Farmers' financing of agricultural research in Israel

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Agricultural research is mostly a public undertaking. In Israel, as in many other countries, farmers participate in the finance of research through taxes imposed by farm organizations on the marketed products. Farmers contribution ranges from 8% of research outlay in tomatoes to 79% in cotton. Strength of organization and ease of collection were the major factors affecting this share. In general, as inflation eroded the real value of government's finance, the farmers increased their share.

Representatives of farmers' organization participate in the bodies that approve grants to proposed research projects. It was found that the higher the share of farmers' finance the larger the part of short-term research directed at immediate outcomes and the smaller the part of long-term, more basic research.

The tendency of the farmers to prefer short-term, applicable research may reflect both their familiarity with practical problems and a comparatively high degree of risk aversion.

It is not clear how farmers' participation in the direction of research, which is based on their financial contribution, affects the efficiency of resource allocation to the agricultural sciences.

1. Introduction

Agricultural research is, in most instances, a public undertaking – part of the government services offered to the farm sector. In Israel, as in several other countries, the government involvement in agricultural research is supplemented by farmers' participation which is effected at two levels: (1) the regional farmers' associations conduct research, sometimes independently but mostly in cooperation with investigators from the national research institutions; (2) nationally, farmers financially support research conducted in the government system. In addition to this direct involvement, farmers affect research indirectly, through the political system. As is usual in such cases, politics and personalities play important roles in initiating and maintaining collective activity. Consequently, one may be drawn to the conclusion that farmers' participation in research is irregular and haphazard in nature. Our major hypothesis is different: basically we take the position that farmers operate as a group, through their representative organizations, to further their objectives as they understand them although subject to social and economic constraints. We report here an attempt to identify and analyze the economic and social regularities that have been associated with the direct involvement of the farmers.

The significance of farmers' active participation in the decision making process in agricultural research was highlighted by Hayami and Ruttan [1] who suggested that research and the associated technological changes in agriculture are "induced" by economic considerations. Ruttan has since studied the institutional mechanism for the transfer of the appropriate signals from farmers to researchers [2]. Biggs and Clay [3] discuss the informal R&D process conducted by the farmers. Guttman [4,5] suggested theoretical models of collective political action and demonstrated the ability of interest group theory to explain the actual intensity of agricultural research in the USA. The problem is, needless to say, of great importance, particularly to developing countries (see Crane [6] and Clark [7]. Partly, farmers' explicit involvement in research replaces market, invisible hand, forces (Mowery and Rosenberg [8]).

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2. Economic aspects of agricultural research

Agricultural output in Israel more than tripled in value (in constant prices) over the last 20 years, despite a continuous and substantial reduction in the farm labor force [9]. Capital accumulation barely offset labor exit, and 90 percent of the growth in output was due to growth in productivity and only 10 percent to growth in conventional inputs.

Research was instrumental in enhancing agricultural productivity: new crop varieties were introduced and tried by the research system, new chemicals and methods were tested, and the basic knowledge and facilities available to the system enabled the development and successful introduction, for example, of trickle irrigation – perhaps the most important single technological innovation in agriculture to originate in Israel in the last two decades.

The knowledge created in the agricultural research system is a public good, easily transferred from one farmer to another and hardly ever appropriable by a single individual. In most cases, even when the outcome of research is embodied in new inputs and varieties, its benefits spread easily throughout the sector. This is the major reason for the public provision of agricultural research: a single farmer, even a large farmer, will only seldom be able to capture most of the benefits of research. He will, consequently, not be willing to cover its cost. [1]

Moreover research and the productivity growth it entails quite often benefit the consumer more than the farmers. If demand for the product is inelastic, farmers' total revenue will decline; even if not, the eventual price reduction will often reduce farmers' net income. Exceptions to the rule are products that are priced or supported by the government (though in the long run the support prices also tend to be adapted to cost and modified with technical changes); other exceptions are export or import-replacing products for which the demand may be highly elastic.

Increased productivity and worsening terms of trade are characteristic of modern agriculture. Seemingly, farmers could avoid being hurt by changing prices, if they refuse to accept and implement the new technologies. This they do not do since agriculture is a competitive industry. It pays any single farmer to adopt improved inputs and practices, even if widespread adoption by all farmers reduces the aggregate income of the sector. Moreover, early adopters enjoy comparatively more efficient production while prices are still high. Latecomers, on the other hand, suffer diminished incomes caused by reduced prices while continuing with the outdated technology before realizing the need to modify methods of production.

The particular characteristics of agriculture and agricultural research raise a major hypothesis about the readiness of farmers to support research: the more advanced farmers will more readily contribute financially to research, and farmers' participation will be comparatively higher in products with elastic demand. Other, more detailed hypotheses will be suggested in the empirical section below.

Agricultural research is a public undertaking, part of the general government administration, and is consequently affected, at least partly, by the same bureaucratic characteristics that affect any public administration. The connection between the operation of the research system and the problems faced by farmers in the field may be weakened by the distance between the bureaucracy and the countryside. These difficulties are further augmented in research by the need te find the right balance between basic and applied research, particularly if investigators are more easily rewarded, socially and materially, for success in science than in immediately applicable technology. By participating in the finance of agricultural research, farmers also participate in its direction. The effect of this participation is also considered in the sequel.

3. Farmers involvement in research in Israel

At the regional level farmers are involved in agricultural research mostly through the regional councils – the local government bodies – which

[1] In a recent paper, Pasour and Johnson [10] argue that agricultural research does not produce a public good. In some cases they are right; corn hybrids, for example, are produced commercially by seed companies that can capture all the returns. However, as a general statement, we are not convinced by the argument: the methodology of breeding hybrids, to continue the example, is a basic scientific knowledge available to all; it has to be developed by a public agency, it will not be done by a profit seeking concern. (We are indebted to Vernon W. Ruttan for this reference.)

either maintain independent laboratories and experimental farms or coordinate experimental work on farmers' fields. Labor and materials are often supplied by farmers while research is carried out by extension personnel (mostly farmers residing in the regions themselves), local full-time researchers, or investigators from the national system.

At the national level, 12 Farmers' Organizations and Marketing Boards collect funds which are channeled to research and extension. [2] Recently this arrangement was institutionalized by an agreement between the Agricultural Research Organization and the farmers according to which 0.625 percent of the value added in agricultural production will be collected by the farmers' organization and distributed as follows: 85 percent to research, 10 percent to extension and 5 percent to an institute conducting economic surveys in agriculture. In the period covered by our study, the financing of research by farmers was carried out under informal arrangements, it was a matter of oral summaries and mutual understandings. The general characteristics of the financing system were, however, similar to those formalized in the more recent agreement. The money collected by the farmers is channeled to research by 21 branch committees, each composed of farmers, researchers and extension agents and responsible for one line of production (cotton, vegetables) or a professional area (soil and water, plant protection).

In principle, the branch committees are to be composed of equal numbers of scientists, extension agents and farmers. In practice the proportion of farmers is slightly higher than a third. Seventy to eighty percent of the budgets of the Committees are derived from the farmers' contributions, the balance is government allocation and comparatively small amounts from other sources and funds.

The money is allocated both to the Ministry of Agriculture research system and to Universities. The regular and development budgets of those facilities are covered by the government and the general university budgets. Laboratories and facilities are established and maintained via these sources which also fund the salaries of their permanent personnel. In general, however, the regular budget will not suffice for extensive experimentation and field trials. Therefore, investigators initiating such research have to submit specific proposals to the appropriate branch committee for approval and financing.

By financing prespecified research projects, the branch committees acquire a leverage which significantly exceeds their share in the total cost of agricultural research. In fact, the permanent personnel and the facilities of the research system are directed by the smaller amounts: 20–30 percent of discretionary money allocated on a project basis by the committees. One might expect that each committee will have and allocate roughly the same proportion of value added in its line of production to research. However, collection is not always as planned – some lines contribute substantially more than others. The factors affecting this diversity will be analyzed in the next section.

4. Empirical analysis

The actual rate and distribution of research activity is a result of a mixture of forces and considerations. Partly, efforts are directed to the highest potential benefits (relative to cost) – the Ministry of Agriculture through its planning section attempts to identify areas of potential benefits for the development of improved technologies. Partly, research is directed to solve urgent and acute problems – farmers are comparatively more aware of such problems; they may also be more averse to risk than the government and inclined, consequently, to short run solutions.

The level of economic resources at the disposal of the research system also reflects technical circumstances which are exogenous to the research budgeting process. For example, the amounts raised by the farmers depend on the existence of "collecting gates" – in cotton, gins may serve as collecting agencies; vegetables, on the other hand, are most often sold directly to the markets and the imposition of taxes by voluntary organizations is almost impossible. As another example of exogenous effects consider inflation. It is generally regarded as a tax on the public. However, as inflation accelerates government offices are also "taxed": budgets set in nominal terms erode during the fiscal year. Adjustments are introduced only gradually and in the meantime, the real value of government outlays may decline. Over the period

2 Marketing Boards: citrus, flowers, vegetables, fruits, poultry, ground nuts, cotton. Growers Associations: livestock, fish, and bees; and the Wine Council and the Grain Farmers Union.

Table 1
Value of product and the distribution of research budgets in eight selected products in 1974

Product	Output ($IL10^6$)	Research outlay ($IL10^6$)	Research as percent of output (%)	Finance distribution (%)		
				Government	Farmers	Others
Cotton	891	0.67	0.16	21	79	–
Ground nuts	59	0.15	0.20	35	65	–
Cut flowers	75	1.27	1.83	52	47	1
Poultry	1,244	0.95	0.15	53	46	1
Avocados	35	0.61	1.91	55	43	2
Wheat	216	0.29	0.13	83	17	–
Citrus	801	1.75	0.22	85	10	5
Tomatoes	163	0.68	0.41	92	8	–
Average			1.18	63	35	2

covered by our analysis inflation in Israel accelerated from an annual rate of 8 percent to 40 percent per annum. Partly, this process was due to world price changes, partly to deficit financing of defence and welfare outlays, at the expense of other public sectors – agricultural research among them. The data surveyed and analyzed in the present section reflect these and other factors that will be discussed below.

Detailed, comprehensive data on finance through the branch committees are not regularly published. We collected information on eight lines of production for 10 years, 1965–1974. Table 1 presents data by product for 1974. On the average, research outlay was 1.2 percent of gross output in these products (value added is approximately 60 percent of output in plant products and 20 percent in poultry). Government covered 63 percent of the costs, farmers 35 percent, and other sources were utilized to cover the rest. There were, however, substantial differences in the farmers' share of finance, from 79 percent in cotton to 8 percent in tomatoes. Table 2 presents the summary of farmers' participation in 10 years in these eight product lines. There is a certain decline towards the middle of the period, and a substantial increase in farmers' share toward its end.

The data for cotton and avocado are also illustrated in fig. 1. The upper panel depicts the distribution of finance by sources. Two interesting phenomena can be discerned in this panel: (1) the share of the government in research in avocados is much larger than in cotton. This probably reflects a conscious effort on the part of the financing authorities to invest more in a relatively novel product which was regarded as having a very high export potential. Cotton is more "established" as a widespread and most profitable field crop deemed

Table 2
Research budgets and sources of finance in the eight product lines (thousands of IL in 1967/68 prices)

Year	Government	Farmers	Others	Total	Farmers share (%)
1965	1,812	503	206	2,521	19.9
1966	2,310	595	336	3,242	18.3
1967	1,424	439	85	1,948	22.5
1968	2,336	590	268	3,194	18.4
1969	2,267	508	237	3,013	16.8
1970	2,649	664	289	3,601	18.4
1971	3,445	895	329	4,669	19.2
1972	2,433	793	233	3,459	22.9
1973	2,245	1,078	107	3,430	31.4
1974	1,193	649	36	1,878	34.5

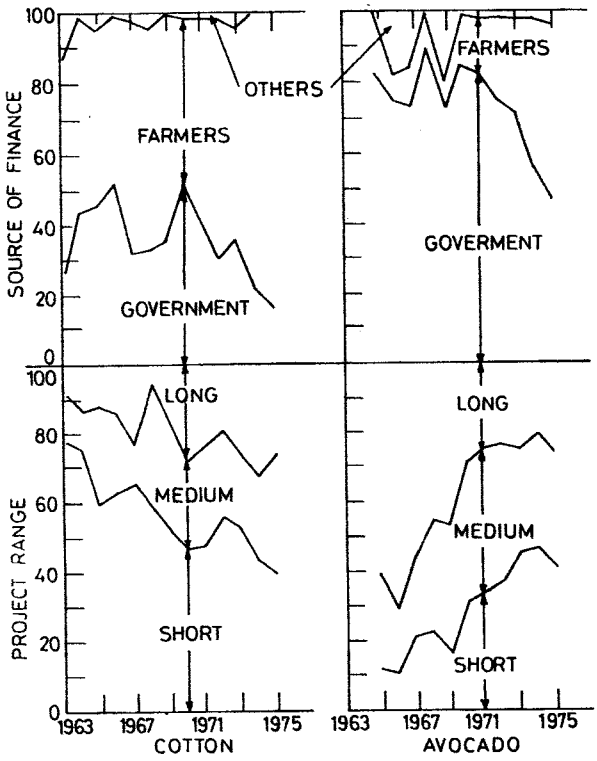

Fig. 1. Budget and projects distribution in avocado and cotton.

perhaps less in need of public support; (2) the share of government finance in both products is decreasing through time while the farmers' share is increasing.

An attempt to evaluate further this data is illustrated in the lower panel in fig. 1 which depicts the distribution of research projects by expected length of time to maturity (as evaluated by the researchers). Short term is up to 2 years; long term 5 years or more. It seems from the diagram that the nature of research changes with time – in cotton the trend is towards longer term research, in avocado to shorter terms. One explanation for these trends can again be based on the vintage of the crop in Israel. Cotton was introduced to the country in the early 1950s. Its introduction was followed by a great deal of applied, practical work, short run in nature. As the crop spread throughout the country and most adaptation problems were solved, research turned to longer term problems such as attempts to breed new varieties. Research in avocados, on the other hand, experienced two stages. The first was the long term process of testing imported varieties; the second – the current stage – consists of the search for solutions to problems arising from the rapid spread of the crop to various regions of the country. These are mostly short term in nature.

The statistical aspects of the analysis is presented in the regressions of table 3, which estimate (1) the factors affecting the share of farmers' finance of research, and (2) the effect of the farmers' participation on the nature of the research conducted.

Table 3
Regression analysis of farmers' participation in financing research [a]

Regression No: dependent variable	(1) Farmers' share in finance (%)	(2) Share of short-run research in total outlay (%)
Intercept	−15.4	12.22
	(6.33)	(2.15)
(1) Production in *kibbutzim* (%)	0.523	
	(0.07)	
(2) Value of product (10^6 IL)	0.057	−0.024
	(0.01)	(0.006)
(3) Rate of inflation (% per annum)	0.326	
	(0.07)	
(4) Export (dummy)	7.473	
	(3.97)	
(5) Mechanization (dummy)	8.835	
	(3.70)	
(6) Farmers' share in finance (%)		0.622
		(0.07)
R^2	0.511	0.517

[a] Number of observations 80 (8 crops, 10 years). Standard deviations in parentheses.

Regression 1 attends to the first issue. The variables included were:

(1) Share of agricultural production in *kibbutzim* (communal villages) – testing the hypothesis that *kibbutzim*, which are technologically more progressive than other sectors in agriculture, benefit more from research output and will, therefore, be willing to contribute more to its finance. The regression coefficient indicates that an increase in the share of the *kibbutzim* by 10 percentage points will increase farmers' finance of research by 5.23 percentage points.

(2) Value of product – there are economies of scale in the research technology complex. The same quantum of new knowledge will generally be of greater economic value the larger the value of the crop to which this piece of knowledge is relevant. If production conditions were homogeneous, the contribution of each bit of information or technical innovation would have been exactly proportional to the value of the crop. In general, however, higher levels of output are associated with wider geographical spread and larger diversification of production conditions and the contribution of research is less than proportional to the size of the industry (for further elaboration of this point, see Evenson and Kislev) [11].

(3) Inflation rate – inflation is often regarded as a tax on the public, but it is also a means to reduce the real value of government expenditures. The real value of government support of agricultural research declined in the 1970s with the acceleration of inflation. Farmers' finance moved to compensate partly for this effect.

(4) Export – crops produced for the export market face generally a more elastic demand than those produced for domestic consumption. For export crops the effect of technological change in deteriorating the terms of trade of the industry is comparatively limited.

(5) Mechanization – was taken as a measure of both sophistication and size of individual units of production.

Regression 2 indicates the effect of farmers' finance on the nature of research. A 10 percentage points increase in farmers' finance, increases the proportion of short term research by 6.22 percentage points. The farmers, it seems, use their financial power to direct research into projects with potentially immediate outcome. However, the larger the volume of production in the industry, the less they tend to do this – a large industry "can afford" more basic, long run, research.

5. Concluding remarks

The empirical estimates testify, we believe, to the existence of economic regularity in the participation of farmers in the financing of agricultural research and in the allocation effect of this participation; a regularity that can be discerned and analyzed despite the complexity of the issues. Farmers' participation is affected by government finance, particularly by its decline. They contribute more to export crops – in which the demand is comparatively elastic – than in other lines of production. In areas where farmers are more "organized", the contribution is higher, and the farmers' finance guides research into areas in which research results can be expected to materialize relatively early. However, many problems are still left to further study. Perhaps the most intriguing of them is the effect of the involvement of farmers on the quality of research direction: is farmers' finance used as an instrument to improve research, to bring it closer to real life problems and to relevant issues, or does the outside involvement deflect the scientists from more productive pursuits, which they are best equipped to judge alone?

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