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AIZE PRODUCTION PRACTICES AND PROBLEMS IN EGYPT:
Results of Three Farmer Surveys

James B. Fitch

CIMMYT Economics Program
Working Paper 03/83

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This report is the result of several years of cooperation in Egypt between the Egyptian Ministry of Agriculture, CIMMYT, The Ford Foundation and scientists from Zagazig University. Personnel from the Department of Agricultural Economics of Zagazig University conducted most of the field research. Representatives of the Maize Research Section of the Ministry of Agriculture made valuable suggestions and provided support, as did the Ministry's Agricultural Economics Research Institute. The Ford Foundation and CIMMYT provided support for field logistics. The Economics and Maize programs of CIMMYT were responsible for much of the conceptualization of the survey research.

CONTENTS

PREFACE

This report describes on-farm research on maize in Egypt. In 1976, concerned that maize yield was not increasing in the country and aware of CIMMYT's interest in technology generation through on-farm research, the Egyptian National Maize Program staff invited CIMMYT's Economics Program to work with national researchers. At that time, it was planned that the research would have certain characteristics--collaboration between biological and social scientists (mostly economists), attention to the needs of representative farmers and concentration on analysis in specific areas.

The work in Egypt was among CIMMYT's early efforts to develop a cost-effective approach to on-farm research. The process which emerged from those efforts featured: 1) the identification of potential research areas in terms of national priorities, 2) the delineation of tentative recommendation domains, 3) the organization of exploratory survey work, 4) the implementation of more intensive surveys where needed, 5) the pre-screening of information to identify leverage points for biological research, 6) the initiation of on-farm experimentation under the conditions of representative farmers and oriented by the survey process, 7) the adjustment of subsequent experimentation in terms of yearly results and 8) the orientation of relevant experiment station research in terms of the findings from survey work and on-farm experiments.

Throughout the period covered by the study, CIMMYT's Maize Program was represented in Egypt by Dr. Wayne L. Haag, who actively supported the on-farm research effort and figured in the preparation of this report. The partnership that evolved included Haag, a selection of national program researchers, agricultural economists from Zagazig University, CIMMYT Economics Program staff in Mexico, and James Fitch who was in Egypt with the Ford Foundation. Fitch worked with the second and third surveys and played the leading role in analyzing and writing up survey and trial results; those studies are the basis of this report.

While the paper gives evidence of much useful work, the initial expectations of the participants were not realized. As the conclusions show, the connection between farmer circumstances and experimental trials was not as strong as it might have been. Moreover, the thrust of the biological research did not accord well with the priorities that seemed to emerge from assessment of farmer circumstances. Perhaps these operational difficulties occurred because biology and economics were not firmly enough joined within the Egyptian Maize Program. We can hope that current efforts, under the auspices of the Egyptian Major Cereals Improvement Program, will have more success in organizing tightly knit research aimed at representative farmers.

Even though initial expectations were not met, the results reported are of considerable interest. The paper presents useful data on Egyptian maize producers and production, it conveys a sense of what on-farm research is all about and it offers suggestions on how the research process may be made more effective. Finally, the tone of the paper is one of advocacy. CIMMYT firmly believes that collaborative, on-farm, area-specific research, focused on the needs of representative farmers, is an essential step in the development of effective agricultural technologies.

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I. INTRODUCTION

This report examines the production system for maize in Egypt. It is based mainly on the findings of three farmer surveys conducted in 1976, 1977 and 1979. Its objective is the summarization of what has been learned from those surveys about the production problems and practices of Egyptian maize farmers, with the resulting information intended for the use of maize research scientists and agricultural policy makers. Also, methods and materials actually used by farmers in maize production are compared to the recommendations of the government's National Maize Program. Problems experienced by farmers in following recommended practices and in obtaining improved production inputs are examined and research needs discussed.

Maize is a crop of major importance to Egypt, occupying almost one-third of the arable crop area in the summer months. It is the main staple in the rural human diet and also provides valuable feed for livestock. National maize production has not kept pace with consumption, however, and recent growth in imports has used up ever larger amounts of the nation's foreign exchange.

The Maize Research Program of the Egyptian Ministry of Agriculture is of long standing. As early as the middle 1960s, the International Maize and Wheat Improvement Center (CIMMYT) began to cooperate with maize scientists in the Agricultural Research Center. Their breeding program was emphasized, first for the development of open-pollinated maize varieties and later for hybrid development. Cooperative efforts also focused on soil and water problems and on agronomy. Research was concentrated on experiment stations until, in 1976, a system of on-farm trials was established to test maize varieties and fertilizer application under more representative conditions.

Despite the growing emphasis on conducting research under realistic farming conditions, very little specific information had been available about the maize farmer in Egypt or his production practices. Therefore, in 1976, the year that on-farm trials were begun, a survey program was initiated to obtain more information about farmer circumstances and practices in the Maize Belt governorates of the Delta. In 1977, a survey was made of Middle Egypt maize growers and, in 1979, a survey of trial and nontrial farmers was made in an effort to help monitor the on-farm trial system.

Egyptian average maize yields had held steady at around 1.5 tons per feddan (3.6 tons per hectare) for the past decade. Given the natural richness of Egyptian soils, the availability of water for irrigation, the favorable climate and the high levels of fertilizer being applied by Egyptian farmers, the obvious question was why their yields were not at least 30 to 40 percent higher, to be in line with yields in other countries with similar conditions. As that would still be less than on-farm trial yields in Egypt, an important research goal was to find ways to increase farmer yields.

The Surveys

The 1976 Maize Survey included villages in the six southernmost provinces of the Nile Delta. The Delta accounts for 60 percent of all of the maize grown in Egypt, and those six governorates, Sharkia, Menonfia, Beheira, Gharbia, Qaliobia and Dakahlia, are the heaviest producers. A random sample of 40 villages was first chosen, with the number of villages chosen in each governorate in proportion to its farming area. 160 farmers were in turn chosen; after stratifying the list of farmer names provided by village cooperatives, four farmers were chosen at random from each of the villages.

Questions on the 1976 survey were adapted from questions on earlier CIMMYT-sponsored surveys in other countries and from discussions of problems and information needs expressed by Egyptian maize researchers. The questionnaire and the survey methods were set up by economists from Zagazig University. Farmers were contacted and interviewed during July through September, the peak months of the maize-growing season. Results of the 1976 survey were reported in Arabic in a paper by A.A. Goueli, M.Z. Gomaa and A.S. Attia (1977).

The second Maize Survey was conducted in 1977 in the Middle Egypt governorates of Fayoum, Giza, Bani Suef, Menia, Assuit and Sohag. Middle Egypt is distinct from the Delta in terms of maize production. The climate is somewhat warmer, the season begins from one to two weeks earlier and irrigation methods and planting practices differ. A higher proportion of Middle Egypt maize is marketed. In the survey, 31 villages were chosen at random, and 185 farmers were chosen in the same stratified random fashion as for the first one. A special survey of 36 Nili maize growers (see page 10) in Fayoum Governorate was also made in the autumn season, to determine the production characteristics and problems of that crop.

The 1977 survey questionnaire was an adaptation and improvement of that used in 1976. More input and feedback were also obtained from biological scientists, based on preliminary findings of the first survey. Results of the second survey were reported in two papers in English by J.B. Fitch, A.A. Goueli and M. El Gabely (1979); a report in Arabic was made by Goueli, Gomaa and Attia (1979).

A third survey was conducted in summer, 1979. It was somewhat different from the first two as it was designed to monitor the on-farm trial program for maize and to compare what was being done on trial farms with the practices of nearby farmers. Trials were carried out on two farms in each of 13 governorates, on a total of 26 farms in 26 different villages. The participating farmer was surveyed in each case, and information was obtained about his trial plot as well as about a field of nontrial maize, if he had one. In addition, three other farmers were selected at random from each of the villages.

Questions in the 1979 survey were adapted from those used in the previous surveys, again with feedback from biological scientists. Special questions were also asked, related to the on-farm trial process. In all, 96 farmers were interviewed. With the participation of the Maize Program in all of the surveys, results were quickly available to those who were working on improved varieties and crop management. A summary of sample survey characteristics is shown in Table 1.

Organization of the Report

In the later sections of this report, survey findings are discussed in detail, proceeding more or less in the order of the crop production cycle. Part IV discusses current maize seed varieties and sources and Part V methods of land preparation and planting. Part VI considers findings on fertilization and irrigation practices and part VII, weed, insect and disease control. Part VIII discusses the dual-purpose nature of maize, with particular emphasis on the farmers' system of planting, stripping and topping to obtain feed for their livestock. Part IX looks at Egypt's maize research with emphasis on the on-farm trial system and the findings of the 1979 survey which monitored that system.

TABLE 1. Characteristics of the Egyptian Farmer Surveys

	1976 SUMMER MAIZE SURVEY	1977 SUMMER MAIZE SURVEY	1977 NILI MAIZE SURVEY	1979 TRIAL MONITORING SURVEY	
Area Included	6 Governorates in the Delta	6 Governorates in M. Egypt	Fayoum Governorate	Total of 13 Governorates	
Number of Villages	40	31	6	24	
				Trial	Nontrial
Number of Farmers	160	185	36	24	72
		(percent)			
Farm Size:					
Under 1 Feddan	13.1	22.2	22.2	0	4.2
1 to 3 Feddans	59.5	54.0	50.0	16.6	62.5
3 to 5 Feddans	23.9	18.7	11.1	29.2	20.8
Over 5 Feddans	3.5	5.1	16.7	54.2	12.5

II. MAIZE IN THE NATIONAL ECONOMY

Agricultural products account for 30 percent of gross domestic product in Egypt. Within agriculture, maize is a major crop in terms of land area; at current domestic prices, it also ranks second in value of production (Table 2).

The importance of maize in the economy is also reflected in ways other than monetary value. Its role in the rural diet has already been mentioned. Unlike urban residents, whose main staple is bread made from wheat flour, rural residents depend on maize, especially bread made from mixed maize and wheat flours.

Egyptians produce and consume white maize. Livestock production has been spurred by imports, mainly of yellow maize, which are sold, at government-subsidized prices, to farmers and to government feed-mix factories.

In terms of international trade, maize is the country's second most important import after wheat. Through a series of area and price controls, plus import decisions, the government has managed to keep maize and wheat prices well below their international levels. Prices paid to farmers for export crops such as cotton and rice have also been held below their international equivalent values. It is important to note, however, that maize has never been subject to the direct area or price controls which have been applied to other trade crops.

A recent study by Habashy and Fitch (1981) shows that, while farm level maize prices averaged 65 percent of their international trade equivalents during 1976-79, wheat prices were only 51 percent, rice prices 47 percent and cotton prices 36 percent of their respective international levels.

TABLE 2. Areas and Values of Maize and Other Major Crops in Egypt

CROP	AREA* (million feddans)	NET REVENUE PER FEDDAN (Egyptian pounds)		NET VALUE FOR ENTIRE CROP (million pounds)	
		(TO THE FARMER)	(TO THE ECONOMY)	(AT FARM PRICES)	(TO THE ECONOMY)
Maize	1.88	46	47	86.48	88.36
Berseem clover	1.77	209	130	432.93	229.10
Wheat	1.39	37	87	51.43	120.93
Cotton	1.20	49	408	58.80	489.60
Rice	1.04	51	206	53.04	214.24

Source: Habashy and Fitch (1981)

* Total agricultural land area in Egypt, six million feddans

While all of these major crops have been subject to heavy indirect taxation, maize has been taxed less than the others. In this sense, maize has been a favored crop, policywise, in Egypt.

Total maize production in Egypt has continued to increase fairly steadily, as Figure 1 illustrates. From the early fifties to the late seventies, production almost doubled, from 1.4 million tons to 2.9 million tons. This represented a 3.7 percent average annual rate of growth, which was well ahead of the 2.2 percent rate of national population growth during the same period. Nevertheless, production has not kept pace with total consumption, particularly in recent years. Maize imports rose from 136 thousand tons per year in the early 1960s to over 500 thousand tons by the late seventies and to one million tons in 1980. Where the country produced 97 percent of the maize consumed in the early seventies, the proportion dropped to 75 percent by 1980. These rising import costs have added an ever-increasing foreign exchange burden to the government budget.

III. MAIZE IN THE EGYPTIAN FARMING SYSTEM

Before discussing the specific maize production practices and problems revealed by the surveys, it is necessary to consider some general characteristics of Egyptian farmers and maize producers.

Since the land reforms of the 1950s and 60s, land tenure has tended heavily toward operator ownership. National figures show that over 60 percent of Egyptian farm land is now owner operated. Farm decision-makers tend to be older and not highly educated; the rate of illiteracy is very high.

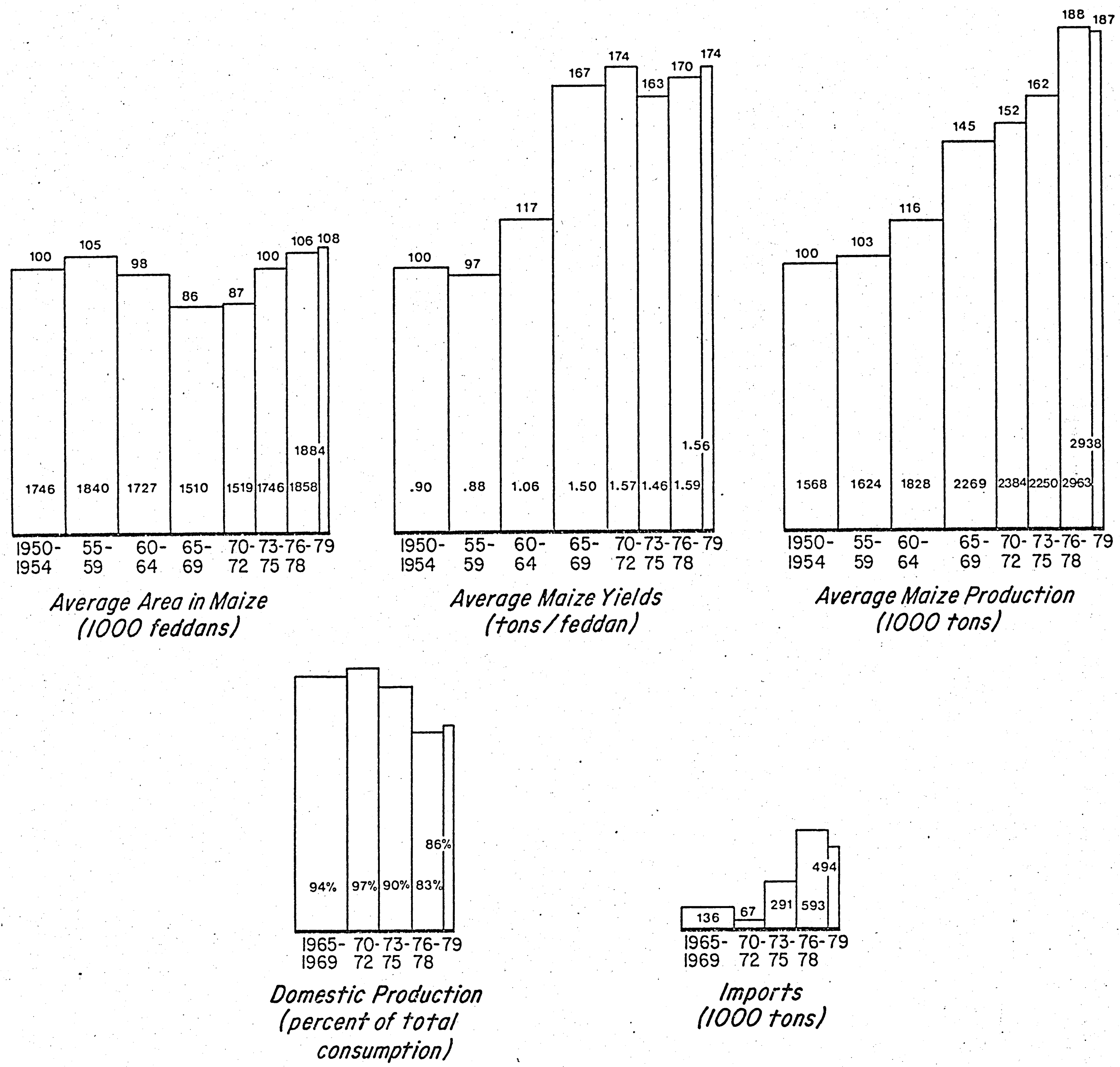

FIGURE 1. Maize Production and Imports

The principal characteristics of Egyptian agriculture are the predominant rural population and small average farm size. Of the country's 45 million inhabitants, about 22 million (53 percent) live in rural areas; of these, some 12 to 13 million are in farm families while another 5 to 6 million are in agricultural worker households. The land base in Egypt is limited and has remained relatively static for the past 30 years; additions of newly reclaimed farm lands have been offset by losses to urbanization. One recent study has pointed out that the number of farms has continued to expand in Egypt, which means that, with the almost fixed land base, farm size has declined. In 1961, the average farm size was 3.8 feddans, whereas by 1975 it had declined to an estimated 2.1 feddans (Fitch, Aly and Mostafa, 1980).

Egyptian farmers normally follow a two- or three-year rotation, with two crops being grown each year. Maize is usually planted following wheat, clover or broad beans. The most common two-year rotation is berseem clover followed by maize in the first year, and clover followed by cotton in the second. In the three-year rotation, wheat/maize is grown after either the clover/maize or the clover/cotton year. Among summer crops, maize competes directly for land with cotton which is grown throughout Egypt, with rice which is grown in the northern part of the Delta and with sorghum which is grown in Upper Egypt. (The Middle Egypt and Southern Delta zone, where maize does not compete with rice or sorghum, is known as the Maize Belt.)

The building of the Aswan High Dam led to a major revolution in the way in which maize was grown. Until the middle 1960s, when the dam was completed, maize was grown as a "Nili" crop. That is to say, it was planted in the late summer, usually July or August, when Nile flood waters were available for irrigation. Once the dam made irrigation water available throughout the summer, however, farmers shifted to earlier planting. As Figure 1 indicates, only 7 percent of the land area was planted to summer maize in 1962-64, whereas 25 percent was in Nili maize. By 1972-74, these figures were almost completely reversed, with only 6 percent in Nili and 23 percent in summer maize. This is a clear indication of the extent to which Egyptian farmers can respond to changing technical opportunities when there is a benefit from doing so; maize yields were improved substantially by the shift to earlier summer cropping.

Given the Egyptian rotation system, a typical farmer could be expected to have less than a feddan--many, in fact, much less--to devote to maize production. With national yields averaging about 1,560 kg per feddan, this understandably leaves many farm families with scarcely enough to feed their five or six members, particularly when the necessity of feeding farm animals is taken into account.

The amount of land planted to maize seems to be little influenced by maize prices; maize area increased steadily throughout the seventies, despite a fairly consistent drop in real and relative prices for the crop (Figure 2). Maize grain prices have scarcely managed to hold their own, relative to rice and cotton, and yet maize acreage has increased while acreage for the other two crops has declined. The fact that maize is such an important subsistence crop may help to explain this fact.

Maize area has varied substantially in the years since the 1952 revolution. The 1.88 million feddans planted in 1979 was only seven percent greater than the 1.75 million planted in 1952-54. However, the area planted dropped considerably in the sixties, after the dam was built, but then began to increase again in the seventies. The probable reason for the drop in area during the sixties was the large increase in yields which was brought about by the shift to

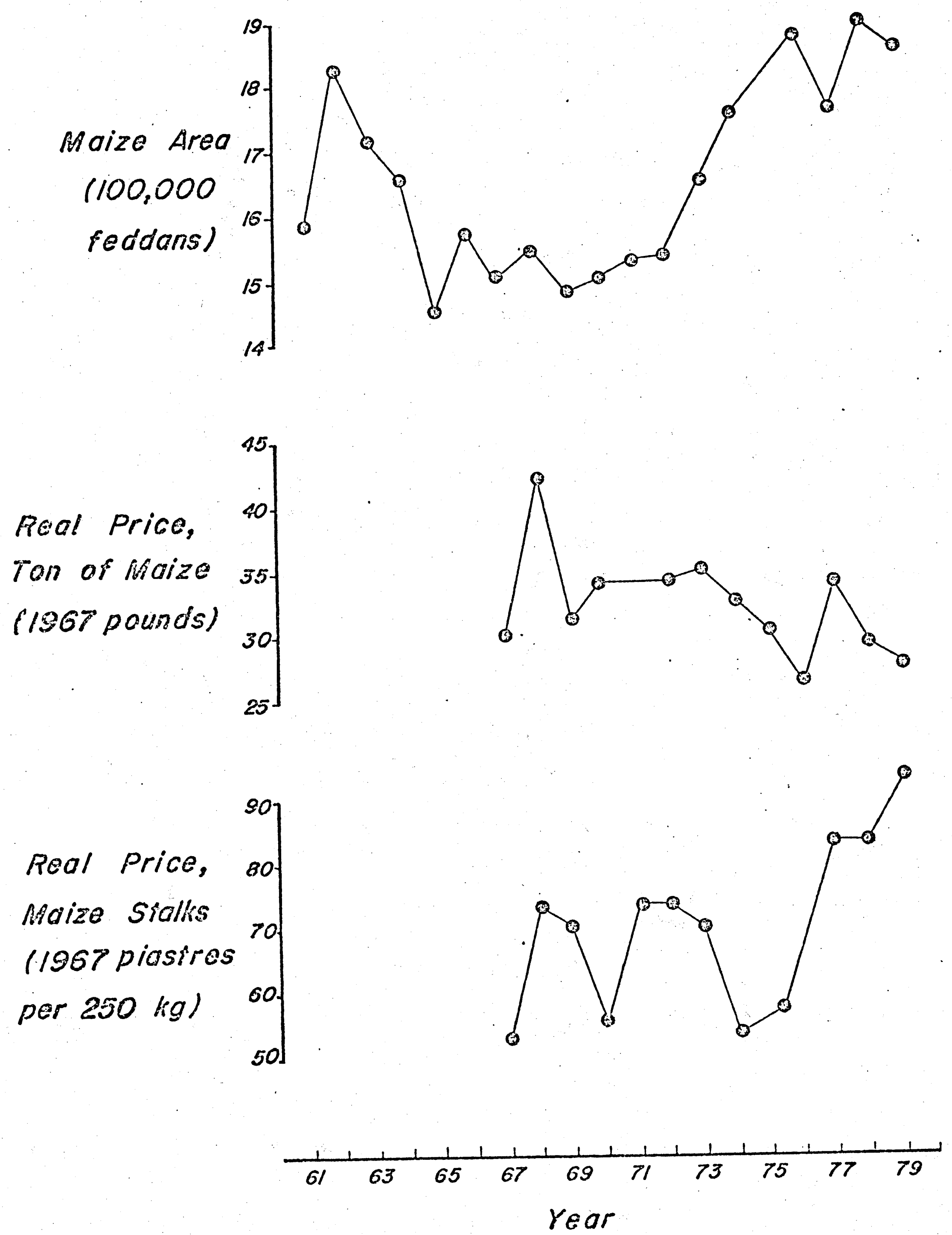

FIGURE 2. Maize Area and Related Prices

summer cropping. It appears that farmers shifted to other crops when they found they could meet their subsistence needs with smaller areas of maize. Following the large 43 percent yield increase in the sixties, yields remained almost constant at around 1.5 tons per feddan throughout the seventies. As yield increases leveled off, maize area rose again, climbing to slightly above what it had been in the fifties. It would appear that, due to the decline in farm size, making them more subsistence oriented, maize plantings were increased to keep up with the needs of the growing rural population.

Another factor which cannot be overlooked in Egyptian maize agriculture is the value of maize by-products. Parts of the maize plant are used for animal feed, and stalks can be used as fuel for cooking. Price series for these items are difficult to obtain since many of them are home consumed and so do not have well-organized markets. However, the Ministry of Agricultrue maintains a series on maize stalks, which converted to real prices is shown in Figure 2. It suggests that an increase in maize area may be related to increased prices of maize by-products.

IV. MAIZE SEED: VARIETIES AND SOURCES

The farmer surveys make it clear that, until now, there has been little in the way of seed of genetically improved maize varieties used by the Egyptian farmer. More than 80 percent reported using local varieties, although most of those varieties have probably been influenced to some degree by cross pollination with the hybrids and open-pollinated varieties which have been introduced or developed locally in the Maize Program. Even so, just over half of the farmers interviewed in the Delta reported having experimented with planting at least one other variety in the past, as did over 40 percent in Middle Egypt.

A number of names were used by the farmers for the different local varieties, but only nab-el-gamal (camel's tooth) and sabaieny were mentioned with any great frequency; nab-el-gamal is a favorite and is identified by the very large, flat shape of the grain.

"Hybrid" was a term sometimes used by the farmers to designate seeds, either hybrid or open-pollinated, purchased from either the agricultural cooperatives or one of the other agencies of the Ministry. The only hybrid name mentioned was American Early, a dent, open-pollinated variety, and it has been in Egypt for so long that it is probably more "local" than "improved" by current standards. It is also probable that many of the varieties identified as hybrid were in reality seed which had been derived from hybrids rather than true hybrids (Table 3).

TABLE 3. Varieties Used by Sample Farmers, Year of Survey

	DELTA (percent)	MIDDLE EGYPT
Various Local Varieties	70.4	68.7
Nab-el-gammal, Local	14.6	14.8
Sabaeiny, Local	0.7	4.2
"Hybrid" (American Early, AE)	12.5	2.4
"Hybrids" (Other than AE)	1.9	9.8

The main source of new genetic material for the Egyptian farmer is the government, particularly the Agricultural Cooperative Society in each village or cluster of villages. The cooperatives distribute certified government seed which is produced on contract by farmers or on state farms, as well as any improved seed imported by government agencies; only recently have there been any private seed production and distribution companies.

In general, farmers do not have a very good knowledge of what seed is available from the cooperatives. In the

Delta, 45 percent of the farmers surveyed did not know anything about the variety available, while 36 percent stated that it was "hybrid" or "synthetic" but could not give it a specific name. The only specific one named was American Early (10.4 percent), but that variety was probably not actually available at the time.

In Middle Egypt, 35 percent of those interviewed did not know whether seed was available that year at the cooperative, 27 percent were sure that it was available and 19 percent said that it definitely was not available. It seems obvious that supplies of seed are not available at all cooperatives, and that supplies for many cooperatives arrive late. 76 percent of those farmers who reported asking for seed at their cooperatives said that it was not available. In the Delta, 60 percent of farmers who had planted government seed in the past said that it was not available when they asked for it again.

Farmer's lack of knowledge about the government's seed distribution program, together with availability problems, is one reason why so few rely on the government for seed. Their main source of seed, as shown in Table 4, is what they have saved from their previous year's crop.

TABLE 4. Source of Seed Used by Sample Farmers, Year of Survey

	DELTA (percent of farmers)	MIDDLE EGYPT (percent of farmers)
Saved from Own Crop	96.6	62.5
Procured from Neighbor or Relative	2.2	14.7
Purchased from Market	0.9	18.0
Purchased from Cooperative or Other Government Agency	0.4	4.7

While farmers attempt to save their better grain for seed, its quality is not very high. Selection procedures tend to be faulty and storage facilities inadequate. In

Middle Egypt, only 72 percent of those interviewed said that they made a special selection of maize for seed, and 86 percent of those so reporting said they selected at home rather than in the field. Thus, important characteristics of the maize plant itself are not taken into consideration. Of those who followed special selection procedures, 81 percent stored the seed in a separate location or container from maize destined for consumption. When questioned about their criteria for selecting seed, most farmers in both Middle Egypt and the Delta mentioned large ears and kernels; some said they looked for resistance to disease and weevil attack. There was no mention of other plant characteristics.

Those Middle Egypt farmers who reported storing their seed separately indicated a variety of storage locations and methods. For the most part, there was no special protection for the seed, except perhaps with those farmers who used mud silos. The majority stored their maize on the cob with very few reporting storage in shelled-grain form. While 57 percent in Middle Egypt stored in the ear with husks removed, 76 percent of the farmers in the Delta reported storage with husks on; otherwise, their practices were quite similar.

As to improvements farmers see as desirable in maize varieties, they most often named higher yield. Of those Middle Egypt farmers who had tried government seed and decided not to plant it again, almost half claimed that it was because of low yields. When farmers in the Delta were asked whether they would forego two ardebs per feddan (280 kg or about 18 percent of average yield) for a variety that could be harvested in 3.5 months instead of the prevailing four months, 72 percent said no. Thus, the government four-month varieties would seem to fulfill the needs of most farmers. Still, a significant number (28 percent) were willing to sacrifice some yield for earlier maturity.

Various plant characteristics other than yield were also important to the farmer. One of the most important was a plant that could be planted and harvested earlier without serious reduction in yield. Part V of this report, a discussion of planting methods and dates, shows that a number of farmers plant earlier than the recommended date; undoubtedly, they often do so to be able to work in an extra crop. Farmers also mentioned the desirability of a plant of medium height, with thick stalks and with large ears and kernels.

In considering desirable varietal characteristics, it is necessary to take into account the end use of the maize crop. The grain itself is used in human consumption, mainly in breadmaking. Table 5 shows farmer preferences in bread flours. Those of Middle Egypt prefer bread made of one-grain flours, whereas Delta farmers prefer mixtures.

TABLE 5. Type of Bread Flour Preferred by Survey Farmers

	DELTA	MIDDLE EGYPT
	(percent)	
Maize Only	5.9	19.0
Wheat Only	13.0	28.5
Maize and Wheat Mix	81.1	35.1
Maize and Sorghum Mix	--	12.2
Maize, Wheat and Sorghum Mix	--	5.3

Not all maize is produced for grain and, even when it is, it is expected to yield valuable forage by-products. It is often recommended that farmers who need forage for animals plant a separate plot of maize. Although maize scientists believe that the practice is growing in importance, only 3 percent of the farmers interviewed in Middle Egypt reported growing a crop specifically for that purpose. Since most farmers continue to strip and top the maize plant for forage, it would be worthwhile to breed plants that would not be too sensitive to the practice. An alternative would be a sufficiently productive forage crop--such as maize, sorghum, sorghum-Sudan grass or elephant grass--so that farmers might rely less on maize stripping.

Two new varieties which show promise for Egyptian farmers are Giza 2 and Pioneer 514. Giza 2 (formerly Composite 2EV2), which is open pollinated and not a hybrid, was developed in the National Maize Program; 514 is a hybrid import of the Pioneer Seed Company. Both are white maize varieties characterized by tall plants which resist late wilt, and both mature in four months. The 514 appears to have better resistance to turcicum leaf blight, an important potential problem, but both varieties have been successful in on-station and on-farm trials.

While the Pioneer seed has the advantage of being produced by a private company with an effective production and distribution mechanism, it is a hybrid which requires annual renewal to maintain yield. Pioneer representatives have been extremely active in disseminating information to farmers and government technical officers about the variety and have worked with many farmers in demonstration trials. While Giza 2 does not have the advantage of vigorous private promotion, it should be distributed by the National Seed Company by 1981 at a lower price.

V. LAND PREPARATION AND PLANTING

Land preparation and planting methods are areas where many farmer practices differ from those recommended and utilized by the government in its trials and experiments. This would seem to be one of the logical places to look in seeking to explain the gap between experimental yields and those of farmers.

The Ministry recommends planting maize between May 15 and June 15, except for Middle Egypt. There the climate is warmer, and the recommendation is to plant before the first of June. These recommendations derive mainly from pest control considerations. For maize planted before the tenth of May, there is danger of <u>sesamia</u> corn borer attack in the Delta and Middle Egypt, and after June 15 there is danger from <u>ostrinia</u> borer in the Delta. Farmers also have considerations other than pest control in selecting planting dates; in particular, planting dates for maize are heavily influenced by the preceding crop in their rotation. In the Delta, some 15 percent of the farmers surveyed planted earlier than the recommended date and 20 percent later. Nearly 60% planted later than recommended in Middle Egypt.

In the Delta survey, most farmers reported that early planting helped control insects. Some 135 farmers (84 percent) said they planted early to escape aphids and 118 farmers (74 percent) to avoid corn borers. 109 farmers (68 percent) said that planting dates depended on their rotation; 38 farmers (24 percent) reported that the winter crop had little influence on planting date.

That there is a relationship in Middle Egypt between planting date and preceding crop can be clearly seen from the data in Figure 3. In cases where maize is planted after berseem clover, it is planted later than after broad beans, winter vegetables or other crops. The time in which clover stays on the ground depends on the farmer's forage needs, and the fact that almost half of the maize that is planted late follows clover shows the importance of forage in farmer decision-making.

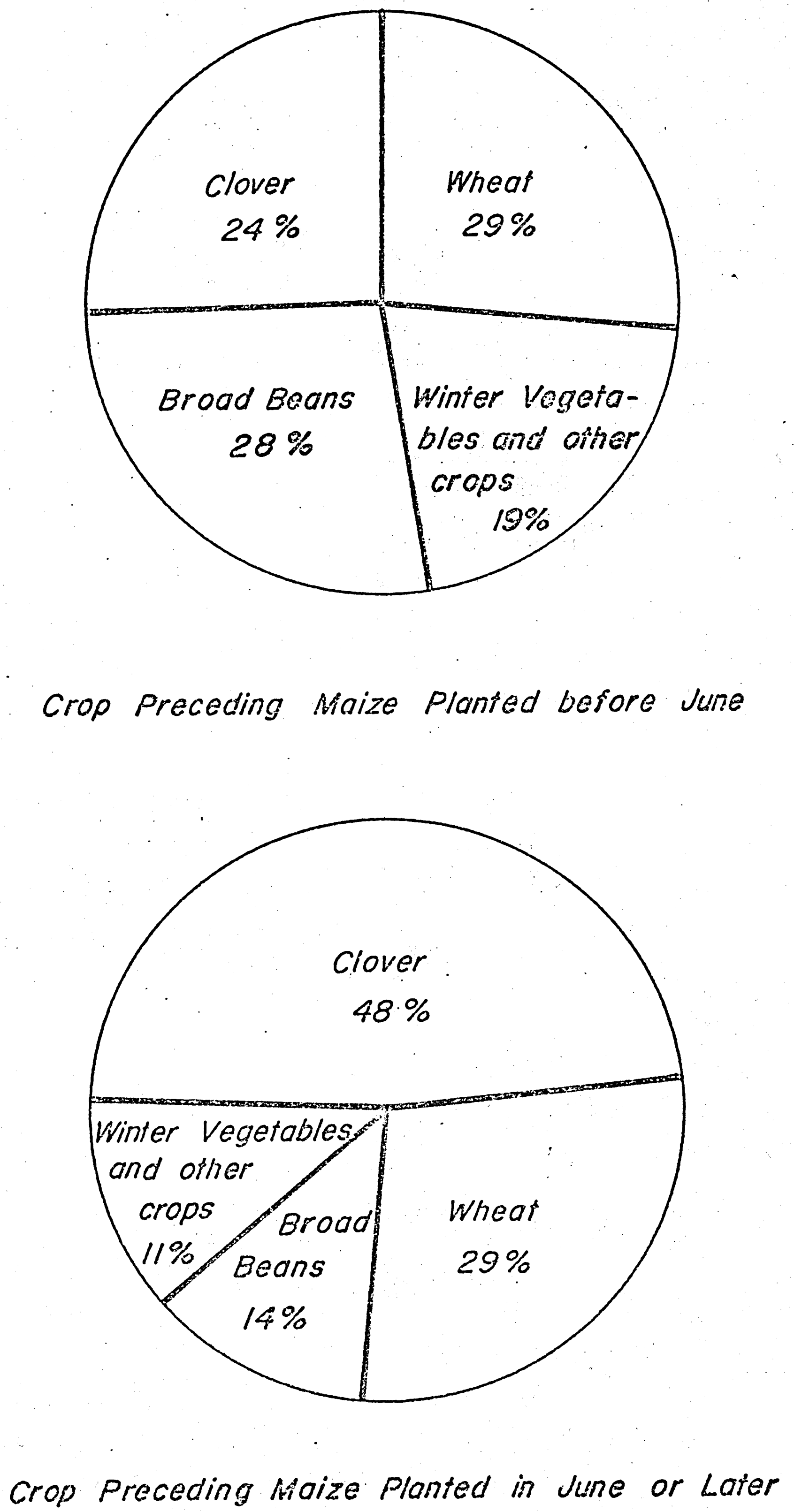

FIGURE 3. The Relationship of Preceding Crop to Date of Maize Planting

Source: Middle Egypt Maize Survey, 1977, as Reported by Fitch, Goueli and El Gabely (1979, Table 2)

The Ministry recommends planting maize on ridges, a procedure used on experiment stations and in on-farm trials. In the trials the soil is prepared with a chisel plow and then with a ridging implement, both tractor drawn. The tractor has to be powerful enough to work Egypt's heavy clay soils, even when fairly dry. Maize is seeded in hills located about 1/3 of the way up the sides of the ridges, and irrigation applied on the same day to facilitate germination. After three weeks, the soil is hoed and fertilizer applied. The soil from the unplanted side of the opposing ridge is pulled over against the maize plants, leaving them closer to the centers of the altered ridges; this helps control weeds by cutting them on the unplanted side and covering them on the planted side. About three weeks later there is a second cultivation and fertilizer application, with still more soil being moved from the opposing ridge. After this second cultivation, the maize plants are in the center of the new ridges (Figure 4).

When questioned about the value of ridging, 75 percent of the Middle Egypt farmers said that they believed it increased yields, whereas 21 percent felt that they were decreased. Most of the sample farmers said that following the ridging system was difficult; many mentioned the high cost in money or labor, and a few mentioned the absence of tractors. However, a review of the costs of land preparation reported by farmers in the 1979 survey did not reveal any significant differences according to the methods used.

There are several advantages to this recommended system of ridging and planting. Initial planting on the side of the ridge places the young plants close enough to water for needed moisture but gives protection against over-saturation. The movement of the soil aids in weed control, and the ridges provide flexibility in water management, particularly where fields are not level.

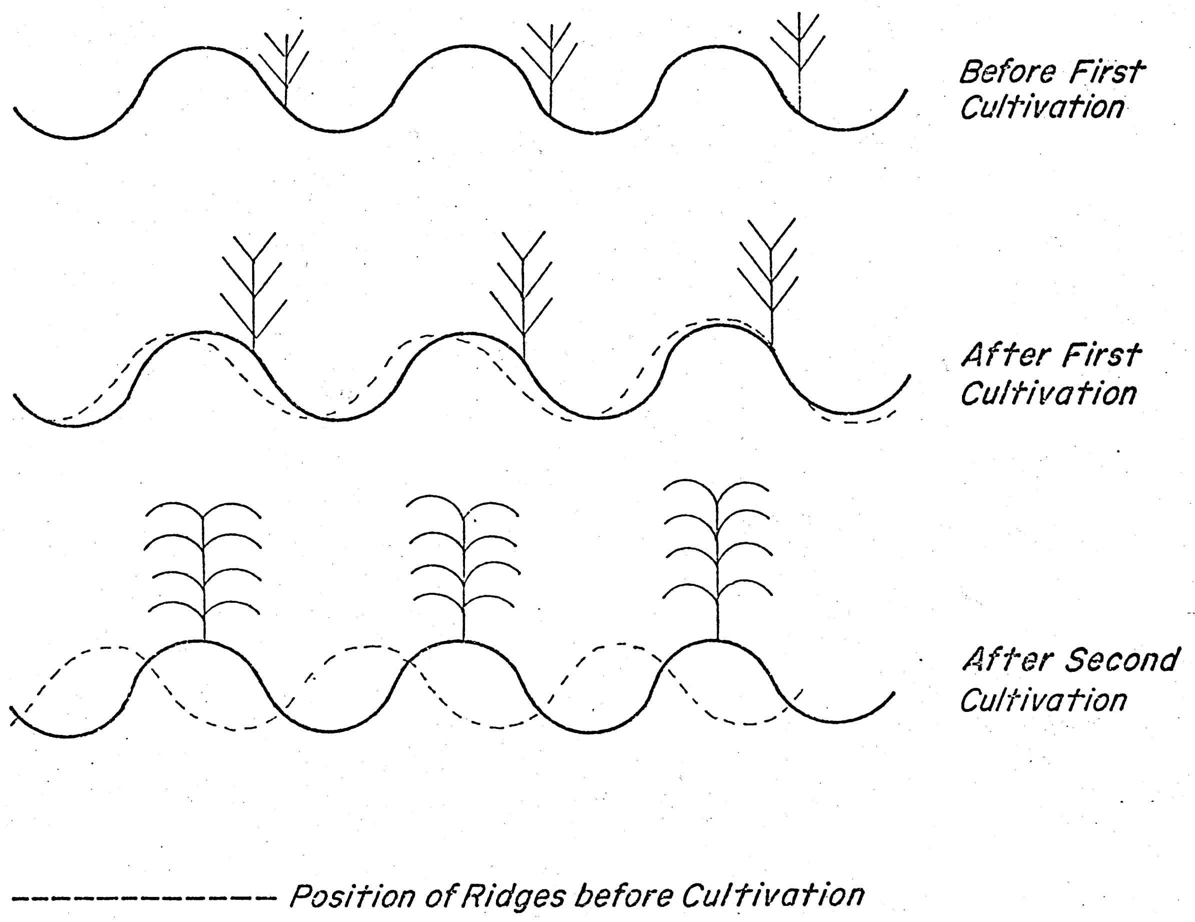

FIGURE 4. The Recommended System of Planting and Ridging

It would seem safe to say that only about half of Egypt's maize farmers follow this recommended system. Alternative methods vary, depending on farmer circumstances. Many follow the so-called heraty (wet) method, irrigating several days prior to plowing, planting in the still-moist soil as it is plowed and then irrigating again seven to ten days later. The preplanting irrigation causes weed seed to germinate before the planting, thus leading to better weed control. In the afeer (dry) system, maize is planted in dry soil which is irrigated immediately afterward. The heraty method is most often used by farmers who use animals for plowing as it makes the soil easier to work; most farmers who use the afeer method have access to tractors for plowing.

Fitch and Afaf (1980) show how land preparation technology varies according to farm size. Farms of less than one feddan still rely heavily on animal power for plowing; only 46 percent of the land on those farms is tractor plowed. On the other hand, about 65 percent of the land on farms larger than one feddan is tractor plowed (Table 6).

TABLE 6. Relationship of Maize Planting Method to Field Size

SIZE OF FIELD	AFEER TILLAGE (percent)	AFEER NO TILLAGE (percent)	HERATY (percent)	% OF MAIZE FIELDS IN SIZE CATEGORY
Less than 1 Feddan	64.6	71.4	88.2	73.8
1 to 3 Feddans	18.2	22.9	11.8	19.9
3 to 5 Feddans	4.0	2.9	0	3.5
More than 5 Feddans	3.0	2.9	0	2.8

Source: Middle Egypt Survey, 1977

Most farmers who use afeer also use the ridging system recommended by the Ministry. With heraty, the ground is usually left flat. Some farmers neither pre-irrigate nor plow; in effect, they use afeer with no tillage. They hoe the soil to prepare it, and make holes for the seeds with a stick. For those fields, the soil configuration which was used for the previous crop is carried over, almost always resulting in an absence of ridges.

The use of afeer versus heraty varies widely from region to region, as well as within regions. In general, more Delta farmers use heraty than do Middle Egypt farmers; as Table 7 shows, over 45 percent of Delta farmers used heraty whereas only 11 percent of the Middle Egypt farmers did. Middle Egypt maize yields are higher than those of the Delta, a fact which may be related to the higher percentage of Middle Egypt farmers using afeer.

TABLE 7. Planting Methods Used by Survey Farmers

	DELTA	MIDDLE EGYPT
	(percent)	
Afeer (Dry)		
With Tillage	35.5	63.1
Without Tillage	19.3	26.9
Heraty (Wet)	45.5	11.0

The recommended seeding practice is to place three to four seeds in holes made with a stick or hoe, the holes at 30-centimeter intervals along ridges 70 centimeters apart. This gives a plant density of about 20 thousand plants per feddan. When asked how they placed seed in the ground, most of the nontrial farmers in the 1979 survey indicated that they placed the seed in holes, although some said they dropped it in a furrow behind an animal-drawn plow. A very few (4 percent) said they hand broadcast. Of those same farmers, some said they covered the seed with a small hoe, some used their feet and some employed an animal- or hand-drawn compacting board. The compacting board method can only be used with heraty and without ridging.

The amount of seed recommended is about 1.5 kaylas (18 kg) per feddan. The 1979 survey found that some 40 percent of the farmers placed four or more seeds in each hole, necessitating more than the recommended amount of seed. 37 percent used more than 2 kaylas of seed, and four farmers reported using 4 kaylas. The high rate of seed used did not appear to result from the fact that farmers had experienced poor germination; most farmers reported high numbers of emerging plants, and 36 percent claimed that four or more seeds emerged from each hole. It seems likely that the higher seed use is for extra plants to thin and feed to livestock.

From an economic point of view, there is probably little incentive for farmers to conserve on seed. Since most seed is homegrown or merely selected from regular grain stocks, the cost is low. Once higher quality--and higher priced--seed becomes more available, farmers may be forced to switch to planting methods which use less seed.

Even though initial densities after emergence are high, ultimate densities in farmers' maize fields are lower than government recommendation. The 1979 survey teams took counts of plants in randomly picked field areas to estimate densities, and estimated that densities ranged from 12 thousand plants per feddan to slightly more than 20 thousand--with 44 percent of the fields in the under 18-thousand-plant category. Thus, even though farmers are using greater quantities of seed than recommended, many are getting plant population densities which are lower than desirable.

It is common practice to thin after the plants have established themselves, both to avoid unnecessary crowding and to obtain plants for feeding; the government recommends thinning only once, although in practice many farmers thin twice. On experiment stations and in on-farm trials, thinning is usually done the third or fourth week after planting.

Farmers in the 1979 maize survey were asked about thinning, and the practices of trial farmers (who followed the practice of one thinning only) were compared to those of the nontrial farmers. It was found that 64 percent of the 72 nontrial farmers were thinning twice.

In 65 percent of the cases, nontrial farmers who thinned twice reported that the second thinning occurred more than 30 days after planting, with the height of the thinned plants ranging between 45 and 110 centimeters. This compared with the 16- to 40-centimeter height for thinned plants reported by trial farmers who thinned only once and early.

Nontrial farmers reported that plants from the first thinning were fed to livestock in 30 percent of the cases; 80 percent of the farmers who thinned a second time reported using those plants as feed. Plants from the first thinning, being less mature, can be toxic to animals, which is not the case with those of the second thinning.

It seems likely that the second thinning, pulling out plants with such well-developed root systems, may well disturb the growth of plants remaining for grain production. In any case, allowing the plants to become so large before removal leads to their competition for nutrients with those plants which are to remain.

Here it has been seen how far land preparation and planting practices diverge from what is recommended; however, it has not been clearly established that these practices actually cause lower yields. Additional research is required to determine just which of the various farmer procedures are responsible and what improvements can be made in those practices. Also more work needs to be done with small farmers who do not have access to tractors--to develop better tillage-planting systems for them.

VI. FERTILIZATION AND IRRIGATION

Fertilization and plant nutrition are areas where, in some ways, Egyptian farmers appear to be ahead of the government. They view the use of fertilizer as the best way for increasing yields and apply heavy doses of chemical fertilizer and manure from their livestock. The main nutrient used is nitrogen, which is recommended and supplied in various forms by the government. As survey data show, application levels vary widely among farmers, with some using less and others more than the recommended amounts; some farmer application practices also differ from the recommendations. Given Egypt's high nitrogen use and modest yields, there is reason to believe that nitrogen-use efficency is low. This leads to the question of which fertilization practices, or related factors such as water management, may be responsible for the low efficiency.

Since early in this century, the Institute of Soil and Water Research (ISWR) of the Ministry of Agriculture has conducted fertilizer response experiments on all of Egypt's major crops. These experiments took on a new dimension after 1960 when the government assumed full responsibility for fertilizer production, import and distribution. ISWR research results then became the basis, albeit subject to the limits of financial realities and fertilizer availability, for setting recommended fertilizer aplication rates; these rates were in turn used to determine the amounts of fertilizer for allocation and distribution through the government's agricultural cooperative system. This system was accompanied by a dramatic increase in fertilizer application levels on all crops, but particularly on maize. National average application levels of nitrogen on maize rose from an estimated 13 kg per feddan in 1950 to 63 kg per feddan in 1975 (Gomaa, 1980).

The current national average application level of 60 kg of N per feddan is equivalent to 143 kg of N per hectare. Egyptian and international maize research workers contend that Egyptian maize yields, which average 3700 kg per hectare, are low for the level of N applied. An accepted norm among plant nutrition experts is that a maize crop yielding 3000 kg per hectare would remove 72 kg of N from the soil, and much of that would be available from the soil itself. While average N application in Egypt is double this norm, maize yields are only 25 percent higher. Thus, it would appear that there is a substantial margin of N which is lost.

Leaching and denitrification due to excess moisture are possible causes for low nitrogen efficiency, as is nitrogen volatilization at the time of application. It is also possible that farmers purposely cultivate their maize and use fertilizer in such a way as to encourage vegetative growth which can be used for livestock feed, to the detriment of grain yields. Another explanation is that other nutrients, such as phosphates or zinc, may not be in proper balance, thus reducing nitrogen efficiency.

Although the government has tried to distribute chemical fertilizer in increasing quantities, it is clear that farmers want still more. Some 65 percent of the smaller farmers cited the use of more fertilizer, or fertilizer plus other factors, as the best way to increase crop yields; 58 percent of the larger farmers also named fertilizer in their response to the question.

It is clear that the government pricing policy has played a prominent role in inducing farmers to use more N on their maize. Although fertilizer was taxed in the sixties, it has been heavily subsidized since 1973. Gomaa has shown that there is a strong inverse relationship between the amount of N used per feddan and the fertilizer-to-maize price ratio (Figure 5). Since 1973, N price has been kept quite stable by the government, first at about 14.5 piastres per kg and, after 1979, at about 15.5 piastres per kg, less than half the world market price.

The government-controlled system has been very successful to date in promoting increased nitrogen application rates on maize. To continue to be, it is important that fertilizer response experiments be well designed and their results properly interpreted, and that national production be sufficient and government financial resources available to back official recommendations.

In 1975, the ISWR published the results of 26 maize fertilization experiments which it had conducted from 1966 to 1968 at different locations in the Delta, Middle Egypt and Upper Egypt. The purpose of the trials was to determine optimum rate of fertilizer application, and the resulting figure for the country as a whole was 45 kg of nitrogen per feddan of maize.

Gomaa (1980) was critical of the experimental procedures and interpretations which were based on them, for several reasons. He found that there was often little uniformity in conditions (control factors) among the

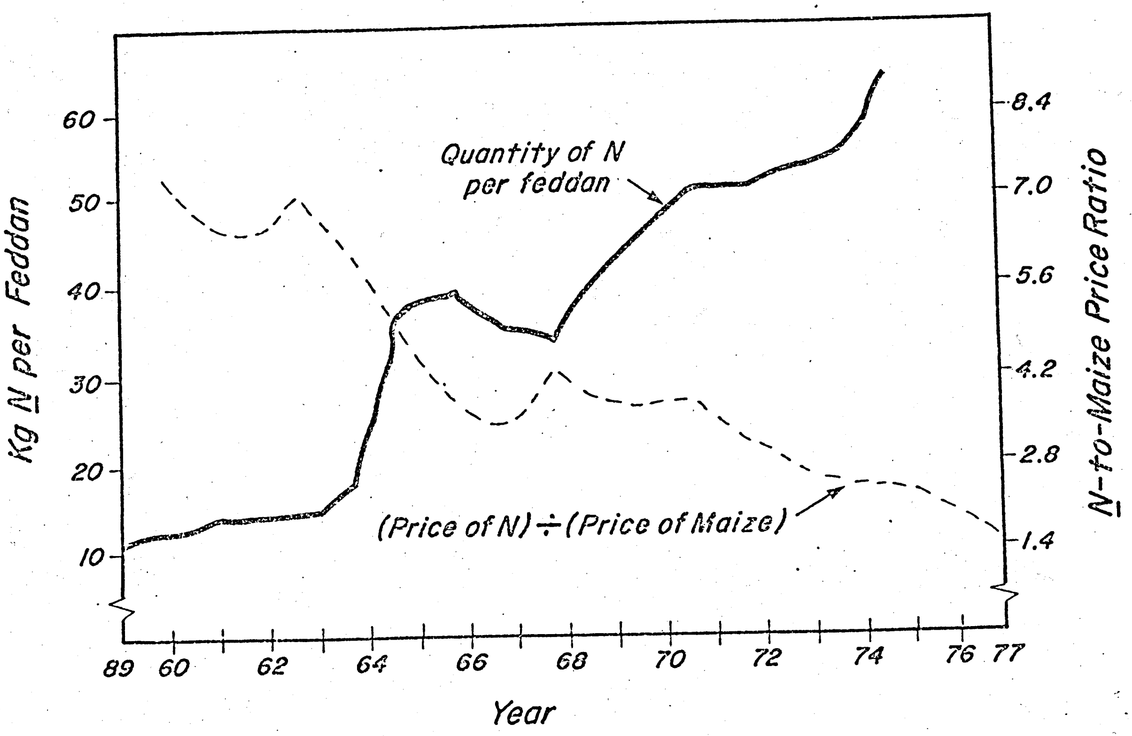

FIGURE 5. National Average Nitrogen Use on Maize and the Nitrogen-to-Maize Price Ratio

Source: Gomaa (1980)

experiments which were conducted in different locations in different years--aside from controlling for preceding crop, for example, there was no attempt to insure that soils were uniform or that initial nutrient levels were comparable. He further criticized the procedures which were followed in economic interpretation of results, pointing out that only the profitability of widely spaced fixed levels was considered and that this permitted only very rough findings--for example, in the Nile Delta 60 kg. of N per feddan is more profitable than 45. Gomaa was further perplexed to observe that, while experiments were interpreted by the ISWR to distinguish only between broad regions, the Ministry of Agriculture always developed recommendations for each governorate, or in some cases for distinct areas in each governorate. Furthermore, he pointed out, experiments found differences in response depending upon the preceding crop, but official recommendations never took this into account.

Nevertheless, the government's fertilizer policy is based on these research findings. To arrive at an estimate of national needs, the recommended levels for each crop are multiplied by the area which is expected to be planted. If national financial resources are insufficient, recommendations are revised downward, as happened after the 1967 war. In theory, the amounts which are planned are procured, either from domestic sources or through importation, and these supplies allocated to farmers at the recommended levels. Farmers receive credit from village banks to cover the recommended amount; additional quantities can be procured from the cooperative for cash, supplies permitting. In practice, distribution is sometimes erratic, and not all cooperatives receive adequate or timely fertilizer supplies. Even when fertilizer is available in the cooperatives, policy can prevent its distribution to some farmers, and credit is not always available.

A tour of village cooperatives (gamaeyas) reveals that of the three main inputs which these agencies supply, seed, fertilizer and chemical pesticides, fertilizers are most likely to be available. Nevertheless, farmers complain that they cannot always find the fertilizer they need, when it is needed, at the gamaeyas. In the Middle Egypt survey, 40 percent of the sample farmers claimed that fertilizer was not available at their gamaeya. When asked why they did not use more fertilizer, however, only 4 percent of the Middle Egypt farmers cited nonavailability at the cooperative as a reason; 55 percent said they did not use more due to cost.

Of the 160 farmers interviewed in the 1976 Delta survey, 71 percent said they would apply more nitrogen if it were available, and 14 percent said they lacked credit to apply more; only 15 percent said they were applying enough. It is well-known that the credit system is used as an instrument to force farmer compliance with the government's planned cropping pattern. Farmers who do not plant as much of a specific crop as required by the official plan sometimes have difficulty in obtaining supplies from the gamaeya or credit from the village bank.

Although the government is the sole supplier of fertilizer, farmers have recourse to a parallel market to obtain supplies over and above what is available through the gamaeya. This is because a substantial amount of supplies from the government system eventually arrive on the free market. This happens in a number of ways. Allocations to some farms and/or regions are in excess of their needs, and some of those supplies are transferred to farmers or regions which did not obtain sufficient amounts. Undoubtedly, some of the supplies on the free market are the result of questionable practices either at the local level or higher up in the system. Although it is expensive compared to official prices (Table 8), the market fills a need by shifting supplies around to places where they are needed, and farmers are willing to pay for the additional supplies.

TABLE 8. Sources and Prices of Nitrogen Used on Maize

SOURCE	PROPORTION OF N (percent)	AVERAGE PRICE (piastres/kg)
Lower Egypt		
Cooperatives	83.0	16.3
Private Sales	17.0	25.9
Upper Egypt		
Cooperatives	67.3	15.6
Private Sales	32.7	26.8

Source: 1979 Survey

The average N application level for the 160 farmers in the 1976 Delta Survey was 63.2 kg per feddan, higher than the 54 kg-per-feddan average recommendation for various governorates in the area at the time (Gomaa, 1980). The gap between recommendations and practices was even greater in Middle Egypt. The 1977 survey found that the 182 sample farmers in that region applied an average of 96.2 kg per feddan to maize, almost 50 percent more than the average 66-kg-per-feddan recommendation for governorates in the zone (Table 9).

TABLE 9. Nitrogen Application Levels of Survey Farmers

NITROGEN (kg/feddan)	DELTA (percent of farmers)	MIDDLE EGYPT (percent of farmers)
0-50	22.3	9.9
50-100	63.9	42.9
100+	13.8	47.1
Average Application	63.2 kg/feddan	96.2 kg/feddan

Nitrogen is not the only nutrient farmers apply to their maize. Most apply animal manure, a practice not followed on experiment stations, and some farmers also apply phosphates, although government experiments and on-farm trials have not shown response to its use.

In the Delta it was found that 96 percent of the farmers interviewed applied manure to their fields. The average was about 363 donkey loads per feddan, with each load estimated to measure about 0.1 cubic meter in volume. About half reported applying new manure while the other half used old (rotted or composted) manure. In the Middle Egypt survey, over 70 percent reported that they manured their fields. About 16 percent of the Middle Egypt farmers used phosphate fertilizers with an average application rate of just over 23 kg of P_2O_5 per feddan. Analysis of the data revealed that farmers used either phosphate or manure, not both (Fitch et al, 1979).

One of the most striking results of the Middle Egypt survey was the prevalence of split applications of N with an average of 2.3 applications. Forty-one percent of the farmers reported three applications, and over 4 percent made 5 or 6. There was a strong positive relationship between the number of applications and the total amount of N applied. It may be that farmers who want to apply more N find it necessary to split their applications, or it may be that the belief in the value of making many applications leads to higher amounts of N. The number of applications may be related to supply factors at the gamaeya, in that there is never quite enough fertilizer available to meet the demand and so farmers are forced to apply it in smaller doses as it comes in. The farmers also may split up the N in order to minimize leaching or denitrification. At any rate, there is a positive correlation between maize yields and the number of N applications (Table 10).

TABLE 10. Fertilizer Use by Survey Farmers

	NITROGEN APPLICATION LEVEL (kg/feddan)	NUMBER OF NITROGEN APPLICATIONS	PHOSPHATE APPLICATION LEVEL (kg P_2O_5/ feddan)	ANIMAL MANURE APPLICATION (percent farmers)
Average*:	97.99	2.79	3.63	70.2
High	268.00**	6	45.00	--
Low	1.69**	1	0	--
Yield Categories:				
Less than 8 Ardebs	80.69	2.55	1.86	75.0
8-11 Ardebs	95.69	2.64	1.82	75.9
More than 11 Ardebs	114.66	3.11	6.74	67.3
Governorate:				
Giza	94.55	2.00	4.62	95.8
Fayoum	72.75	2.57	1.76	76.4
Beni Suef	92.83	2.52	0	85.7
Menia	110.70	3.25	2.09	51.3
Assuit	123.77	3.29	10.76	57.1
Sohag	117.84	3.82	10.86	45.5

Source: Middle Egypt Survey, 1977

* Averages based on 141 farmers with one maize plot only

** Maize researchers are skeptical of these extremes

Fertilizer application varies according to circumstances. An analysis of the Middle Egypt data showed that larger farms tended to apply relatively less N than smaller farms. It also showed that N levels varied among governorates and depended upon the preceding crop (Fitch, Goueli and El Gabely, 1979). A surprising factor in the latter case is that farmers apply more N--and also more manure--to maize planted after berseem clover than after other crops. Clover, being a legume, is normally expected to be a nitrogen supplier but, evidently, Egyptian farmers believe otherwise; perhaps, too, not all Egyptian berseem has favorable rhizobial bacteria.

All of the farmers reported applying N by hand. In Middle Egypt, 91.0 percent reported applying it "far" from the plants, whereas 9.1 percent said they placed it "near" the plants; the remaining few said that they broadcast fertilizer.

Timing of irrigation after N application is an important consideration, from the point of view of N-use efficiency. When fertilizer absorbs moisture from the soil or from dew, and then is exposed to high temperatures from the sun before irrigation, there is danger of loss of N through volatilization. This is particularly true for urea fertilizer, but there is also a chance of loss from ammonium nitrate under the same conditions. The volatilization occurs in all soils, but most readily in alkaline soils. (Studies conducted by IRRI in the Philippines show that N loss due to volatilization can reach as high as 70 percent for handbroadcast urea on rice fields.)

In 1975, 36 percent of the N applied in Egypt was derived from urea fertilizer and 54 percent from ammonium nitrates of various strengths. Urea use has been increasing more rapidly than other sources--it accounted for only 2 percent of the N in 1965--and it is expected to increase in importance even further as a result of Egypt's new urea plants at Abu Khir and Talkha. Therefore, Egypt will be depending even more heavily on sources of N that are subject to volatilization loss.

In the 1979 survey, maize farmers were asked to indicate how much time elapsed between N application and irrigation. Almost 50 percent of the farmers reported delays in excess of six hours, while almost a quarter had delays of more than 12 hours. At this point, evidence is not sufficiently complete to say whether this degree of delay is sufficient to lead to substantial N loss, but it provides a possibility for further investigation.

A 1978 wheat survey points to evidence suggesting that the delay in irrigation following N application is related to the type of irrigation device used by the farmer. The surprising factor from that survey was that farmers who depended on the most ancient and labor intensive of irrigation devices, the Archimedian screw, reported shorter delays than farmers using motor pumps. To explain this fact, survey enumerators stated that motor pumps tend to be used in areas where water supply is a problem--a pump can often lift water from ditches with lower water levels than can other devices--and that pumps are also usually in short supply, resulting in farmers waiting longer periods for them to become available.

There is one other aspect of timing that is crucial with respect to nitrogen-use efficiency, and that is the time of application in the plant's life cycle. The recommended practice is to make a first application of N (about half of the total to be applied) within 10 to 25 days of planting to support early plant development. It is recommended that the second half be applied 35 to 45 days after planting, well before the flowering period which usually occurs 55 to 60 days following planting.

As pointed out earlier, farmers in Middle Egypt were found to average between two and three separate N applications. In the 1979 maize survey, more detailed questions were asked about the timing of the applications, and the farmers were found to have departed far from the recommended norms (Table 11). More than 20 percent reported making the first application later than 25 days after planting; more than 10 percent reported making the second application later than 50 days after planting and about 38 percent reported making a third application later than 50 days after planting. Thus, it appears that a substantial portion of farmers made first N applications which were too late to support early plant growth, while an even greater proportion made a second or a third application after the flowering period, too late to be effectively assimilated for optimum plant growth and grain yield.

The cross tabulation with yields, shown in Table 8, supports the belief that higher N applications lead to higher yields. In a previous paper, Fitch et al used the same Middle Egypt data to make a regression analysis with maize yields as the dependent variable, and utilizing fertilizer, application practices, preceding crop and planting methods as independent variables. It must be pointed out that credibility of this analysis was subject to some doubt to begin with, since the only yield variable available from the survey was the farmer's expected yield at midseason. Nevertheless, the results did have some interest.

Based on the regression, Fitch and his colleages used marginal analysis and assumed a variety of possible conditions, in order to derive the optimum levels of N which would apply. Their results are shown in Table 10. These

TABLE 11. Nitrogen Application Timing, 72 Nontrial Farmers

	NUMBER OF APPLICATIONS			
	ONE	TWO	THREE	FOUR*
Percent of Farmers Applying N	2.8	34.7	51.4	11.1
Average Percentage of Total N Applied	40.6	39.0	14.8	5.6
Timing of Application (Days after Planting)		(percent of farmers)		
With Planting	4.2			
11-15	16.7			
16-20	30.6	2.8		
21-25	25.0	2.8		
26-30	12.5	9.7		
31-35	8.3	20.8		
36-40	2.8	27.8	2.8	
41-45		15.3	6.9	
46-50		6.9	12.5	
51-55		6.9	11.1	
56-60		1.4	15.3	
61-65		2.8	4.2	
66-70			4.2	
71-75			1.4	
76-80			1.4	
81-85			2.8	

Source: 1979 survey

* Timing information not collected for fourth application

results suggest that those farmers who are forced to rely on free market sources (high prices) would logically choose to apply lower levels of N and that they might also apply less N following broad beans. This is consistent with the lower application levels after broad beans which were actually observed in the Middle Egypt survey. Based on the results shown in Table 10, farmers with very low costs of N application--small farms with surplus family labor, for example--might choose to use more N, provided, of course, that funds to buy the extra fertilizer are not a limiting factor. Surplus labor or low application costs would certainly favor splitting the N into a greater number of applications.

An attempt to corroborate these findings with regressions based on 1979 maize survey data was not successful. Even so, survey results suggest that application rates are influenced by preceding crop, planting method, fertilizer price and application costs. This is only suggestive of some of the factors and circumstances which cause farmer fertilizer application levels and practices to vary as widely as they do in Egypt and of reasons why these practices diverge as far as they do from government recommendations. These findings suggest a number of avenues for needed future research.

With the growing recognition that farmers are applying more N to their maize, on average, than has been recommended in the past, on-farm fertilizer trials have already been redirected to focus on higher levels. Until now, the trials have shown little response to application levels above 90 kg per feddan; however the two-application approach should be considered from the point of view of the potential benefits of split applications under typical on-farm irrigation systems. Greater use of split applications may be one way to raise N-use efficiency in Egypt.

The three farmer surveys did not delve deeply into irrigation practices, other than the kind of irrigation devices used and the frequency and timing of irrigation. Irrigation technology was found to vary by region (Table 12) and by parcel size, with Middle Egypt farmers relying on the Archimedian screw and gravity flow to obtain their water, whereas the water wheel dominated in the Delta. In Middle Egypt, also, smaller parcels of land were found to be served more by the Archimedian screw while larger parcels relied on motor pumps.

TABLE 12. Irrigation Systems Used by Survey Farmers

	DELTA	MIDDLE EGYPT
	(percent of farms)	
Sakia (Persian Wheel)	80.1	6.8
Tamboor (Archimedian Screw)	5.8	23.4
Motor (Fixed or Movable)	1.7	12.9
Gravity Flow	3.9	37.6
Other	8.5	19.3

As mentioned earlier, farmers irrigate a week to ten days before planting (heraty system) or immediately after (afeer); these are referred to as the planting irrigations. The first irrigation following the planting irrigation is timed to reach the fields after the plants have emerged; it is recommended that it take place about three weeks after planting. Thereafter, irrigation depends on soil conditions, and normally would take place every two to three weeks.

A study conducted at three of Egypt's experiment stations in the late 1950s concluded that the optimum timing for the first irrigation following planting was 14 days, with subsequent irrigations at 12-day intervals (Mustafa, Ahmed and Fatah, 1962).

In all three of the surveys, farmers were found to irrigate between 7 and 8 times, including the planting irrigation. This means that, on average, irrigations occur at about 16-day intervals which would appear to be an adequate number. The number of irrigations varied substantially, nevertheless, with some 9.2 percent of farmers reporting as few as five irrigations in Middle Egypt. There was also an indication that often the irrigation following the planting irrigation (referred to by farmers as the mohiya or "wetting" irrigation) does not take place as soon as it should for optimum benefit.

In the Middle Egypt survey, more than 85 percent of the farmers stated that increasing the number of irrigations resulted in increased yields, and more than 95 percent stated that heavy irrigations had a harmful impact on maize yields. Thus, farmers appeared to have a reasonable understanding of the basic moisture needs of the maize plant.

VII. WEED, INSECT AND DISEASE CONTROL

Relatively little attention has been paid to the problems caused Egyptian maize farmers by weeds, insects and disease. When asked their opinion about weed problems, farmers in the 1979 maize survey did not, in general, believe that yields were greatly reduced by weeds. Sixty-two percent stated that weeds had no effect and 27 percent some impact; only 11 percent said that weeds had a great yield-reducing effect.

Methods used for weed control are very labor intensive, which may be economically sound in view of the abundant available family labor. The surveys found no farmers to be using chemical herbicides, and the village cooperatives did not stock them. The majority of farmers weeded twice during the growing season, as recommended, although there was a marked difference in the number of weedings between Middle Egypt and the Delta (Table 13). Survey farmers in the Delta averaged 1.6 weedings, compared to 2.3 for farmers in Middle Egypt. Almost all farmers reported using the hoe; one farmer in the Delta reported hand pulling. In the 1979 survey, farmers were asked to estimate the number of man hours required to weed a feddan, and the quantity varied from 15 to 65 hours, with an average of 29.2 hours.

TABLE 13. Number of Weedings Reported by Survey Farmers

	DELTA	MIDDLE EGYPT	1979 SURVEY
	(percent of farmers)		
No Weeding	1.5	0.9	4.4
One Weeding	37.3	3.5	21.1
Two Weedings	56.2	58.3	54.5
Three Weedings	4.0	37.3	20.0
More than Three	1.0	--	--
Average Number of Weedings	1.62	2.32	1.90

It will be recalled that one reason for irrigating before planting is to control weeds by causing their germination prior to planting. The recommended weeding practice is to weed first shortly before the first irrigation, at about three weeks after planting. Just over 30 percent of the 1979 survey farmers reported the first weeding as later than 21 days after planting, however, and about 10 percent reported weeding more than 30 days after planting. This may allow weeds to develop to the point where they seriously compete for plant nutrients and moisture, and they also may have developed such large roots that their removal disturbs the soil enough to interfere with maize plant growth. The only clues as to why farmers delay weeding is that many are known to use weeds for livestock feed; in the Middle Egypt survey, some 36 percent of the farmers reported using them as feed.

There are several insects and diseases which present problems for Egyptian farmers. Late wilt is a problem in all zones, whereas the <u>sesamia</u> and <u>ostrinia</u> corn borers are a threat in the Delta and the red spider in Middle Egypt. Aphids are known to present problems, especially in Middle Egypt, and whorl worms are also recognized as a threat.

Tables 14 and 15 show a tabulation of farmer responses concerning insects and diseases, and how they control them. It appears that there may have been some confusion among the farmers as to whether they were responding about their problems during the year of the survey or whether they were responding as to whether they had ever experienced a particular pest. Furthermore, some of the differences shown between regions in the tables probably represent differences in survey years. Nevertheless, the results are suggestive of the problems which exist and how they vary between the Delta and Middle Egypt.

TABLE 14. Insect, Disease Problems Reported by Survey Farmers

INSECT OR DISEASE	ATTACKS DURING SURVEY OR IN PAST YEARS DELTA	MIDDLE EGYPT (percent farmers)	1979 SURVEY
Aphids	41.1	30.4	35.6
Late Wilt	64.3	10.8*	4.4
Borers	27.9	0.8	15.6
Whorl Worms	22.2	1.4	?
Green Worms	2.5	4.3	?
Downy Mildew	--	0.8	--
Red spider	--	0.7	8.9
Smut	?	?	2.2

* A figure this low may be an indication that farmers did not know how to identify late wilt or that there was confusion in coding

TABLE 15. Pest Control Measures Used by Survey Farmers

CONTROL METHOD	APHIDS	BORERS (percent of farmers)	GREEN WORM	LATE WILT
No Control	48.2	17.4	47.6	50.3
Hand Removal	33.0	67.4*	18.2	40.1*
Chemical Control	16.2	15.2	34.2	9.6**
Removal of Affected Plant Parts	0.4	--	--	--
Other	2.2	--	--	--

Source: Middle Egypt Survey, 1977

* Hand removal possible for <u>Sesamia</u> but not <u>Ostrinia</u> corn borer and not applicable for late wilt, another indication farmers not identifying disease properly

** Chemical control not appropriate for late wilt

Aphids appear to be the most widely recognized pest problem among farmers, although late wilt was also frequently cited by Delta maize growers. Delta farmers also reported a higher incidence of borers and whorl worms than did Middle Egypt farmers.

As to how badly these attacks affect the maize plant and yield, of the 22 1979 survey farmers who reported aphid problems in the survey year, three indicated that they expected no loss in yield, six reported an expected loss of one ardeb (140 kg) or less, eight reported expectations of two ardebs or less, and five from 2 to 4 ardebs. Of 13 farmers who reported borer attacks in the survey year, two expected no loss, three expected an ardeb or less, five expected from 1 to 2 ardebs, and three expected a 2-to-3-ardeb loss. The four farmers who reported red spider attacks said that they expected losses of from 0.5 to 4 ardebs.

Farmers do not appear to be very actively interested in obtaining chemical pesticides to treat their insect and disease problems. Chemicals are used in only 10 to 15 percent of the cases, most often for green worms; the rest reported hand control techniques. When Middle Egypt farmers were asked whether chemicals were available through the local village cooperatives, seventy-six percent of the respondents said that thay had not asked for them, 14 percent said that chemicals were available and 10 percent that they were not available.

The village cooperatives are supposed to stock three insecticides, Malathion (for aphids), Sevin (for whorl worms) and DDT. Table 16 shows the results of a query of 20 village cooperatives in the Delta, made during the 1976 maize survey. Insecticides were often not available, so farmers could not have obtained them if they had wanted to; they seem to use some chemicals when available.

TABLE 16. Availability of Insecticides Reported by Twenty Delta Village Cooperatives*

	AVAILABLE	NOT AVAILABLE
Malathion	10	0
Sevin	11	9
DDT	2	18

* 1976

It is important that pesticides be made more available to the Egyptian farmer and that he see the role that they can play in helping him to increase maize yields.

VIII. MAIZE AS A DUAL-PURPOSE CROP

The maize plant contributes more in Egypt than just grain for human and livestock consumption. One aspect of the dual-purpose nature of maize, the practice of making a late second thinning for livestock forage, has already been discussed in Part V of this report. In addition, the leaves and tops of the maize plant--removed while the plant is still growing and before the ear is harvested--are also used for livestock feed. These materials are available during the midsummer period, when feed is scarce. At the end of the season, the dry stalks are loaded on donkeys and taken to the farmer's house in the village, where they are an important source of fuel for cooking and heating. Thus, strictly speaking, maize is a multiple-purpose crop, and it is the two primary uses, grain production and livestock fodder, which appear to be in conflict.

Stripping and topping have long been thought to reduce maize grain yields, and thus have been discouraged by agricultural officials. Experiment station research conducted in the early 1960s showed that yield reductions of up to 25 percent resulted from various combinations of stripping and topping (Fawzi, Iskandar and Gouda, no date). As a result of such evidence, the government has discouraged the practices, encouraging farmers to set aside a small portion of their crop land to grow densely planted forage maize (darawa) or other forage crops for their animals.

The 1979 maize survey provided some information about the value of fodder resulting from the growing maize plant. Of the 90 farmers interviewed about their own (as opposed to trial) maize fields, more than 60 percent stripped. Most of those placed a value on the strippings, even though the vast majority did not market stripped leaves. The values reported ranged from 1.50 to 10 Egyptian pounds per feddan, with an average value of 4.19 pounds. A similar proportion reported topping and gave values similar to those of stripping.

The 1979 survey farmers who stripped reported that it took at least eight hours to strip a feddan, with 40 percent indicating times in excess of 27 hours. All but three of the 55 strippers reported that stripping was the work of men, rather than women or children. Thus, it appears that it takes a substantial amount of adult male effort to strip, probably reflecting the importance of experience for stripping properly.

The majority of farmers believe that stripping and topping do not cause a decrease in maize yields; of the 1979 survey farmers reporting stripping, more than half reported no resultant drop in yield. One-fourth said the loss was only one ardeb per feddan or less, 16 percent said that it was between one and two ardebs, and only 5 percent said the loss was between two and three ardebs. On average, including those farmers who thought the loss to be zero, the expected loss from stripping was just over 0.5 ardebs or, at 1979 prices, about 5 Egyptian pounds.

In rough terms, then, based upon what farmers reported in the 1979 survey, one would expect stripped leaves to have a value of more than 4 pounds per feddan and a cost, in terms of reduced yield, of roughly the same amount or perhaps somewhat more. In addition to this, there would be the cost of the two to three days of labor which stripping requires. Clearly, the farmer places little if any value on his labor if he strips. Stripping is time consuming, but it is not heavy work and it occurs in the latter part of the summer, after the planting of summer crops but before the heavy labor demands of harvest.

If surplus labor is a key factor, stripping could be expected to be more common on small farms than on large and, truly, the Middle Egypt survey showed that 66 percent of the farms of less than five feddans stripped in contrast to only 41 percent of those of more than five feddans. This would tend to confirm the theory that stripping is related to surplus labor; also, however, smaller farms have higher livestock densities so the demand for fodder must be considered as well.

If wages continue to rise in rural Egypt and if seasonal slacks in the labor force diminish, the practice of stripping may disappear. Similarly, if livestock numbers and the demand for summer feed decrease, stripping and topping should decline in importance. A recent study by Fitch and Soliman (1981), however, shows that, although Egyptian agriculture has become more and more mechanized, livestock is on the increase, due to its subsistence role on small farms.

The surveys showed a considerable difference between zones in the extent to which farmers practiced stripping. In the Delta survey, 80 percent of the farmers reported stripping, compared to less than 70 percent in Middle Egypt.

In the Delta, most farmers who stripped reported stripping two or three times, whereas most in Middle Egypt stripped only once (Table 17).

TABLE 17. Survey Farmers Reporting Stripping

	DELTA	MIDDLE EGYPT
	(percent)	
No Stripping	20	39
One Stripping	28	36
Two Strippings	32	24
Three Strippings	20	1

The Middle Egypt maize survey proved, beyond a doubt, that farmers strip in a carefully planned manner. Furthermore, their method was not the same as that of the experiments which showed that stripping reduced yields. The experiments had entailed dividing the maize plant into four quarters (the ear representing the half point) and removing leaves from one, two, three or four of the quarters in an effort to detect impact. All of the leaves which were removed were taken at one time, either 20 or 35 days after silking. While these experiments were useful, they did not duplicate farmer practice. The field surveys showed that farmers started from the bottom of the plant and worked upward, usually stopping before the ear leaf.

A tabulation of the Middle Egypt data is indicative of why stripping, as practiced by farmers, may have little effect on grain yields. Table 18 lists various stripping practices. Of those farmers who strip, the majority (59 percent) strip only once. The first stripping most often results in the taking of four leaves and the second, when employed, three. Few farmers take the leaf next to the ear leaf, and none take the ear leaf itself or those above it.

The first stripping seldom occurs earlier than 40 days before harvest (11-20 days after flowering), and the second,

TABLE 18. Maize Stripping Practices of Survey Farmers

	FARMERS (number)	(percent)	% FARMERS REPORTING STRIPPING
Taking Only Green Leaves	28	15.1	25.0
Taking Green and Dry Leaves	70	37.8	62.5
Taking Only Dry Leaves	14	7.6	12.5
Stripping Only Once	66	35.7	58.9
Stripping Twice	46	24.9	41.1
Stripping Ear Leaf or Above	0	0.0	0.0
Taking up to Ear Leaf	24	13.0	21.4
Average No. of Leaves Taken on First Stripping :			4.2
Average No. of Leaves Taken on Second Stripping:			3.4
Average Total Leaves Taken :			5.6

Source: Middle Egypt Survey, 1977

30 days before (21-30 days after flowering). Many farmers strip within 20 days of harvest (31-40 days after flowering) (Table 19). In other words, farmers strip in such a manner that plant vigor is not lessened during the grain-filling period.

The 1977 survey also served to clarify farmers' maize topping practices. Almost all farmers reported removing the whole top, the majority (63 percent) 12 days or less before harvest. Thus, topping, like stripping, seems carefully executed to have a minimal effect on yields.

TABLE 19. Time of Stripping Reported by Survey Farmers

DAYS BEFORE HARVEST*	DAYS AFTER FLOWERING**	FIRST (no.)	STRIPPING (percent)	SECOND (no.)	STRIPPING (percent)
Less than 20	31-50	17	15.2	16	34.8
20 to 29	21-30	36	32.1	22	47.8
30 to 39	11-20	41	36.6	4	8.7
40 or More	-10	12	10.7	4	8.7
Total Farms		112		46	

Source: Middle Egypt Survey, 1977

* Harvest expected to occur at about 105 days after planting

** Flowering at about 55 days after planting

Since 1978, Agricultural Research Center maize scientists have redesigned their stripping experiments to more closely follow farmers' practices. Fewer leaves are taken, the ear leaf is not disturbed and stripping is conducted later in the plant's life cycle. While the results of these experiments have not been officially released, research workers feel that yields are little affected.

While stripping may not greatly reduce the yields of the common local maize varieties, there is always the chance that it could reduce the yields of new varieties being developed. This could cause such varieties to be rejected by the many small farmers who must, for the time being, continue to rely on stripped leaves as a vital source of summer forage for their livestock. Therefore, as long as farmers rely on stripping for fodder, it is recommended that maize breeders ensure that grain yields of new varieties are not too sensitive to stripping as it is practiced by farmers.

Aside from the issue of the physical effects of stripping and topping _per se_, there is the broader issue of maize as a single-purpose versus maize as a dual-purpose crop. So far, there is insufficient physical or economic evidence available to demonstrate that raising two single-purpose crops (maize as a strictly grain crop and maize or some other crop as a forage crop) is superior to raising maize as a dual-purpose crop. The clear challenge to researchers in the future is to explore this issue more thoroughly.

More research must be pointed toward the benefits and costs of alternative forage crops. Recently, Ministry agencies have promoted elephant grass as a permanent forage crop and have distributed a limited amount of seed for forage sorghums and Sudan grass. Nevertheless, in 1981, there was still little sound information available as to forage production alternatives for the summer months.

IX. THE EGYPTIAN ON-FARM TRIAL SYSTEM: FINDINGS OF THE 1979 MAIZE SURVEY

It has been noted that farmers in Egypt are not achieving yields which are as high as their circumstances seem capable of producing. One of the reasons for deducing that farmers are not achieving up to potential is that on-farm trials conducted in the National Maize Program consistently produce higher yields than most farmers achieve on their own. Of course, if the on-farm trial procedure is not valid--that is, if the trials are not conducted under circumstances which are representative for most Egyptian farmers, and if they do not employ inputs and procedures which typical farmers can be expected to adopt--then the results are not valid representations of farmer potential. The 1979 Maize Survey was designed to monitor the on-farm trial system. Some results of that survey have been cited earlier in this paper; here they are examined again, with specific emphasis on the validity of the trial process itself, in order to examine the reasons for the yield gap between trial and nontrial farmers.

On-farm trials can be a means for testing varieties and technologies which are often first developed on experiment stations under controlled farming conditions. In this case, the purpose of the trial system was to verify that higher yields could be obtained using available technology applied under typical or representative farming conditions. Trials could show which factors made the adoption of new practices difficult. By involving farmers in the research process, a means of feedback would be provided for the research system, permitting it to develop inputs and technologies appropriate for typical farming situations and easy for farmers to adopt.

The procedures used in these on-farm trials were based on the recommended practices of the National Maize Program. Seedbed preparation followed the recommended ridging system, which the trial farmer carried out under the supervision of the Maize Program farm trial teams. An irrigation was applied immediately after seeding, utilizing whatever irrigation system and devices were available to the farmer. Ninety kilograms of N, supplied by the government, were applied in two equal applications, the first 10 to 25 days after planting, and the second 35 to 45 days after planting. The trials did not include the application of phosphate or manure. Trial farmers were directed to thin once, in the third or early in the fourth week after planting; they were instructed to weed twice, once in the third week and once in the fith week after planting. All of these operations were supervised or verified by the Maize Program's trial team. No topping of maize plants was permitted.

For the trials, twenty-four maize farmers were chosen from throughout Egypt--one from each of two villages located in the twelve maize producing governorates of the country. While some effort was made to select representative farmers, other criteria were also considered in the selection of trial farmers. Because of the need to monitor and collect data about trial results, and because trials can also serve as demonstrations for nontrial farmers, readily accessible fields adjacent to roads were selected. Farm and field size were also considered. It was believed that larger farmers would find it easier to allocate a small parcel for trials without seriously disrupting their normal cropping cycle, and that they were better able to afford to risk loss, should the trial fail.

One of the purposes of the 1979 Maize Survey was to determine the extent to which trial maize farms were representative of average or typical conditions. For the survey, three farmers were selected at random from the same villages as the trial farms. This provided a sample of 72 nontrial farmers who were interviewed along with the 24 trial farmers. Table 20 shows how some of the basic attributes of the trial farmers compared to those of the nontrial farmers. The age distribution of the two groups was about the same. More than 60 percent of the nontrial farmers were illiterate, compared to just half of the trial farmers; a much higher proportion of the trial farmers had school graduation certificates. Table 20 also shows the difference in farm size, with trial farms averaging 10.1 feddans, compared to 3.36 feddans for the sample of nontrial farms. A much higher proportion of trial farmers were land owners; more than 70 percent of the trial maize plots were owned by the farmer, whereas more than half of the fields of nontrial farmers were rented.

While trial farmers, as a group, appear to be somewhat different from nontrial farmers, none of the characteristics noted above is necessarily related to differences in maize yields. Investigations based on the earlier surveys did not show yield differences to be related to differences in literacy, farm size or land tenure *per se*. The recent study by Khedr, Petzel and Monke (1981) also confirms that farm size and literacy are not directly contributing factors to production performance. Nevertheless, it is possible that some of the differences in farmer characteristics are indirectly responsible for differences in maize yields.

Yield

Table 21 summarizes the yield results of the 1979 on-farm variety trials. It compares these to yields obtained

TABLE 20. Characteristics of Trial and Nontrial Farmers

	TRIAL FARMERS (24)	NONTRIAL FARMERS (72)
	(percent)	
Age of Farmers		
21-40	33.3	32.3
41-60	45.9	50.0
Over 60	20.8	17.7
Literacy of Farmers		
Illiterate	50.0	61.1
Can Read and Write	33.3	37.5
Read and Write Plus School Certificate	16.7	1.4
Farm size		
Under 1 Feddan	--	4.2
1 to 3 Feddans	16.6	62.5
3 to 5 Feddans	25.0	20.8
5 to 15 Feddans	29.2	12.5
Over 15 Feddans	29.2	--
Average Farm Size	10.1 feddans	3.36 feddans

Source: 1979 Survey

by 18 of the trial farmers on their own nontrial fields and to yields obtained by the 72 nontrial farmers. The highest average yield for an improved variety in the trials was 18.7 ardebs per feddan, compared to 17.0 ardebs for the "best" local variety raised on the trial plots. These results suggest that the high on-farm trial yields are far more than a matter of variety, since the local variety, used as a trial control, averaged almost as high as several of the improved varieties. In the 1980 on-farm trials, farmers provided their own local variety for use as a trial control; although the gap between their average yields was somewhat greater, local varieties used in the trial still averaged 17.8 ardebs per feddan (Table 22), much higher than national average maize yields.

Average yields of 12.8 ardebs were reported by trial farmers who raised their own maize varieties on their own

TABLE 21. Average Yields of Trial Farms and Nearby Nontrial Farms

	YIELD, ON-FARM TRIALS, BY VARIETY (19 FARMERS) (ardebs/feddan)				"BEST" LOCAL*	YIELD FOR 18 TRIAL FARMERS' OWN LOCAL VARIETIES	YIELD FOR 72NONTRIAL FARMERS' OWN LOCAL VARIETIES
	DC-19	COMPOSITE 2EV2	COMPOSITE 5	PIONEER 514			
Delta	16.32	18.87	16.07	19.11	19.61	14.9	12.1
Middle Egypt	12.93	16.97	14.09	18.37	14.43	8.7	8.5

Source: 1979 Maize Survey

* The "best" local for each area selected by researchers, based on past performance

TABLE 22. Average Yields in On-Farm Variety Trials, 1980

	COMPOSITE 2EV2	COMPOSITE 5	DC-425	FUNK G4787W	LOCAL*
Delta	21.82	19.71	20.79	19.51	16.64
Middle Egypt	24.88	21.31	22.96	19.41	19.75

* Farmer's own local variety used as trial control

separate plots, compared to yields of 10.7 ardebs reported by farmers in the same villages who were randomly selected for the survey. This suggests that trial farmers employed superior practices independently of anything imposed on them by the trial process itself, or that they enjoyed superior circumstances. However, the 12.8 ardebs achieved by trial farmers on their own maize plots was still below those obtained in the trials.

Are the differences between the yields obtained on trial plots and those obtained on nontrial plots significant? Given the nature of the data obtained in the survey, it is difficult to say. The yields for the trial plots were those of a complete harvest, measured by the farmers with accurate weighing equipment and under the careful supervision of the on-farm trial teams. Those yields may also have been biased upward due to border effects of the small trial plots. The yields reported for the nontrial plots, on the other hand, were based on reports of the farmers who probably did not have accurate weighing equipment; thus, their yield reports could be expected to contain errors. Nevertheless, the gap between the yields reported for nontrial and trial maize plots were larger than might readily be explained by errors in farmer yield estimates. It is believed that trial plots actually did produce higher yields, and that trial farmers obtained higher yields with their own maize than did other farmers.

The analysis of the reasons for the yield differences is highly subjective and in most cases is backed up by little more than simple tables. However, attempts were made to explain the differences through the use of statistical regression analysis. In most cases, such analysis failed to produce significant results. Evidently kinds and quality of survey data was not of sufficient quality to support sophisticated statistical analysis. Nevertheless, the analysis was considered to be a necessary step in searching for reasons for the yield differences which were observed.

Variety

While trial results affirmed that high yields were more than a function of improved variety alone, they also suggest that it can be an important factor. This is especially clear from the 1980 trial results (Table 22), where the local variety used as a control was the trial farmer's own local, rather than the "best" local for the region, as used in 1979. In 1980, all of the improved varieties used in the trials produced higher average yields than the locals. Composite 2EV2, the synthetic which was produced by the National Maize Program and which has now been released as Giza 2, produced yields which averaged more than five ardebs higher than the locals provided by trial farmers.

Previous Crop

The previous crop can be expected to affect maize yields in two ways, through nutrient carryover and the influence of the crop on the maize planting date. Trial plots were not chosen to be representative with respect to previous crop, as can be seen in Table 23. More trial maize

TABLE 23. A comparison of Previous Crop for Trial and Nontrial Maize Plots

PRECEDING CROP	TRIAL PLOTS (24)	NONTRIAL PLOTS ON TRIAL AND NON-TRIAL FARMS (90)
Wheat	58.3	41.2
Berseem Clover	20.8	42.1
Broad Beans	12.5	7.9
Flax	4.2	0.9
Winter Vegetables	4.2	7.9

Source: 1979 Survey

plots were planted following wheat and fewer following berseem clover than was the case for nontrial plots.

Planting Date

As was discussed in Part V of this report, recommended planting date may be difficult for farmers to follow, particularly if they raise berseem clover prior to maize and need to prolong its availability for livestock feed. Nevertheless, the 1979 survey found that only three (4 percent) of the nontrial farmers planted their maize either before May 1 or after June 15, the times which would normally be considered too early or too late for planting. In contrast, three (13 percent) of the trial plots were planted after June 15. Therefore, it does not appear that failure to adhere to recommended planting dates could be cited as a reason for the low nontrial maize yields observed in the 1979 survey.

Seedbed Preparation and Seeding

This is an area where there are substantial differences between trial and nontrial maize plots. While the recommended practices are to seed in holes on ridges, as described earier, the ridging system normally requires a tractor for land preparation. Whereas 87 percent of trial plots were plowed with a tractor, less than half of the nontrial farmers' plots were tractor plowed; a third were plowed with animals and almost 20 percent were not plowed at all (Table 24).

The heraty system of irrigating prior to seedbed preparation is normally required to soften the land so as to facilitate animal plowing, and indeed some 24 percent of the

TABLE 24. Plowing Practices, Trial and Nontrial Maize Plots

TYPE OF PLOWING	TRIAL PLOTS (24)	NONTRIAL PLOTS OF TRIAL FARMERS (18)	PLOTS OF NONTRIAL FARMERS (72)
Tractor	87.5	66.7	45.9
Animal	12.5	5.6	33.3
Hoe	--		1.4
No Plowing	--	27.7	19.4

nontrial farmers employed heraty, whereas the afeer system was followed for all of the trial plots.

When animal plowing is used, it is common to scatter seed in the furrows behind the plow, rather than to plant in holes on ridges, as is recommended. Whereas all of the trial plots were seeded in holes on ridges, 29 percent of the nontrial farmers reported seeding their maize in furrows. In contrast, only 6 percent of the trial farmers reported seeding behind animal-drawn plows on their own maize plots.

The differences reported for seedbed preparation and seeding practices thus appear to be significant. The contrast between the practices followed by nontrial farmers and by trial farmers on their own plots suggest one dimension in which the circumstances of trial farmers may differ from those of ordinary farmers. The fact that trial farmers tend to have larger farms and larger fields probably explains why they are able to employ a higher degree of tractor plowing, and thus why more of them are able to follow the recommendation of ridge planting.

Thinning and Weeding

The methods followed by farmers in thinning and weeding were discussed in Parts V and VII of this report. All of the trial plots were thinned only once, as recommended, but half of the trial farmers thinned their own maize plots a second time and 64 percent of the nontrial farmers thinned twice. Whereas all of the trial plots were weeded twice, 25 percent of the nontrial plots were weeded only once. The first weeding was completed by the 21st day after planting on all of the trial plots, but one-third of the nontrial farmers delayed their first weeding beyond that date. Thus, there is a substantial variance between the thinning and weeding practices used on trial and nontrial plots.

Fertilizer Use

As previously noted, the trial plots received a 90 kg-per-feddan application of N, but no phosphate or manure was recommended. The average N application reported in the survey for nontrial plots was 97 kg per feddan. The survey showed that manure was applied to 29 percent of the nontrial maize plots and to 33 percent of the trial plots. Phosphate was applied to 21 percent of the nontrial plots and to only 8 percent of the trial plots. Presumably, some trial farmers believed so strongly in the need for manure or phosphate that they applied these materials even though they were not recommended.

Although nontrial farmers were found to apply only slightly more N than the amount used on the trials, there was a marked contrast in the number and timing of the applications. Whereas all of the trial plots received two applications of N, as recommended, more than 60 percent of the nontrial farmers applied N to their maize in three or four separate applications, and a similar percentage of trial farmers made three or four applications to their own nontrial plots of maize. Whereas all of the trial plots received their last (second) application of N at least 55 days before harvest, 33 percent of the nontrial farmers applied their last N application 45 days or less before harvest. Only 11 percent of the trial farmers applied N this late to their own maize plots.

There also appears to have been more opportunity for the N to volatilize on nontrial plots--while 95 percent of the trial plots received irrigation water 12 hours or less after N application, 25 percent of all nontrial plots received irrigation more than 12 hours after the N was applied.

There was an interesting difference in the source of the fertilizer used by the nontrial farmers and that used by trial farmers on their own plots. Whereas all of the trial farmers obtained the N used for the first application on their own plots from the village cooperative, only 87 percent of the nontrial farmers received theirs from the cooperative; the remainder had to procure theirs on the open market. Thus, it appears that trial farmers had greater access to fertilizer at the low prices offered by the cooperatives.

Stripping and Topping

There was no stripping or topping of maize plants on the trial plots. Whereas more than two-thirds of the nontrial farmers followed the practice of stripping, only one-third of the trial farmers followed that practice on their own maize plots. Similarly, more than 70 percent of the nontrial farmers reported topping, while less than 40 percent of the trial farmers topped their own nontrial maize plants.

The procedures and timing followed by farmers in stripping and topping were discussed in Part VIII of this report. Little evidence could be found in survey data to indicate that the particular procedures used by farmers had negative impacts on yields, although many farmers stated that the practices reduced yields. Earlier in this chapter it was noted that most of the attempts to explain yield differences in the 1979 survey data with regression analysis were not successful. It is worth noting, however, that the dummy variable for stripping was one of the few that consistently proved to be significant. The sign of the coefficient was negative, lending more credence to the idea that it may well have a negative impact on yields.

X. CONCLUSIONS

This discussion has shown that the on-farm trial system in Egypt is producing worthwhile evidence about the potential benefits of both improved maize varieties and production practices. The surveys have disclosed several areas where farmer practices could be improved, among them the timing of the application of fertilizer and irrigation water, seed selection techniques for those farmers planting seed from earlier production, the timing of the second weeding and the entire question of thinning including thinning techniques. Also brought out are opportunities for improving the distribution of seed, insecticides and fertilizer, although fertilizer use is already widespread. Questions still remain as to tillage practices for farmers with little access to tractors.

There is a continuing need to focus research on these and other questions relative to the circumstances of Egypt's small farmers. They produce the bulk of the country's maize and, with their small resource base, would be most helped by such research.

Information from surveys conducted in conjunction with the 1979 trials suggest that farmers may find some of the improved practices difficult to follow, for example, seedbed preparation. This may also be true of other elements of apparently improved technology. Trials tend to be held on larger farms and, therefore, may not be representative of typical Egyptian farming conditions.

The fact that trial farms tend to be larger, and trial farmers better educated than the average, suggest that they may enjoy certain advantages which others do not. In addition to having better access to tractors for plowing, trial farmers may also have advantages in the acquiring of seed and fertilizer; the fact that they are more timely in their application of nitrogen may reflect that supplies at the cooperatives are more available to them. As a result, it may not be realistic to expect trial yields to be matched by all farmers.

While there is an understandable need to select trial plots for a number of characteristics other than that of how representative they are, the trial process would surely benefit from increasing the proportion of small farms. It would be revealing to include some farms of less than one feddan in size, so that maize researchers could reach a better understanding of the needs of those farmers. And, as well as the researcher, Egyptian policy makers and extension personnel would benefit from a clearer understanding of their representative farmers.

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