production function, means that for given levels of land and manufactured

inputs, managers with greater talent will produce more output. While this construction captures the basic characteristic of the heterogeneous management assumption, namely better managers are more productive, we have not said anything about what a manager does, and we have not allowed the possibility of varying the endowed managerial talent levels. Because the output of a firm with managerial talent level x is: $x\alpha[F(a,b)]^\beta$ it is obvious that the marginal products of both inputs a and b are increasing functions of x . From this we can infer that, if all firms face the same input prices, then the optimal levels of a and b will be dependent on x . The implication is that if there exists a distribution of managerial talents in the population, as we have assumed, then there will also exist a distribution of firm sizes, as we actually do observe. Because the input level can vary between firms it is more correct to write the output of a firm with a managerial talent level of x as: $x\alpha[F(a(x),b(x))]^\beta$. For brevity the following notation will be used: $a_x=a(x)$, $b_x=b(x)$, $F_x=F(a(x),b(x))$.

The production technology in the manufacturing sector is given by a Cobb-Douglas function exhibiting decreasing returns to scale so that the output per unit of labor is given by: γk^β . The mean availability of capital is k . In this simple static model the amount of capital is determined exogenously; that is, capital formation by foregoing consumption is not a possibility.

All agents are assumed to have identical utility functions, $U(A,M)$, which are assumed to be well behaved; that is: continuous, twice differentiable, increasing, and strictly concave. If we assume a continuum of agents, then

competitive behavior is implied. In the absence of externalities, a competitive equilibrium is given by the solution to the social planners problem. We can envisage some division of agents into those who are farm managers and those who work in the manufacturing sector. Since all agents are equally productive in the manufacturing sector, it seems reasonable to suppose that in allocating agents between the two sectors the appropriate selection criterion is the level of farm management ability, which is assumed to vary among agents. Accordingly we can envisage a farm managerial talent level, z , which is such that all agents with $x \geq z$ will be farm managers, leaving all agents with $x < z$ to work in the manufacturing sector. An allocation can be defined as a number, z , which gives the separation line between farmers and nonfarmers, and a pair of functions, $a(x)$ and $b(x)$, which give quantities of inputs used by a manager with a managerial talent level of x . The maximization problem involves choosing z , $a(x)$, and $b(x)$, so that social welfare is maximized.

The stated assumptions allow the social planners problem to be formulated as the following representative agent model:

Maximize $U(A, M)$
 A, M, z, a, b

$$\begin{aligned} \text{subject to: } & \int_z^\infty x \alpha F_{x^2} dT(x) - A \geq 0 \\ & \int_0^z \gamma k^2 dT(x) - M - \int_z^\infty b_x dT(x) \geq 0 \\ & 1 - \int_z^\infty a_x dT(x) \geq 0 \end{aligned}$$

$$\kappa - \int_0^z k \, dT(x) \geq 0$$

It is assumed an interior solution exists. The first order conditions for a maximum solution are:

$$U_A - \lambda = 0$$

$$U_M - \nu = 0$$

$$-\lambda z a F_z^A + \nu \gamma k^A + \nu b_z + \mu a_z - \kappa k = 0$$

$$\int_z^\infty x a \beta F_x^{A-1} F_{x/z} \, dT(x) - \mu \int dT(x) = 0$$

$$\int_z^\infty x a \beta F_x^{A-1} F_{x/b} \, dT(x) - \nu \int dT(x) = 0$$

$$\int_z^\infty x a F_x^A \, dT(x) - A = 0$$

$$\int_0^z \gamma k^A \, dT(x) - M - \int_z^\infty b_x \, dT(x) = 0$$

$$1 - \int_z^\infty a_x \, dT(x) = 0$$

$$\kappa - \int_0^z k \, dT(x) = 0$$

where λ , ν , μ , κ are the shadow prices of food, the manufactured output, land, and capital respectively. $F_{x/z}$ and $F_{x/b}$ are the derivatives of F_x with respect to a and b respectively.

The first two conditions imply utility maximization by equating marginal utility with the price of the good in question. The third condition is of most interest and so we will defer discussion on it. The third and fourth conditions are the marginal conditions on the use of land and the manufactured good on farms. The remaining four conditions specify market clearing in each of the

four implied markets: food, manufactured good, land, and capital.

It is the third condition which makes this model interesting and useful. This condition specifies that the agent with farm managerial talent z , will just break even when the economy is in equilibrium. We shall define this as the marginal farm firm. All farms with $x > z$ will be making a positive return to managerial input (=positive managerial rent =profit), while all farms with $x < z$ will earn negative managerial rent (=losses). Under standard assumptions of economic analysis, farms which earn negative managerial rent will quit the industry. The terms in the third condition are as follows:

$\lambda z \alpha F_z$ gives the value of output of a farm with managerial input z .

$v b_z$ gives the value of the manufactured input used by such a farm.

μa_z gives the value of land used by such a farm.

$v r k^d$ gives the gross value of output of a unit of labor in the manufacturing sector.

$u k$ gives the value of capital used per unit of labor in the manufacturing sector.

$(v r k^d - u k)$ can be viewed as the marginal revenue product of labor

= market wage rate or the wage rate in the manufacturing sector.

The third condition implies that the marginal firm earns revenue which is just sufficient to cover the cost of purchased inputs, land rent, and the opportunity cost of the farm manager. The opportunity cost of a farm manager is the value of his labor when he is employed outside agriculture. This is the manufacturing sector wage rate. This model is interesting and useful because it can be used to study the various factors which can cause z to

change. An increase in z means that the farm managerial talent level of the marginal farm has increased which implies that there are fewer farmers. A decrease in z means a fall in the breakeven talent level, and hence more farmers.

If we make the assumption that the agricultural sector is small relative to the economy as a whole then this implies that changes in the former have an insignificant effect on the rest of the economy. For example, if there is some parameter change internal to the agricultural sector, which causes z to decrease, (meaning that more agents become farmers), then this will cause k (capital per worker in the manufacturing sector) to increase which in turn would have some impact on the wage rate or the marginal product of labor in the manufacturing sector. The small sector assumption means, among other things, that the impact on k , of variations in z are sufficiently small to be ignored. Of course the opposite is not true. Changes in the larger sector which result in changes to the price of the manufactured good and the wage rate cannot be ignored.

The various models derived within the above framework have made the small sector assumption. This facilitates considerable simplification. For example, if we assume: (a) that the marginal product of labor in manufacturing is essentially independent of behavior of agents at the margin between the two sectors, (b) the market price of the manufactured good is constant, and (c) the demand for food is effectively independent of other components of the system, we can propose a much simpler model which will enable us to more easily study the features of interest. If we assume that: the inverse

demand by each agent for agricultural output (food), is given by $P(q)$ such that $P' < 0$, the price of the manufactured good is v , and the wage rate is w , we can formulate a "sector equilibrium" model of the agricultural sector which effectively captures the features of interest from the above general equilibrium model. The sector equilibrium model can be stated as:

$$\text{Maximize}_{z, a, b, Q^*} \int_0^{Q^*} P(q) dq - \int_z^{\infty} (vb_x + w) dT(x)$$

$$\text{subject to: } \int_z^{\infty} x \alpha F_x^{\beta} dT(x) - Q^* = 0$$

$$1 - \int_z^{\infty} a_x dT(x) = 0$$

where Q^* is the total output of the agricultural sector. The first order conditions for this model are:

$$- \lambda z \alpha F_z^{\beta} + vb_z + w + u a_z = 0$$

$$\lambda \int_z^{\infty} x \alpha \beta F_x^{\beta-1} F_{x/z} dT(x) - u \int_z^{\infty} dT(x) = 0$$

$$\lambda \int_z^{\infty} x \alpha \beta F_x^{\beta-1} F_{x/b} dT(x) - v \int_z^{\infty} dT(x) = 0$$

$$P(Q^*) - \lambda = 0$$

$$\int_z^{\infty} x \alpha F_x^{\beta} dT(x) - Q^* = 0$$

$$1 - \int_z^{\infty} a_x dT(x) = 0$$

In this case, the first condition requires the marginal farm to break

even, the second and third conditions are the marginal conditions on the use of land and the manufactured input, the fourth condition specifies the market clearing price for food, while the last two conditions are the market clearing conditions for food and land. This is the basic sector equilibrium model which is used as a foundation for the analysis of farm structure in this research.

Variations of, and extensions to, this model are used to investigate the impact on the structure of the agricultural sector of various changes in the technical and economic environment of the agricultural firm. Inferences about the structure of the sector can be made by observing the behavior of the marginal firm.

Consider a simple example. It is a straight forward matter, although algebraically a little tedious, to show that an increase in the wage rate in the manufacturing sector will cause farm closures at the margin (because farm managers who are making negligible profit will be attracted out of agriculture). This in turn will cause a reduction in the relative price of land and an increase in the average farm area. The price of the agricultural output will increase and farmers will seek to increase output. However total output of the sector will decline.

Examples of more complex analyses include: the investigation of the impact of technological change on the number of farm firms when there is an adoption cost which is a decreasing function of the level of farm managerial ability; and the impact of output price support and input subsidy programs on the structure of agriculture.

The next section will contain a brief description of the discussion papers issued to date on this research and their principle results or conclusions.

Outline of the Papers Completed to Date

(a) On the Size and Structure of the Agricultural Firm: In this paper the two main issues to be investigated are defined. These are the size distribution of farm firms and the changing patterns of specialization observed in modern agriculture. The general framework for investigating the size distribution of farm firms is outlined and some preliminary results from a simple model are presented. Tentative approaches to analyzing various situations are proposed. Of particular interest, is the impact of technological change on the structure of agriculture. Also outlined is a possible approach to investigating the important factors which influence decisions regarding the degree of farm production specialization. As this is a background discussion paper no conclusions are presented.

(b) On the Nonneutrality of Neutral Technological Change in Agriculture: This paper shows how a neutral change in farm production technology can adversely, or beneficially, impact on the profitability of marginal farm firms. The technological change considered is assumed to increase the production of all farm firms by the same proportion. It is also assumed that the technology is immediately, costlessly, and completely available to all. The nature of the impact on the structure of the agricultural sector is determined by the elasticity of output demand. A larger number of smaller farm firms will result if output demand is elastic, while a smaller number of larger farm

firms will result if demand is inelastic. With unit elasticity, the number and size of farm firms will not tend to change.

(c) On the Distribution of Benefits of Agricultural Price Supports and Input Price Subsidies: This paper investigates the impact on the structure of agriculture of simple output price support and input price subsidy programs. The perfectly competitive model suggests that all benefits from such schemes will be capitalized into land prices. The model proposed in this research involves the assumption of heterogeneous farm management talent which is inelastically supplied to each farm. In this case, the farm management input captures some of the benefits (or incurs some of the losses) caused by price support and subsidy programs. The conclusion is that profits (=rent to farm management talent) will be increased by farm output price supports, and by input price subsidies when output demand is sufficiently elastic. In these cases there will tend to be new entrants into agriculture and so there will be more, smaller farms. But if farm output demand is sufficiently inelastic, rent to the farm managerial input will fall and farm closures will occur as a consequence of losses incurred by farm near the margin; the outcome is fewer, larger farms.

(d) The Impact of Technological Change on the Structure of Agriculture: This paper involves a critical evaluation of the so-called "treadmill" model of technological change, which suggests that technological change in agriculture will always result in fewer, larger farms, and that output price supports will do nothing to alter this process because all the benefits of such programs are capitalized into land prices. The model developed in this research is used

to show that there are conditions under which technological change can be beneficial to "marginal farm firms" to the extent that new entrants are attracted to the sector so that the result is more farm firms, of a smaller average size. Also it is shown, contrary to the treadmill analysis, that output price supports do reduce the impact of technological change in cases where the change results in farm closures. This paper also includes a study of situations where new technologies are costly to adopt. Various cases are analyzed which show that technology adoption cost do cause pressure on marginal farm firms to leave agriculture even when farm output demand is perfectly elastic. One result obtained suggests that if agricultural technology is becoming more expensive (in terms of adoption costs or learning costs) then this will place marginal farmers under continual pressure to quit agriculture.

(e) The Acquisition of Information and the Adoption of New Technology: A Comment. In this paper, it is argued that simple models of learning about, and adopting new technology, which assume a myopic view of the future, do not adequately capture the complex nature of decisions involving knowledge acquisition. Knowledge acquisition decisions need to consider not only the impact of such knowledge on future production, but also on future learning behavior. The model developed in this paper is not a "sector equilibrium" model, but rather it involves a complex decision situation for an individual firm. The model is used to show that decisions concerning knowledge acquisition are more complex than is suggested in the recent literature. Consequently, it is argued that some policy prescriptions, for example subsidization of adoption of new technology, may be inappropriate. It is shown elsewhere, that when learning cost are significant, marginal farm firms will incur losses as a

consequence of the actions of early adopters of new technology. In this case, subsidization of early adoption is also detrimental to late or non- adopters. Our general conclusion is that policies to actively promote the adoption of new technology may have unwanted distributional, and efficiency consequences.

(d) Other work in progress: Other research undertaken but not yet reported includes an investigation of part-time farming. The preliminary results indicate that part-time farming appears to provide an efficient use of resources, and tends to increase the economic viability of marginal farmers. Also some analysis has been undertaken of situations where some farmers do not have any viable income earning opportunities outside agriculture. As one would expect, the analysis shows that when there is pressure on marginal farmers to quit agriculture, an increasing number of farmers without an income earning alternative, decline towards a poverty situation. Limited progress has been made on modeling multiproduct farms in some type of sector equilibrium framework, so as to investigate the important elements of farm production specialization decisions. Also some limited empirical work is underway.

As this work in progress was begun while this research was funded by BARD, appropriate acknowledgement of BARD support will be given. While there have been no publications to date from this research, the intention is to prepare papers suitable for publication from the work already completed and that which is currently underway.

II. In much of the recent economics literature the prevailing view appears to be that new mechanical technology has displaced or pushed labor out of

agriculture. An alternative hypothesis is that labor was pulled out by increasing real wages in nonfarm occupations, with new and larger machines developed and adopted to replace lost labor.

The mechanical cotton harvester is frequently used as an example of labor push. Consequently we used the development and adoption of this machine as a test of the two hypotheses. The results should provide a lower bound to the estimate of labor pull out of agriculture.

A simultaneous equation model of the market for cotton picking labor in the U.S. covering years 1930 to 1964 was formulated and estimated. The decrease in the demand for this labor caused by the decrease in the price of harvesting cotton mechanically was used to measure the push effect. The decrease in the supply of labor caused by the increase in nonfarm wages reflected the pull effect. Using the estimated structural coefficients from the model, we calculated that about 79 percent of the decrease in cotton picking labor which occurred during the period of analysis was due to the pull effect, and the remaining 21 percent is attributed to the push effect.

III. The research in Israel focused on the family farm in the moshav. The economic environment in which the family farm in the moshav operates is quite complex and its analysis has to cover many aspects.

The economics of the family farm is just part of the economics of agriculture. Paper B surveys the major economic developments of agriculture in Israel since the early 1950's. It attempts to put the problems of the family farms and the cooperative organization in a wider perspective.

The family farms in the moshav are part of a network of cooperatives. Particular importance should be attached to the regional supply cooperative since in recent years it has been functioning more and more as a financial intermediary and the major channel of credit to the moshav and its members. A study of all aspects of the operation of one such supply cooperative was undertaken. The findings are being summarized now. Paper 10 is included here as an example of one aspect of the operation of the regional cooperative. The paper is being published in the Economic Quarterly (Hebrew).

Another factor that gained importance in the last decade is income tax. This has been particularly so since 1976 when the income assessment method for the tax purpose was modified. A study of income tax in the family farm was initiated and a preliminary report is included here as paper 11.

Paper 9 is the core of the empirical analysis explaining farm structure simultaneously with off-farm work.

The functioning of the moshav, the cooperative-democratic decision making, and possible externalities raise questions of its economic structure. In an attempt to construct a theoretical basis for the moshav as an entity, we started by adopting modern developments in urban economics to a theory of settlement (paper 7). Empirical work continues now on the determinants of the value of membership in the moshav.

Description of Cooperation

Professors Kislev and Peterson maintained continuous communication regarding the work in both countries by letter and telephone. In addition Professor Kislev spent 10 days at the University of Minnesota in September 1984. During this time he cooperated with Peterson on the cotton harvester study and contributed to the development of the farm structure research at Minnesota.

Research Achievements

Several important findings relating to farm size and structure have come out of the work in both countries.

1. A model which can be used to explain changes in the size distribution of farm firms and in the degree of specialization is developed and applied to U.S. agriculture. Particular emphasis is given to the impact of differences in managerial talent among farmers.
2. A model which predicts the impact of technological change on various types of farm managers is developed, and the model's predictions are compared to the familiar treadmill analysis.
3. A model which assesses the distribution of benefits of farm price supports is developed with particular emphasis given to the effects of differences in managerial ability among farmers.
4. A model is developed which shows that new technologies which are technically neutral to farm scale are unlikely to be neutral in their impact on marginal farmers.
5. It is shown that simple models of learning which assume a myopic view of the future do not adequately capture the nature of decisions involving knowledge acquisition.
6. Using the mechanical cotton harvester as a case study, it is shown that labor has in large part been pulled out of agriculture by rising real wages in nonfarm occupations rather than pushed out by new mechanical technology.

7. A theory of agricultural settlement is developed, and conditions for the optimal level of services and community size are derived together with rules of finance of village operations.
8. The development of agriculture in the State of Israel is traced from its formation in 1948 to the present. Major emphasis is given to changes in input, product composition, international trade, government policy, credit, productivity, the moshav, and cooperatives.
9. An analysis of the structure and specialization in the family farm in Israel has been conducted highlighting the major changes in agriculture and the family farm, productivity estimates, and the determinants of off-farm income.
10. An in-depth analysis of an Israeli grain elevator and feed preparation plant was conducted with objective of identifying problems common to the operation of such firms in Israel.
11. The effect of income assessment for tax purposes in Israel on the demand for factors of production is analyzed.

Benefit to Agriculture

The results of the research conducted under this project should have their main value in the policy making arena. If the reasons for structural changes in agriculture are not known, or more likely if the profession and policy makers have incorrect and/or incomplete information about the reasons for these changes, the adopted policy can intensify rather than alleviate problems. Some of the results of the project call into question the perceived theory and factors regarding structural changes in agriculture. Other results clarify under what conditions the conventional wisdom can be applied.

List of Publications

1. On the Size and Structure of Agricultural Firms
2. The Impact of Technological Change on the Structure of Agriculture
3. On the Distribution of Benefits of Agricultural Price Supports and Input Price Subsidies
4. On the Nonneutrality of Neutral Technological Change in Agriculture
5. The Acquisition of Information and the Adoption of New Technology: Comment
6. The Cotton Harvester in Retrospect: Labor Displacement or Replacement
7. A Theory of Agricultural Settlement
8. Aspects of Agricultural Development in Israel
9. Structure and Specialization in the Family Farm in Israel
10. Plant A--An Economic Analysis
11. Income Assessment for Tax Purpose: A Comparative State Analysis