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Deregulating Technology Transfer in Agriculture

Reform's Impact on Turkey in the 1980s

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Liberalizing the regulation and welcoming the private delivery of inputs and technology greatly increased the private transfer of technology to Turkish farmers. Regulatory reform in Turkey allowed private firms to increase their share of input markets and allowed farmers to significantly increase yields and production.

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Summary findings

Turkey is one of a handful of developing countries that have liberalized regulation of agricultural inputs and welcomed private firms delivering technology and inputs. Gisselquist and Pray show that Turkish regulatory reform affecting seeds and other inputs in the 1980s:

- Greatly increased private technology transfer into Turkey.
- Encouraged market entry for more foreign and domestic companies involved in production and trade in Turkey.
- Allowed private firms to increase their share of input markets.
- Where inputs brought new technology, allowed farmers to significantly increase yields and production.

Gisselquist and Pray recommend that the World Bank and other donors involved with agriculture pay more attention to the regulation of inputs in developing countries. They also recommend that developing country governments revise regulations to leave choices about technology performance to farmers and markets — and to focus instead on externalities, removing unnecessary obstacles to private technology transfer through the production and trade of inputs.

Other countries that have similarly reformed the regulation of agricultural inputs include Chile (in the 1970s), Bangladesh and India (at the end of the 1980s), Malawi (in 1995–96), and Romania (in 1997).

This paper — a product of Trade, Development Research Group — is one of four country case studies of regulatory reform for agricultural inputs. Other studies examine the impact of regulatory reform in Bangladesh, India, and Zimbabwe (where reform was partial). This study was funded by the Bank's Research Support Budget under research project "Regulating Technology Transfer: Impact on Technical Change, Productivity, and Incomes. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Lili Tabada, room MC3-333, telephone 202-473-6896, fax 202-522-1159, Internet address ltabada@worldbank.org. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/html/dec/Publications/Workpapers/home.html. David Gisselquist may be contacted at dgisselquist@worldbank.org. March 1999. (57 pages).

DEREGULATING TECHNOLOGY TRANSFER IN AGRICULTURE:

Reform's Impact on Turkey in the 1980s

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ACRONYMS AND ABBREVIATIONS

ai	active ingredient
CIMMYT	International Maize and Wheat Improvement Center
DONATIM	see TZDK
dus	distinctive, uniform, and stable
GDAR	General Directorate of Agricultural Research
GIFAP	International Group of National Associations of Manufacturers of Agrochemical Products
ha	hectare
ICD	Industry Council for Development
IPM	integrated pest management
kg	kilogram
MARA	Ministry of Agriculture and Rural Affairs
OPV	open-pollinated variety
PVP	plant variety protection
SEKER	Sugar Factories Company
SIS	State Institute of Statistics
SOE	state owned enterprise
t	metric ton
TEBD	Seed Industry Association
TIGEM	Agricultural State Enterprises
TISIT	Association of Pesticide Manufacturers, Importers and Agents
TDF	Technology Development Foundation
TKV	Development Foundation of Turkey
TL	Turkish lira
TZDK	Agricultural Supply Organization
UPOV	International Convention for the Protection of New Varieties of Plants

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1. INTRODUCTION

From the early 1980s Turkey progressively eased regulations controlling private introduction of new agricultural technology through inputs production and trade. This study describes Turkey's 1980s reforms and estimates impact on technology transfer, productivity, and incomes.

Section 1 presents research hypotheses and introduces agriculture in Turkey. Section 2 describes Turkey's reforms. Sections 3 and 4 assess impact on technology transfer, inputs supply, productivity, and incomes. Section 5 presents conclusions and recommendations.

1.1 Hypotheses: Regulations Slow Technical Change

Governments of many World Bank client countries regulate private introduction of new agricultural technology -- through seeds, fertilizers, and other inputs -- in ways that go beyond concerns about externalities (Gisselquist 1994b). Controls on agricultural technology -- beyond what is necessary to deal with externalities and other public responsibilities -- are inconsistent with standard principles for managing a market economy. However, that alone is not sufficient reason to spend political capital to promote regulatory reform if reform would have no impact. The case for reform rests on the following hypothesis:

> Hypothesis: Reducing regulatory obstacles to private introduction of new technology accelerates technology introduction based on private research and/or technology transfer and has a signficant net positive impact on productivity and incomes.

Those who argue that regulatory reforms would have minimal impact raise doubts on several points, including: suitable foreign technology might not be available; companies and farmers might not respond to opportunities; and new private technology might have little beneficial impact. These concerns are addressed in the following sub-hypotheses:

> Sub-Hypothesis 1: Appropriate new technology is available for borrowing from other countries.[1]

> Sub-Hypothesis 2: When policies allow the private sector to introduce new technology, companies offer and farmers adopt new technology (from in-country research and/or technology transfer).

[1] Sub-hypothesis 1 revisits an old argument in agricultural development literature. Immediately after WWII, many agricultural experts looked for technology transfer to deliver productivity increases. However, for important crops, varieties from temperate developed countries were not suited for many tropical developing countries. During the 1950s and 1960s, optimism about technology transfer gave way to pessimism and to increased emphasis on research. Over the last 30 years, more plant breeding and other research -- in private companies, international agricultural research centers (IARCs), and national research programs -- has generated new technologies for tropical environments. These arguments, however, are not relevant for Turkey, which lies at similar latitudes to the Great Plains in the US.

Sub-Hypothesis 3: Technology transfered by the private sector has a significant positive impact on producer and/or consumer incomes.

If research supports these hypotheses, it makes sense for donors and governments to promote regulatory reforms. Since regulatory reforms cost little to implement, this would not at all undermine other programs and strategies for agricultural growth, such as public sector research and extension.

1.2 Country Study to Test Hypotheses

Fortunately, research can be designed to test these hypotheses. Over the last several decades, governments of developing countries have demonstrated a wide range of regulatory strategies. Some countries, such as Thailand, have allowed private companies to introduce new agricultural technology with minimal interference. Others have extended input regulations beyond externalities into other issues, such as technology performance, price, and protection for domestic input industries.

Over the last 15 years, a small but growing number of countries have eased regulations to facilitate private introduction of new agricultural technology. A partial list of reforming countries includes Chile from the 1970s, Turkey from the early 1980s, and Bangladesh and India from the late 1980s. These countries present opportunities to test the hypothesis that easing regulations has an impact on technical change, productivity, and incomes. This country case study looks at Turkey, a country with extensive regulatory reforms for which impact can be observed over more than a decade.

1.3 Pre-Reform Agriculture in Turkey

Turkey lies the same distance from the equator as Spain, northern China, Japan, Kansas in the US, and southern Argentina. The country offers a wide range of climates that supports a varied agriculture. Along the Mediterranean coast, hot dry summers and mild winters support citrus and other fruit production, while on the Anatolian Plateau in the center and east of the country, cold winters with little precipitation favors grain and pastures. With its relatively high latitude and wide range of climates, Turkey has been able over the years to adopt plant varieties, animal breeds, and other technologies from the US and Central and Western Europe as well as from Mediterranean and sub-tropical countries.

After WWII, Turkey shifted rapidly from an agriculture-dominated economy to a mixed economy. Around 1950, agriculture in Turkey employed 80 percent of the labor force, produced 50 percent of GNP, and supplied 90 percent of exports. By 1980, agriculture's share of labor was near 60 percent, while share of GNP had fallen below 25 percent; agriculture continued to produce two-thirds of total exports (MARA 1968, pp 11, 107; SIS 1977, p 166; SIS 1985, p 210; GATT 1994, vol 1, p 21).

Tractors and Fertilizers (Table 4.1): From WWII to 1980, despite government controls on technology transfer, government allowed and sponsored enough new technology to support agricultural growth, though technology and growth was uneven across crops and products. For

relatively simple inputs such as tractors and major fertilizer nutrients, government-led growth worked reasonably well.

With support from the Marshall Plan, government from the 1950s encourged introduction of tractors. Sown area increased by 50 percent during the 1950s (MARA 1968, p 41), and by the 1980s use of tractors for land preparation was nearly universal. Similarly, fertilizer consumption (nutrients) grew from less than 10,000 tons in 1950 to more than 1.3 million tons (average of 100 kilograms per hectare [kg/h] for sown area) in 1980 (MARA 1986, p 29; Ange 1994, p 10). Such large increases in fertilizer use imply shifts to new varieties and yield increases for major crops.

New Varieties for Wheat (Table 4.1 and Figure 4.2): Wheat, which is indigenous to the area, is the major crop and dietary staple. Spring wheat is grown on the coastal plain and covers 27 percent of wheat area, while winter wheat is grown in the Anatolian Plateau and a transition zone. Government scientists conducted research on wheat from the 1920s and had released about 30 varieties by 1960 (Dalrymple 1986). Despite this in-country research effort, the percent of wheat area planted to improved varieties in the mid-1960s was in the low single digits. Wheat yields increased only 0.5 percent per year from 1938-42 through 1962-64 (MARA 1968, p 45).

From 1960, government scientists in Turkey had begun to field test newly developed spring wheat varieties from the International Maize and Wheat Improvement Center (CIMMYT) in Mexico. Although tests soon demonstrated to scientists as well as many farmers that CIMMYT varieties offered significant gains over local ones, government continued to treat them as illegal, actively discouraging their introduction. One expert speculates that government scientists blocked CIMMYT varieties because they wanted to breed and release their own varieties, crossing CIMMYT and Turkish wheats. However, "such a program would ... take a long time. It turned out farmers were not willing to wait" (Aresvik 1975, p 154).

In 1965, John Elisham, a farmer and businessman, acquired about 25 kgs of seed of a CIMMYT variety with assistance from an AID official, who smuggled the seed from Pakistan through the US diplomatic pouch (Elisham personal communication 1994; Frizzell 1968, p 3). The farmer's wheat field, which was prominently located near a government farm, yielded more than four tons per hectare (t/ha), twice yields in nearby fields. More than 100 farmers in the region arranged funds and asked Ministry of Agriculture (MARA[2]) for permission to import 60 tons of seed of CIMMYT varieties for 1966. After discussions that went as far as Parliament, and with the support of a senior MARA administrator who had seen Elisham's wheat field, MARA agreed.

One year later, in 1967, the Minister of Agriculture, Bahri Dagdas, pushed through MARA approval to import 20,000 tons of seed of 13 different varieties -- mostly CIMMYT spring wheats, with some US winter wheats -- using USAID funds. Government scientists opposed the initiative, arguing that "not enough was known about the adaptation of the Mexican varieties" (Aresvik 1975, p 157). At the time regulations required field testing varieties for five years, a rule which was

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[2] For all time periods, this paper uses the acronym MARA to designate the ministry responsible for agriculture, though its name and other duties have shifted over time.

waived for the 1967 wheat seed imports. From less than 0.01 percent of wheat area in 1966/67, CIMMYT varieties spread to 8.9 percent in 1968/69, giving 18 percent of wheat production (Aresvik 1975, p 168). Thereafter, government agencies steadily tested and introduced new varieties of spring wheat from multiple sources.

For the winter wheat areas, government imported US winter wheat in 1967 and also approved introduction of the variety Bezostaya from Russia in the late 1960s. In the 1970s, government registered several local crosses. Another technology transfer that boosted winter wheat yields on the Anatolian Plateau in the 1970s was introduction of the herbicide 2,4-D. With these new technologies, wheat yields rose from an average of 1.1 t/ha during 1962-1966, the five years before CIMMYT, US, and Russian wheats were introduced, to 1.8 t/ha in 1976-80. Over this 14 year period, wheat yields increased 3.6 percent per year (SIS 1981, p 3).

New Varieties for Cotton and Sugar Beets (Figure 4.3): Something similar seems to have occurred in cotton and sugar beets, where production-oriented government agencies introduced improved varieties from foreign lines as early as the 1950s and 1960s. Around 1950, government released foreign-origin Acala varieties. During the 1960s, government seed programs promoted new upland varieties locally bred and selected from Deltapine and Coker varieties imported in 1948 (Evans and Porter 1971, p 13). Cotton (lint) yields increased from an average of 216 kg/ha in 1945/46-1949/50 to 780 kg/ha in 1975/76-1979/80 (Cotton Advisory Committee 1993).

Over the years, cotton farmers also chaffed under varietal restrictions. John Elisham, the man who helped to introduce CIMMYT wheat, reports that a relative in 1930 planted seeds of an acala cotton variety that government had not approved, and again in the 1960s planted seeds from Syria of another cotton variety that government had not approved; both times government began but did not pursue court cases against him.

KWS, a German company that is a world leader in sugar beet breeding, began working in Turkey from 1928. In 1956, KWS became a partner with the government in Pan Tohum. KWS germplasm in Pan Tohum's sugar beet seeds contributed to large yield increases in the 1960s.

Livestock and Poultry (Figure 4.5): Turkey's programs for livestock development, both public and private, have been built around efforts to import and to extend foreign technology. Government began to introduce exotic cattle breeds from 1925. Other technology imports include feed pre-mixes, pharmaceuticals and vaccines, and equipment such as incubators.

The modern poultry industry in Turkey began in the 1960s. Pfizer began to sell poultry pre-mixes in the 1960s. In the 1970s, six private broiler breeder farms began operation, and Development Foundation of Turkey (TKV), a large production-oriented NGO, began its poultry activities (TKV 1992, part 1, p 10). Average annual increases in number of birds rose from 2 to 6 percent from the 1960s to the 1970s, while annual growth in egg production rose from 4 to 8 percent (SIS 1981, p 13; SIS 1994, p 15). Toward the end of the 1970s, continuing rapid growth brought some problems into focus. Poultry farmers faced more disease problems, while government controls blocked vaccine imports. Also, import controls disrupted markets for major feed components, including maize and soy meal.

Problems with Technology Transfer: Before 1980s, government agricultural development efforts focused on export crops and wheat, the major staple. Even for these crops, however, farmers and input industries often faced official road-blocks against new technology. For other crops and agricultural products, regulatory obstacles to technology transfer attracted less attention and criticism.

By 1980, however, the development of Turkish agriculture, even with limited technology transfer, created a demand for more new technology. Company and farmer interest and ability to transfer and adopt new technology -- such as poultry vaccines and vegetable varieties -- contributed to regulatory liberalization from the 1980s.

2. REFORMS

In the mid-1960s, a USAID agricultural expert in Turkey noted that government import policies blocked technology transfer (Mathiasen 1967, p 26):

> ... new types of farm machinery, implements, or other inputs that are not included in the import regime cannot be imported by private individuals except with the greatest of difficulty. Hence, the adoption by private farmers of new techniques and devices developed abroad is discouraged.

Import controls and other policies that blocked technology transfer continued in place through the 1970s.

In the early 1980s, Turkish economic strategy shifted from import substitution with extensive trade controls towards trade liberalization and industrial export promotion. Merchandise exports grew from 5 to 8 percent of GDP from 1980 to 1990, while manufactures increased from roughly one-quarter to two-thirds of exports (GATT 1994, vol 1, pp 1, 133). Early 1980s reforms ended many price controls and other limits on domestic economic activities, eliminated most non-tariff barriers on imports and exports, established market allocation of foreign exchange, and removed barriers to foreign investment.

Despite economic reforms, specific regulations continued to block private sector production and trade for seeds and other agricultural inputs. Nevertheless, economic liberalization created conditions that favored subsequent deregulation of inputs production and trade, as described in this paper.

2.1 Seeds

2.1.1 Pre-1980s Government Controls

For many years Turkey regulated seed trade without any special seed law, taking authority from more general laws governing trade and investment. Turkey's seed legislation dates from 1963, with

Seed Law No 308 giving MARA authority over seed production, domestic trade, imports, and exports (Freiberg and Grobman 1985, pp 284-288). While this law provides the framework for control, implementation depends on subsidiary regulations and practices. Over the years, government has amended the law and associated regulations, and practices have also shifted.

Registration: With respect to variety registration -- listing of crop varieties for which seed may be sold -- Article 4 of Law 308 gives the Minister of Agriculture authority to decide which species (crops) are subject to compulsory registration. MARA has over the years insisted on compulsory registration for essentially all crops of interest to seed companies. For major crops, only local varieties, for which seed is commonly sold farmer-to-farmer rather than by seed companies, do not have to be registered.

Article 6 gives the Minister authority to decide whether or not to register each foreign variety after "adaptation tests in our country and after their economic and agricultural values have been determined..." In other words, registration is based on economic performance; externalities are not even mentioned. Sometime before 1980, MARA began to issue "production permits" as a form of second-class registration. Production permits expire after a fixed term (often four years), and some production permits limit use of the seeds, such as to produce goods for export only.

Turkey's system of compulsory variety registration based on in-country performance tests was more restrictive than practices in many countries, including most developed countries. The US, India, Chile, Mexico, and many other countries do not require variety registration before seed can be sold. Although EU countries require registration, once a variety is registered in any one EU country (after two years of tests), seeds can be sold in all EU countries without further tests.

The impact of compulsory variety registration on technology transfer depends in part on the attitude of those managing the registration process. MARA's Registration Committee is an advisory body that reports directly to the Minister, who has legal authority. This Committee takes advice from multiple sources. Before 1980s reforms, control-oriented advice from MARA's research scientists and their close associates in MARA's Variety Testing and Registration Institute[3] dominated Committee decisions. With such advice, MARA used compulsory registration to block entry for most foreign varieties, making it all but impossible for private companies to operate.

Certification: Certification is an assertion that seed is of the variety that it is presented to be. In Turkey, as in many other countries, certification includes additional quality assurances, such as that germination is above some percent, that seed of other varieties or species is less than some percent, etc.

Law 308 authorizes MARA to set seed quality standards as well as to test seeds. MARA exercised this authority by insisting on compulsory certification for all seed sold, except for farmer-to-farmer

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[3] The Variety Testing and Registration Institute and the Seed Testing and Certification Institute have been with MARA from the time of the 1963 Seed Law. In 1987, these agencies were merged into the Seed Registration and Certification Centre.

sales. With compulsory certification, seed producers must arrange for MARA to test and approve seed in the field as well as after processing, and this can be particularly troublesome for relatively small producers.

Turkey's approach -- compulsory certification -- is similar to EU practice. Seed certification is voluntary in the US, India, and many other countries. With voluntary certification, seed producers attest to the quality of their seed, while governments enforce truth-in-labelling.

Other Controls: With authority from Law 308, MARA annually fixed seed prices for most major crops. In addition, Article 11 gives MARA authority to control seed imports and exports, without limiting controls to phytosanitary issues. Before 1980s reforms, MARA used this authority to restrict private seed trade primarily to vegetables.

2.1.2 1980s Reforms Welcome the Private Sector

Entering the 1980s, MARA limited variety approvals for most field crops to those sponsored by government research agencies. Although private companies were more active in vegetables, importing and producing seeds, MARA controls blocked entry for new companies and cultivars. For example, through 1980 MARA had registered (allowed) only one cucumber hybrid and two tomato hybrids, for which seed trade was monopolized by domestic companies licensed as sole distributors. Several local firms, most prominently May Seed Company, open-pollinated vegetable seed. Smuggling provided a significant share of vegetable seeds, including, for many years, all hybrid watermelon seeds.

Along with smuggling, other evidence of failed seed policies included government inability to popularize hybrid maize and large and expensive government seed agencies serving no more than about 10 percent of planted area. Frustrated with these and other difficulties, officials decided to stimulate rapid expansion of Turkey's private seed industry and to invite multinational seed companies to participate.

In 1981, Turkey asked the International Finance Corporation (IFC) to help promote private seed production and trade. IFC in turn asked the Industry Council for Development (ICD)[4] to identify seed markets, to evaluate strategies for private participation, and to suggest policy changes (ICD 1982, vol 1, p 2). A 1982 ICD mission diagnosed policy obstacles:

> The government variety testing program makes it extremely difficult to introduce genetic advances in seed technology available elsewhere in the world... The time span for new variety introduction, including hybrids, and their approval by the key Variety Registration Committee, is a minimum of three years... Seed companies operating outside Turkey have been very reluctant to undergo the lengthy time period required to obtain commercial introduction of hybrids in Turkey or to make

[4] ICD is a US-based non-profit organization, supported by large multinationals, with a mandate to promote trade and investment to support development.

available the local production of parent lines under the system of rigid price fixing and the minimum margin structure of the industry (ICD 1982, vol 1, p 35).

ICD recommended that Turkey eliminate price controls on seeds and allow "free import ... by private organizations for testing and marketing purposes, subject only to phytosanitary import regulations" (ICD 1982, vol 1, p 75). Notably, allowing free import for marketing entails doing away with compulsory variety registration.

Government acted quickly, though reforms fell short of dismantling compulsory variety registration. A 1983 ICD paper reported changes "in the body of regulations pertaining to the seed industry," including (Grobman 1983, pp 1-2):

* from October 1982 government allowed private companies to do their own variety performance tests, reporting results to the government, which continued to decide whether or not to approve each variety;

* MARA's Registration Committee is prepared to issue production permits for new varieties "even without testing, provided that evidence is presented that such a variety has been successfully grown in a similar ecological region."

* government lowered testing requirements from the previous minimum of three years to 1-3 years, depending on crop and type of seed (eg, one year for hybrids, two years for vegetables);

* since December 1983, each seed firm is allowed to set its own seed prices.

As part of efforts to stimulate private domestic and foreign investment, MARA and ICD organized a National Seed Enterprise Development Workshop in Istanbul in May 1984, inviting private Turkish and foreign seed companies and soliciting their views. Government also relaxed controls on private foreign investment and made credit available for seed companies.

2.1.3 Post-Reform Seed Regulations

Seed regulations have continued to adjust over time. Throughout, government regulatory agencies have continued to claim and exercise controls that go beyond externalities and that are in some respects more stringent than in most developed countries. Nevertheless, regulations have been implemented in a way that allows private companies to operate, despite continuing limits on seed imports and entry for new varieties and firms.

Licensing Seed Companies: Government licenses seed companies in two categories, designating stronger ones (with land and scientific staff) as research companies, which allows them to do their own variety trials. Other seed companies must ask research companies or government farms for help with variety trials.

Variety Registration: Turkey has maintained compulsory variety registration, but has reduced required tests, allowed companies to do their own testing, and expanded use of production permits to speed entry for new varieties. Changes in regulations and the attitudes and behavior of the Registration Committee reflected advice from MARA's Seed Division (which was more reform-oriented than MARA's Variety Testing and Registration Institute) along with private seed companies.

As of 1997, the Registration Committee accepts identification and description of varieties from foreign registration[5] and asks for one year of performance tests only. For varieties not registered in another country, the Committee asks for two years of in-country tests (MARA 1994, item 47). From the early 1990s, government has stopped public listing of varieties granted production permits, putting more emphasis on registration.

Private seed industry sources agree that major companies have no trouble getting varieties approved. In 1994, companies reported that the Registration Committee approves about 80 percent of applications for production permits and 95 percent for registration. However, registration may be a more serious barrier for small and new companies.

In cases where seeds of a non-registered variety are to be imported exclusively to produce an export crop or product (eg, seeds or tomato paste), government grants import permits within several weeks without any in-country testing or registration, provided that the variety is listed in the OECD List of Cultivars Eligible for Certification.

Seed Certification: Government continues compulsory certification, but this does not seem to create problems, at least for major seed companies. Major companies lobby for a larger role in seed certification rather than for voluntary certification. Currently, the Seed Registration and Certification Centre certifies vegetable seeds without field checks (or in other words allows companies to check their own fields). Centre managers say this is due to lack of staff rather than any intention to shift responsibility for quality control to private firms. However, this is consistent with common OECD practice.

Import Controls: Government continues seed import controls that protect local seed producers and established seed companies:

* Government uses import permits to limit seed imports by company, with attention to factors such as previous seed production and land available for seed production.

* Government allows only registered seed companies to import seed. This hurts food processors who want "higher quality seed and...new seed varieties required by the processing industry" (FAO and MARA 1994, p 24).

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[5] To determine whether or not a group of plants or seeds constitute a variety, standard DUS tests determine if plants are distinctive, uniform, and stable (over several generations). Turkey accepts DUS tests from countries with strong testing capabilities, such as OECD countries.

* According to many experts, Turkey's phytosanitary restrictions go beyond realistic concerns about pests and disease threats.

Plant Variety Protection (PVP): In 1994, government passed a PVP law to allow companies to claim property rights in varieties. Based on 1994 interviews, companies expect implementation of this law to encourage companies to introduce more non-hybrid varieties from testing or breeding programs (even without PVP, companies have been able to protect hybrids through physical control of parent lines). Industry sources also expect PVP to encourage foreign companies to contract in Turkey to produce seeds for export by making it easier to prosecute anyone who pirates seeds to compete in export markets.

Subsidies: Government from 1985 through 1994 paid subsidies to private and public seed companies on specific categories of seeds (eg, hybrid maize, soybeans, etc). Government annually announced subsidies in TL per kg, and paid that amount to companies against receipts demonstrating sale to farmers. Subsidies have fallen precipitously; eg, subsidies on hybrid maize seeds ranged from 12-38 percent during 1987-1990, fell to about 1 percent during 1992-1993, and were eliminated in 1994.

2.2 Inputs for Poultry and Other Livestock

Although introduction of foreign technology before and after 1980s reforms benefitted all livestock subsectors, the impact is most evident in poultry. Poultry currently provides almost a third of total meat and a nearly equal tonnage of eggs. For other livestock sub-sectors, adoption of modern breeds and feeding technology is less extensive than for poultry, and shares of meat and total animal protein continue to fall.

Breeds: Introduction of new breeds has been crucial to expansion of the modern poultry industry. Industry sources report that breeds have come in as needed, with no particular bottle-necks. One expert reported that government from the late 1970s relaxed controls on introduction of new breeds; however, poultry breeds did not change much in the 1980s.

Pharmaceuticals and Vaccines: Through the early 1980s, government did not allow private companies to manufacture or to import poultry vaccines, while government vaccines were unreliable (Kreuger and Bobel, p 17). Moreover, government produced only two vaccines, for pox and Newcastle, arguing that other diseases were not present. Facing mounting problems with other diseases, such as egg-drop syndrome, farmers in the early 1980s pushed government officials to recognize other diseases and to allow vaccine imports. Around 1984, government changed policies to allow private vaccine imports.

As is standard among countries, MARA lists allowed veterinary pharmaceuticals and vaccines. When a private company asks to add an item to the list, MARA authorities commonly ask advice from non-MARA experts, including university professors. Sources agree that MARA approvals for new poultry pharmaceuticals and vaccines are reasonable, and that the industry does not currently suffer from lack of these items.

Feed and Pre-Mixes: Technology embodied in pre-mixes is one of the keys to modern poultry and livestock production, enabling low feed-to-meat ratios with different macro-components. During the 1980s, general economic reforms encouraged private expansion and competition in all components of the feed industry. However, multiple sources -- including a private pre-mix company -- reported no major change in the character of feed and pre-mix regulations.

Regulations continue to exceed concerns about externalities, interfering in choices that could be left to markets. Externalities from antibiotics and hormones justify some limits on feed additives. However, MARA also registers and regulates vitamins and pre-mixes, sets minumum percents for nutrients in feed, and sets maxima and minima for many components. MARA's objections to low-cost components such as citrus residues boost feed costs.

2.3 Pesticides

Applying chemicals for pest control began in Turkey on a large scale at the end of the 1950s (MARA 1968, p 29). Initially, MARA applied pesticides, and this has continued for some pests. From the First Five-Year Plan (1963-67), the government has shifted responsibility for pest control back to farmers, encouraging them to buy and apply chemicals (Aresvik 1975, p 75). Until the late 1980s, government-managed cooperatives, selling pesticides along with other inputs on credit, dominated wholesale and retail pesticide trade and largely decided what pesticides farmers would use. On the other hand, from at least the 1960s, most pesticide production and import has been in private hands.

The 1957 Agricultural Pest Control and Quarantine Law No 6869 sets the legal basis for regulating pesticides. Legal frameworks for registering active ingredients (ai's), formulations, and products are similar across most countries, and Turkey is no exception.[6] Within this standard framework, countries differ in details, such as: time and expense to register new products; who tests products; whether tests from other countries are accepted; etc. Changes in these details have been important in Turkey's 1980s reforms.

General import and investment liberalization from 1980 favored competition and production efficiency. In addition, reforms specific to pesticide production and trade facilitated private introduction of new technology (ie, new ai's) and strengthened competitive private markets. Pesticide reforms include:

* Until 1988, all in-country efficacy tests had to be done by Plant Protection Institutes. From 1988, Institutes allow companies to arrange their own tests with reputable researchers.

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[6] An active ingredient (ai) is the chemical that does the job. A formulation is usually a mix with one or more active ingredients that is prepared for sale. A product is a formulation with a brand name. For new and patented ai's, there will normally be only one product (brand) for each formulation. Once patents have expired, many companies may offer competing products (brands).

* From the end of the 1980s, government drastically cut its involvement in pesticides trade through government-managed cooperatives, leaving trade at all levels to private dealers.

* Government from 1994 removed pesticide price controls, which had become unwieldy due to rapid inflation.

Several other features of Turkey's current pesticide registration process favor new technology and competition. Government accepts toxicology data from other countries, which reduces time and expense for companies to introduce new formulations. To register competing brands for old off-patent formulations that are already in the market, government asks only for chemical analyses of new brands, which favors competition and low prices for me-too or commodity products. Also, government has from 1971 de-registered (banned) many chemicals that are highly toxic, persist in the environment, or have chronic health or reproductive impact.

2.4 Fertilizers

From 1971, government stopped the small amount of private trade previously allowed, restricting fertilizer import and domestic trade to Agricultural Supply Organization (DONATIM or TZDK) and the Sugar Corporation, with government-controlled cooperatives dominating retail trade. While government dominated trade, a mix of public and private companies generally supplied over two-thirds of domestic demand along with some exports.

With general import trade liberalization from 1980, the fertilizer industry gained improved access to raw materials and spare parts, allowing higher capacity utilization and production (State Planning Organization 1988, p 11). However, government continued to control prices and trade at all levels, so that improvements for producers had little impact at the farm level.

From July 1986, government replaced its monopoly in fertilizer trade with a public-private oligopoly, allowing the handful of fertilizer producers along with government-controlled cooperatives and their agents to enter international and domestic fertilizer trade at all levels. From 1988, government further opened domestic fertilizer trade to anyone with TL 1 billion capital, leaving import trade in oligopoly hands. From September 1994, government removed this trade barrier as well, opening fertilizer imports to any company with TL 1 billion capital. At the same time, anticipating customs union with EU, government eliminated duties on fertilizer imports from EU and cut duties on imports from other countries to EU levels (4.8-11 percent on various major fertilizer products).

Despite trade liberalization, subsidies have continued. Before July 1986, government set high factory and low farmgate prices, paying subsidies directly to TZDK and Sugar Corporation. During 1986-1994, government allowed dealers to set domestic prices, but paid subsidies in TL per kg to dealers presenting receipts from retail sales. During 1994-97, government paid subsidies -- set in terms of percent of fertilizer price -- directly to farmers presenting proof of purchase, an arrangement which allowed price and product competition, but which burdened farmers and retailers with expensive paperwork.

Comparisons of domestic and international fertilizer prices show that farmers gain much less than the government spends in subsidies. Other policies -- protecting oligopolies, extending tax benefits to exporters, and taxing imports and domestic sales -- off-set fertilizer subsidies and shift them away from farmers.

2.5 Agricultural Machinery

Over the last several decades, Turkey's agricultural machinery industry has had two sub-sectors: a few large companies with international connections produce tractors with some imported components; and more than a thousand mostly small and independent companies produce plows, planters, and other farm machinery. Most of the production capacity for tractors and other equipment has been in the private sector. Turkish companies produce most of the agricultural machinery that is used in the country and also produce for export.

At the beginning of the 1980s, general import reforms (market access to foreign exchange and removal of most quantitative import controls) made it easier for agricultural machinery producers to import production equipment and parts. 1980s reforms with specific impact on the agricultural machinery industry include:

* In May 1984, government abolished price controls on agricultural machinery (L Clarke 1985, p 329).

* In early 1985, government abolished rules for domestic tractor producers (from the 1964 Assembly Industries Regulation) on minimum percent of domestic content and lists of components not allowed for import (WB 1985, p 24).

* With several changes in import rules through about 1985, government allows imports of tractors, harvesters, and other machinery without special permission but with tariffs.

For important items, tariffs have been reasonable; for example, in October 1994, duties on tractors less than 100 hp, which compete with local tractors, were 23 percent, while tractors greater than 100 hp paid 15 percent duty). Lower tariffs are imminent as Turkey maneuvers for membership in the European Union.

3. IMPACT ON TECHNOLOGY TRANSFER AND INPUT INDUSTRIES

The chain of causation by which regulatory reform has an impact on agricultural productivity and incomes goes through technology transfer and inputs supply. This section describes the impact of reforms on technology introduction and inputs industries, which addresses the first two sub-hypotheses of Section 1.1: that appropriate technology is available; and that private companies are willing and able to introduce new technology when reforms allow.

3.1 Seeds

Technology Transfer: With seed reforms from the early 1980s, the number of improved varieties allowed for sale (with either registration or production permits) increased dramatically over the next several years, as shown in Table 3.1. For sunflower, for example, the number of varieties increased from three in 1982 to about 30 in 1987. For soy beans, varieties increased over the same period from two to more than 40. Many of these new varieties have been introduced and tested at the initiative of private seed companies as part of their efforts to expand seed sales.

Even for crops with strong public sector involvement in seed trade, 1980s reforms brought increases in numbers of varieties available, through public as well as private efforts. In wheat, for example, government allowed a total of only 21 improved varieties in 1982; after reforms, government approved an average of over five new varieties per year during 1984-94. In 1980, Agricultural State Enterprises (TIGEM) produced seeds for 14 wheat and four barley varieties; by 1994, TIGEM offered 42 varieties of wheat and nine of barley. In sugar beets, KWS (partner with the government in Pan Tohum) responded to competition from several fully private competitors by selecting additional lines from their breeding program that are specially suited for Turkey.

Prior to the 1994 PVP law, companies have had no legal way to stop any other company from taking and reproducing seed for self or open-pollinated crops such as wheat, barley, and soy bean. Nevertheless, companies have invested to identify, test, and introduce new varieties for non-hybrid crops. During interviews in 1994, seed company managers reported only one case of a company multiplying seed of a variety introduced by another: TIGEM multiplied seed of a soy bean variety that May and its international partner Asgro had introduced.

Expansion of the Seed Industry: Before the 1980s reforms, the few private seed companies importing and producing seed in Turkey (one source reports only one, May Seed Company [Freiberg and Grobman 1985, p 279]) focused on vegetables. In addition, there were two semi-private seed companies: Pan Tohum, a joint venture between the government's Turkish Sugar Factories Company (SEKER) and KWS, a German firm; and BETA, for which the dominant owners are sugar cooperatives, so that BETA is controlled by Pankobirlic, a government-run apex cooperative.

In 1980, government directly managed or controlled most commercial seed production and trade through cooperatives and SOEs, including TZDK and TIGEM. For sugar beet seeds, Pan Tohum had a monopoly for production and import and distributed seeds through sugar cooperatives.

A 1985 World Bank paper reports nine new seed companies established from the time seed reforms began (Freiberg and Grobman, p 280). That number increased rapidly; several years after reforms, all major US and European-based seed multinationals had established a presence in Turkey along with companies from Israel, Taiwan, Thailand, Japan, Korea, and other countries. In 1986, Turkish seed companies founded a Seed Industry Association (TEBD); TEBD in 1994 represents 29 companies, most of which are private. The seed industry includes another 50 or so private companies that have not joined TEBD.

Private seed sales expanded to dominate markets for several field crops and to take a share of sales for other crops, as shown in Table 3.2. Most of the increase in private sales has been for varieties that private companies have introduced, so that private sales correlate strongly with technology transfer.

For wheat, despite subsidized competition from SOEs, private seed companies have introduced new varieties from CIMMYT and Europe, and more are in the pipeline. Recognizing that farmers multiply wheat seed for own use and sale to neighbors, one seed company manager described his plan to continuously introduce new varieties, staying ahead of mutating diseases and offering new varieties with attractive features (eg, a US durum wheat with low percent of yellow bellies). With farmers planting a million tons of wheat seed each year, even a small market share represents large sales. In 1994, private companies sold wheat seed at about double TIGEM seed and grain prices.

For selected crops, Table 3.3 shows seed production plans by type of firm in 1994. Numbers do not show market shares because firms do not follow these plans (eg, TIGEM is unlikely to more than double wheat seed production from 1993), seed may not all be sold, and some of what is sold may be exported. These are, however, the only numbers available to show market share. Subsidiaries of six foreign firms proposed to produce about half of the hybrid maize and sunflower seed. Most of the remaining hybrid maize and sunflower seed as well 98 percent of soy bean seed was to be produced by six joint venture firms. Unofficial estimates from the firms we interviewed suggest that market share for the largest company in maize is about 30 percent and in sunflower about 25-30 percent. Competition appears strong in major seed markets; for example, the leading maize seed company reports that its market share is being eroded by smaller firms undercutting its price. Overall, the large number of companies in Turkey's seed industry favors competitive markets despite some tendency toward over-regulation (eg, continuing compulsory variety registration).

Seed Imports and Exports: Reforms lowering barriers to varietal introduction and to seed imports led to more imports for some crops, such as maize and sunflower. Soon, however, production expanded to take care of demand and then pushed into export markets as well (see Figures 3.1 and 3.2). From 1988 maize seed exports exceed imports; for sunflowers, exports exceed imports from 1990. Once reforms allowed seed technology to enter, Turkey has been able to exploit its comparative advantage in seeds based on climate, scientific skills, and low cost labor. Table 3.4 shows Turkey's exports and imports for all seeds. Chile, another early reformer, shows the same progression from maize seed imports, to local production, and then to exports.

Maize and sunflower seed imports in the early 1980s assisted introduction of new varieties, allowing farmers to adopt them before locally produced seed was available. During the 1960s, imports of Mexican wheat seed played a similar role, facilitating rapid expansion of area planted to new varieties. A recent study of maize yields for 50 countries over 25 years found strong correlation between yield increases and volume of seed imports (Pray and Echeverria 1992, pp 372-373).

Considering the importance of imported seeds to introduce new varieties, Government efforts to discourage seed imports (see Section 2.1) may be more effective in slowing technology transfer than in protecting domestic seed producers. In the early 1990s, Turkey has been importing seeds for

roughly 1 percent of planted area. This can be compared to seed imports into Thailand and Chile, which have more open seed policies, for roughly 1-3 percent of planted area in the mid-1980s (FAO 1987, p 307; Pray 1990, p 195). Seeds are bulky and costly to move, and even reasonable phytosanitary rules add to import costs. Aside from some high-value vegetable seeds and seeds that require special conditions for production, lower costs with in-country production tend to dominate decisions about where to produce seeds, favoring local production, even without protective trade interventions.

Shrinking Public Sector Seed Sales: Seed reformers in the 1980s concentrated on building up the private sector rather than tearing down the public sector. With even reformers afraid that private companies would not be interested to produce relatively low value seeds for open pollinated crops such as wheat, barley, and fodder crops, government continued to produce seed for wheat and other major crops.

As private companies have expanded, pressure mounts for government to limit SOE seed production and unfair competition. During interviews in 1994, managers of private seed companies vehemently objected to SOE sales of hybrid maize seed. However, seed industry sources expected the government through TIGEM to continue to produce wheat and barley seeds in the near and medium-term future.
In the mid-1990s, KWS signed a 10-year contract with Pan Tohum, demonstrating government intentions to keep a large share of the market for sugar beet seeds as well. Cotton seed production and trade continue to be dominated by state-managed cooperatives.

3.2 Poultry

Technology Transfer: The biggest impact of 1980s reforms on poultry technology appears to have been in the area of vaccines, where government now allows more vaccines and also private vaccine imports. Feed technology has also improved. In 1994 Kartal Kimya, one of the two major feed pre-mix companies in Turkey, sold 65-70 standard pre-mixes and produced another 150-200 pre-mixes tailor-made for specific customers. Experts report feed-to-meat ratios in the poultry industry falling from 2.2-2.5 in the early 1980s, to 2.0 in 1989, and to 1.9 in 1994.

More Competitive Private Industry: Before reforms, government monopolized production of both allowed poultry vaccines. In 1994, an industry source estimates government's share of Newcastle vaccine at 10-20 percent only. Table 3.5 shows impact of reforms on Turkey's poultry vaccine imports from the US.

Competition improved in the feed pre-mix industry. Roche for many years had been the only major company importing feed pre-mixes and components. Kartal Kimya began to compete from 1985 and now holds about 30-35 percent of the pre-mix market, with Roche having about half.

From the 1970s, about a half dozen companies have been running breeder farms for broilers or laying hens. There are also two (formerly three) Turkish farms producing grandparent stock. Chick imports help to keep markets competitive (see Table 3.5). However, 1980s reforms had no major impact on breeds or chick supply.

3.3 Pesticides

Technology Transfer: At the beginning of the 1980s, Turkey had approved a cumulative total of just over 100 ai's. After 1980, the pace of approval of new ai's and products accelerated. Annual registration of new ai's increased from seven in the 1970s to nine in 1980-84 and then 20 during 1985-92 (see Table 3.6). By the end of 1992, Turkey had approved a cumulative total of more than 300 ai's, which can be compared to more than 700 ai's in production in the US in the 1990s and to more than 200 ai's approved in a number of middle income countries in Latin America and Southeast Asia around 1990 (eg, Brazil, Columbia, Mexico, Indonesia, Korea, and Malaysia).

Accelerated registration of new ai's shows farmers gaining access to a wide range of new technology, including plant growth regulators for high value horticulture and biopesticides such as bacillus thuringiensis (Bth). Virtually all pesticides introduced into Turkey in recent decades come from research in developed countries.

More Competition: Post-1980 increases in numbers of new products registered indicates increasing competition in the pesticides market, which presumably lowers margins and prices. Through the 1960s, the ratio of new products to new ai's did not exceed two, which shows that many pesticide products sold in monopoly or oligopoly markets. In the 1970s, the ratio of new products to new ai's rose to about three, which implies more competition. From 1980 the ratio has jumped to nearly five. During 1994 interviews, pesticide traders described the market as very competitive.

Retail trade has also shifted into private networks. The manager for a major pesticide multinational reported that four invoices for bulk sales to cooperatives accounted for 80 percent of annual sales in 1988, whereas 85 percent of retail sales went through the company's own dealer network in 1994.

Imports and Exports: Government has consistently favored import substition for pesticides, but this does not appear to be a major problem. Industry sources in 1994 reported a 40 percent duty on ai's that can be produced in Turkey, but that this duty can be avoided. In 1994, Turkey imported 100 percent of specialty ai's (ai's for which patents remain current) as well as a major share of commodity ai's (ai's for which patents have expired). Turkey also exports pesticides. Pesticide exports responded more strongly than imports to 1980s economic reforms (see Table 3.5).

3.4 Fertilizers

Technology Transfer: After 1986 reforms, competing companies introduced new products. Prior to 1986, government had allowed only two composite fertilizers, whereas by 1990 traders offered eight composites. Also, at least one fertilizer company initiated a soils research and testing program. Private sales of micronutrients and liquid fertilizers have increased, but these have been allowed all along, even when government claimed a trade monopoly for major fertilizer products.

Oligopoly: After 1986 reforms broke the government's fertilizer import monopoly, share of imports by TZDK and Sugar Corporation fell from 100 to roughly 20 percent in 1990 (WB 1991, p 12). Through late 1994, however, government restricted private imports to the four private producers in

Turkey. In 1994, only nine public and private companies produced fertilizer, of which four were responsible for 95 percent of total production, and concentration was even higher for individual products. Oligopoly protected large trading margins, which along with import duties largely offset subsidies nominally intended for farmers. In 1994, one expert estimated that trade barriers kept retail prices comparable to border prices despite $ 400 million in subsidies, which were "half of the [retail] value of the fertilizers" (Gencaga 1994, p 3).

From late 1994, when government allowed competitive fertilizer imports, farm-level fertilizer prices before subsidy have closely followed import parity prices.

Exports (Table 3.5): During the 1980s, value of annual fertilizer exports increased from nothing to more than $ 100 million, while imports showed no trend. Tax incentives favored exports. However, Turkey's fertilizer exports depend on raw material imports. During the 1990s, exports have almost disappeared in the face of competition from low-cost producers in Central and Eastern Europe.

Fertilizer Use: Trade liberalization from 1986 improved the convenience and reliability of supply to farmers. However, with continuing oligopoly, domestic prices rose from FYs84-86 to FYs91-93, while world prices for nitrogen and phosphates generally fell (Ange 1994, pp 17, 21-22). With further trade liberalization in 1994, ex-factory prices fell to import-parity levels, while farm-level prices fell even lower with heavy subsidies. Average annual fertilizer use increased from 1.5 to 2.0 million tons from FYs84-86 to FYs91-93 (Ange 1994, p 13), an average annual growth of 4 percent, somewhat less than the 8 percent growth rate observed during FYs69-71 to FYs84-86 (Aresvik 1975, p 65; Ange 1994, p 13). From 1994, fertilizer use shows large year-to-year fluctuations due mainly to instabilities in macro-economic management, with no net growth in use. Slower recent growth is consistent with patterns in a mature fertilizer market.

3.5 Agricultural Machinery

Technology Transfer: Aside from major pieces of equipment such as tractors and harvesters, the pattern for introducing new agricultural machinery in Turkey has been to import prototypes which manufacturers copy for local sale. During the 1980s, new equipment copied -- or copied on a larger scale -- included: pneumatic seed drills, drying equipment, silage machines, drip irrigation eqipment for greenhouses, and rotary harrows. Introduction of relatively expensive hybrid seeds for maize and sunflower created a demand for pneumatic seed drills. More maize production created a market for grain drying equipment.

Strong Competition Except for Tractors: After 1980s reforms, the number of tractors produced and sold in Turkey stayed roughly constant, while the number of companies producing tractors fell from 11 in 1984 to three in 1994. One possible interpretation is that liberalization sped exit for firms too small to be efficient. Two private companies dominate the market (one is a joint venture with government), which raises the spectre of oligopoly, particularly since there appears to be little competition from imports. For most other types of agricultural machinery, the large number of domestic producers suggests competition, a situation which predates reforms and continues.

Imports and Exports: Turkey exports non-tractor agricultural machinery. Imports are most important for tractors and some other specialized large machines such as combine harvesters. Table 3.5 shows exports of farm machinery increasing while imports tend to fall during the 1980s. Compared to West European farmers, Turkey's farmers want lower prices and accept lower quality, which gives domestic producers some natural protection against imports from Western Europe, but not from transition and developing countries. As customs union approaches, industry insiders see opportunities to expand exports.

3.6 Convergence to OECD Patterns

From Single to Multiple Channels for New Technology: In developed countries, competition, communication, and trade guide and coordinate research nationally and internationally, without central plans and managers. Farmers and scientists keep up with new technology through multiple national and international links between companies, universities, and government research agencies. Without such links, even the most advanced country would soon fall behind as research forged ahead in other countries.

Despite a proven multiple-channel model for new technology, donor and government experts for several decades to the 1990s built single-channel systems for technology introduction into many developing countries, with central coordination through a public agency attached to the ministry of agriculture. Some experts are challenging this model. McMahon, for example, encourages governments to move from the "national institute model" toward a system with "many research players" and with "upstream, downstream, and horizontal links among institutes, universities, firms, policy-makers, and social groups" (McMahon 1992, p 6). Antholt advocates "institutional pluralism" with an enhanced role for the private sector to generate and spread new technology (Antholt 1994, p 16).

Before reforms, Turkey fit the single-channel model insofar as government maintained a near monopoly on research and technology transfer in agriculture. However, government control was not fully centralized in MARA's General Directorate for Agricultural Research (GDAR). Other government agencies, such as the Cotton Department, Sugar Corporation, and agricultural departments of state universities, had their own scientists and research budgets and made their own decisions.

Reforms from the 1980s allowed multiple new private channels for technology transfer. Before reforms, private individuals broke the law to introduce new technology through smuggled inputs, including cotton, wheat, and vegetable seeds and poultry vaccines. Reforms de-criminalized these activities, encouraging private individuals to scout technology in other countries, to bring samples back to test in Turkey, and then to introduce new inputs to the market.

After reforms, Turkish inputs companies have multiplied channels to world technology. For example, one Turkish seed company in 1994 reported formal connections with at least seven international companies and Cornell University as well as $ 50,000 annual expenditures to test new varieties of maize, wheat, and other crops in Turkey. A Turkish feed pre-mix company sells products for a half dozen foreign companies.

The multiple-channel pattern of technology transfer that has emerged after 1980s reforms not only converges to patterns in other developed countries but also facilitates technology transfer from those countries. With similar institutional patterns for in Turkey as in other developed countries, Turkish companies, universities, and other institutions can more easily access technology from a similar array of foreign institutions.

Despite convergence in regulations, Turkey may have gone backward in another respect, cutting budgets for public research below levels in developed market economies. Whether and where (GDAR, universities, etc) to rebuild budgets and public research capacity are questions for further review.

Competitive and Private Inputs Industries: Regulatory reforms favor expansion of private inputs industries in Turkey, moving the country towards common OECD patterns. With reforms, new companies have been established, and private producers and traders have taken larger market shares. Inputs firms have joined into trade associations, for which one of the major objectives has been to further company influence in policy formulation. Seed companies in 1986 created the Seed Industry Association (TEBD), which reported 29 members in 1994. Trade associations for other inputs include Tarmakbir, an association for agricultural machinery producers, and TISIT, the Association of Pesticide Manufacturers, Importers and Agents, formed in 1985. In 1994 TISIT had 28 members and was an associate member of GIFAP, the international industry association for pesticides. Stronger companies and new trade associations reinforce reform processes, pushing Turkey further toward convergence with common OECD patterns.

4. IMPACT ON PRODUCTIVITY AND INCOMES

Addressing the third sub-hypothesis in Section 1.1, this Section presents evidence that Turkey's regulatory reforms have had a "significant net positive impact on producer and/or consumer incomes." To prove this point, we show that a partial measure of benefits less all costs is significantly positive:

> Benefits: Benefits are uneven across outputs. Following the train of evidence from reforms through inputs to outputs, Section 4.2 estimates partial benefits -- from selected outputs only -- of 1980s reforms. In Turkey, new technology after reforms had a relatively bigger impact on inputs for maize, sunflower, vegetables, and poultry than on inputs for some other outputs, such as cotton or barley.
>
> Costs: Section 4.3 considers all costs of regulatory reform.
>
> Net Benefits: Subtracting estimated total costs from partial benefits, Section 4.4 presents a lower bound estimate for net benefits.

Section 4.1 presents an overview of changes in agricultural production from the early 1960s through early 1990s. The impact of regulatory reforms cannot be determined from such aggregate

data since many other changes (eg, general trade and investment liberalization) also impact agriculture in the period under review. Nevertheless, aggregate data provide a context for discussions about productivity and production for maize and other selected outputs.

4.1 Overview of Agricultural Growth 1961 to 1990s

Growth Indices: FAO indices for agriculture, crop, and livestock production in Turkey (see Figure 4.1) show little change in rate of growth from years before to years after 1980. For all three indices, average rates of growth for 1961-63 to 1978-81 fall in the range 2.2-3.2 percent per year, while from 1979-81 to 1991-93, growth rates ranged from 2.3-2.5 percent per year.

Inputs and Outputs: Aggregate data mask important changes in source of growth. Table 4.1 shows that fertilizer use and tractor numbers grew at double digit annual rates in the 1960s and 1970s, declining to 2.9 and 4.4 percent, respectively, from 1981. This suggests that new varieties and other new technology (improved planting equipment, new pesticides, better match of fertilizers to soil deficiencies) contributed relatively more after 1980 than before. Irrigation has not had a major impact on growth; latest figures report only 7 percent of cultivated area irrigation.

Aggregate data also mask important differences in rate of growth for various outputs. Table 4.1 shows production for maize, sunflower, soybeans, chickpeas, potatoes, and tomatoes growing significantly faster after 1980 than FAO's crop index. Among animal products, poultry meat and egg production grow much faster than FAO's livestock production index both before and after 1980 (see Figure 4.5).

Agricultural Terms of Trade and Other Factors: During the 1980s, government commitment to industrial development led to policies that squeezed agriculture, so that "agriculture was taxed in aggregate rather than subsidized as in the 1970s" (WB 1990, vol 1, p 3). Despite many liberalizing reforms, government continued export restrictions on agricultural outputs, forcing domestic prices below world prices, ensuring cheap food and inputs for the rest of the economy. During the 1990s, policy-based movements in domestic input and output prices have reduced if not eliminated the 1980s bias against agriculture.

Other factors affecting agricultural performance in the years after regulatory reforms include weather (eg, drought in 1993 and 1994) and wars in Irag and the former Yugoslavia that interfered with sales to Iraq and Western Europe.

4.2 Benefits through Selected Outputs

For maize and sunflower, we use international prices to calculate economic benefits from actual production compared to a counter-factual estimate of what would have happened without reform. For several other outputs we present data to show that reform has had an impact, but we do not estimate any monetary estimate of the magnitude of that impact.

For many agricultural commodities, Turkey's farm-level prices have been somewhat higher than import-parity prices over most of the last several decades. Taken alone, this suggests that Turkey

could have realized even greater benefits by liberalizing import of maize and other outputs, which would cut farm production as well as benefits from input reforms. However, taxes and trade controls also affect non-agricultural goods, so that it is not a simple thing to hypothesize benefits from output trade liberalization in a distortion-free environment. Allowing tariff-free maize imports, for example, would create a distortion against maize, since the currency is generally over-valued, and may even increase overall distortions in the economy, reducing economic efficieny. Hence, we calculate economic benefits from input deregulation based on actual production, without making any counterfactual assumptions about what might happen with other hypothetical reforms to end all trade distortions.

4.2.1 Maize

With FAO collaboration, government began maize research in the 1950s. After years of work, government by 1980 had released a number of open-pollinated varieties (OPVs) and some hybrids, but none gained popularity with farmers. As part of 1980s reforms, MARA invited foreign companies to send hybrids for testing. From 150 varieties submitted, MARA scientists selected 20 for tests around the country. In 1982 trials, hybrids yielded over 9 t/ha, much more than national average yields of 2.1 t/ha, and more also than provincial average yields of 2.7 t/ha for Adana and 2.9 t/ha for Bursa, two provinces with irrigated maize and relatively high yields.

Based on these trials, government imported several thousand tons of hybrid maize seed and sold it over several years in the mid-1980s. After about 1986, government stopped selling and left the market to private companies. Farmers readily adopted foreign maize hybrids: CIMMYT estimates that by 1985 one third of maize area was planted to new foreign hybrids, after which expansion of hybrid maize area slowed. Figures for seed production and trade support these estimates. Hybrids have replaced open-pollinated varieties on irrigated land in Cukurova near the Mediterranean, along the Aegean, and in Marmara. In the north along the Black Sea, where maize is planted in small upland plots, farmers continue to grow OPVs.

With a simple yield response function, we estimate the impact of post-reform hybrids on yields. Since Turkey is a small producer and regularly imports maize, we assume that changes in maize productivity and production have no impact on price. With some assumptions about input costs, we then calculate the impact of higher yields on farmer net incomes.

We model maize yields in tons per hectare as a function of hybrids, fertilizer, irrigation, and rainfall. Hybrid use is shown as percent of maize area sown to private hybrids, all of which came in after and because of reform; we do not include pre-reform public hybrids, which covered only 1 percent of maize area in 1992 (CIMMYT 1994). We also include a trend variable to capture impact of transport improvements, extension, and other activities which could increase yields. Annual fertilizer use on maize is calculated from 1980 share of fertilizer applied to maize times annual total fertilizer use (FAO reports that share of fertilizer going to maize drops slightly from 1980 to 1988; we use 1980s share throughout; see Ange 1994, p 10). Maize irrigated area is not available, so percent of total area under irrigation is used. For rainfall, we use national annual rainfall.

Table 4.2 reports results of this regression. Irrigation is not included because the variable for percent of total land under irrigation was never statistically significant. The coefficient for percent of maize area planted to hybrids is positive and significant in all specifications. The trend variable is positive and significant and lowers the coefficient for hybrids. Fertilizer is not significant in the regressions except when the trend variable is not included; over the period, national average fertilizer use and hence calculated use on maize grew slowly.

Figure 4.6 shows actual yield of maize and projected yield using estimated coefficients from specification two and actual values for fertilizer use, rainfall, and trend, but with zeros for post-reform hybrids. The gap between actual and projected yields was greatest in 1990 at almost 2 t/ha. Impact of post-reform private hybrids on maize yields in Turkey parallels a similar impact of imported hybrids on maize yields in Greece during the 1970s (see Figure 4.7). Virtually all maize in Greece is irrigated, which largely explains why national average yields for Greece exceed those for Turkey. Figure 4.7 also shows lower maize yields in Syria, which limits variety introduction, and higher yields in EU countries, which allow free intra-EU movement of varieties.

During 1990-92, farm-level annual gross financial value of additional production due to post-reform hybrids was about $ 130 million ($ 255/ha over 515,000 ha; see Table 4.3). CIMMYT reports 1992 farm-level maize and nitrogen prices of $ 178, which we use to calculate financial benefits. We did not find cost of production surveys showing cost differences between local and hybrid maize; we estimate higher costs for hybrid seed and for harvesting and drying a larger crop (see Table 4.3); we assume similar fertilizer use on local and hybrid maize. With these assumptions about costs, we estimate annual net financial benefits in 1990-92 of $ 97 million (see Table 4.3). This is the sum of net increases in farm incomes realized by all maize farmers.

Adjusting farm-level maize and fertilizer prices to international prices, the annual net economic benefit from private maize hybrids in 1990-92 was $79 million (see Table 4.3), or 24 percent of the gross economic value of Turkey's average annual maize production ($ 330 million) during 1990-92.

4.2.2 Sunflower

Sunflower was originally introduced from Europe. It has gone through several cycles of area expansion due to imported varieties then decline due to spread of the orobanche parasite. The most recent complete cycle started in 1963 with introduction of Vinimik, an OPV orobanche-resistant variety from Russia. In the late 1970s, Vinimik's resistance to orobanche began to break down, with 1981 being the worst year. Private foreign hybrids, introduced on a large scale from 1985, are resistant to the parasite. They also have higher yield potential. However, sunflower is commonly grown as a rainfed crop in relatively dry climates. In such conditions, lack of moisture limits yield gains possible with hybrids. The government also developed some resistant hybrids, releasing them in 1984; these never became popular with farmers. In 1985 Vinimik and private hybrids covered almost equal shares of Turkish sunflower area. By 1992, Turkish seed companies produced only 193 tons of Vinimik seed compared to 3,500 tons of hybrid seed (including some for export), and about 90 percent of area was planted to hybrids.

Since Turkey has been importing vegetable oils and related products, we assume that increases in sunflower productivity and production do not bring lower prices. Thus, as for maize, sunflower hybrids boost farm profits rather than consumer surplus.

However, we met problems measuring impact of sunflower hybrids on farm income. A regression using time-series data understates hybrid impact on yields if we do not factor into the model how much the orobanche parasite would have reduced yields for pre-reform OPVs; we do not have information to make those adjustments. Also, sunflower area increased with hybrids, and one cannot assume that new fields realize the same increase in profits per hectare as old fields. Ideally, data from detailed farm-level surveys over time would show changes in costs and benefits, including risk of parasite damage, as sunflower farmers adopt hybrids or shift into sunflower. In the absence of such data, we estimate hybrid impact from changes in sunflower national area and average yield.

From information on seed import and production (see Figure 3.2), we identify 1980-84 as the immediate pre-reform period, and we take 1985-92 as the post-reform period. Period average sunflower area increased from 540,000 hectares during 1980-84 to 690,000 hectares in 1985-92. Similarly, period average yields went from 1.26 t/ha for 1980-84 1.43 t/ha for 1985-92.

Multiplying the increase in average yield from base to post-reform periods (170 kg/ha) times base period planted area (540,000 hectares), we get an increase of 91,800 tons of oilseed production worth $ 24 million at 1990-92 Rotterdam CIF prices, or 14 percent of the gross economic value of Turkey's average annual sunflower production ($ 173 million) during those years. This figure excludes gains from: increases in planted area; higher oil content of private hybrids; and preventing further decline in sunflower area and yield due to the orobanche parasite. On the other hand, the economic benefit would be lower to the extent that production costs are higher for private hybrids than for local varieties.

4.2.3 Wheat

After 1980s reforms, private companies began to introduce wheat varieties and public agencies introduced new varieties at an accelerated rate. Information on seed production suggests that seeds of these new varieties are beginning to reach farmers in sufficient quantities to shift varieties over a significant share of wheat area. However, average yields do not show any impact to date. We may be several years early to measure the impact from private wheat varieties.

Private companies in 1993 planned to produce 4,000 tons of seed for varieties that companies had introduced from 1987 (including CIMMYT and foreign public varieties), plus 5,000 tons of other varieties. In 1993, TIGEM planned to produce 275,000 tons of wheat seed, of which about 70,000 tons was for varieties introduced after 1982. Gross figures of actual seed production show that private companies roughly met their plans, while TIGEM produced only about 40 percent of its plan (see Table 3.2). We have no breakdown of actual production or sales by varieties; assuming that TIGEM's actual production fell short evenly for all varieties, TIGEM would have produced about 30,000 tons of seed for varieties introduced after 1982.

With nine million hectares planted to wheat at a seed rate of about 100 kg/ha, total planted seed would come to about one million tons. Private sales of 4,000 tons of seed of new varieties would plant only 0.4 percent of total wheat area. TIGEM sales of seed for new varieties might supply another 3 percent of planted area.

However, the share of wheat cropped area reached by these new varieties could be much larger than 0.4 or 3 percent. An average farmer buying commercial seed of a new variety keeps his own seed for several years before buying new seed; also, many multiply seed for sale to neighbors. If farmers buy new seed every four years and do not sell seed to neighbors, then annual sales of seed for x percent of wheat area would deliver a new variety to 4x percent of area in four years. If farmers buying commercial seed also sell seed to one or two neighbors in the first year, then annual sales of seed for x percent of wheat area would deliver a new variety to 7x-10x percent of area in four years. With these estimates, new private varieties may be reaching 1.6-4.0 percent of wheat area, while new TIGEM varieties could reach 12-30 percent of planted area.

The above estimates agree with some other available information on wheat varieties. CIMMYT estimates that share of wheat area planted to improved varieties increased from 50 percent in 1984 to 71 percent in 1990. In that year, almost 30 percent of wheat area was planted to varieties from CIMMYT, Italy, US, and Eastern Europe, some of which were introduced after 1982.

While people shifting to new varieties are responding to economic incentives, aggregate data on wheat yields after reform do not give any indication of the effect of these incentives. Over the 1980s, Turkey's average wheat yield grew more slowly than in previous decades and did not even keep pace with increases in world average yield. Part of the explanation for slow growth in wheat yield may be slow growth in fertilizer use, as already discussed.

In the early 1990s, the annual value of the wheat crop in Turkey is roughly $ 3 billion. New varieties coming with reform have spread to a portion of this area. National yield data do not show an impact. Although private companies currently have a small share of the wheat seed market, they have been actively looking for new foreign varieties to introduce, and they have been selling more wheat seed. The reform impact on wheat may be expected to grow as private companies push into the market.

4.2.4 Vegetables for Export

Vegetable exports is an area where one would expect an impact from reforms allowing in new varieties as well as new specialty chemicals such as plant growth regulators. The limited data which are available show a large increase in value of vegetable exports after reform period, but are not sufficient to estimate the increase in value due to regulatory reforms (see Table 4.4). Furthermore, only a fraction of that value would be net economic benefit, since vegetable producers and processors would be taking resources away from other productive activities. This section is based on information from a 1994 FAO and MARA study, Turkey: Horticulture Subsector Review: Approaches to Market-Led Development.

Available data shows that total vegetable exports increased well over 200 percent or $ 200 million from the early 1980s to the beginning of the 1990s (see Table 4.4). Growth was not even across all vegetables, but was rather concentrated in a few. Among canned vegetables, "pickled cucumbers and artichoke hearts packed in glass have become major export items in the last two years" (FAO and MARA 1994, annex 4, p 9). Among fresh and frozen vegetables: fresh potato exports went from $ 5 million in 1987 to $ 37 million in 1991; fresh cucumber exports increased from $ 1 million to $ 13 million over the same period; and frozen vegetable exports increased from $ 7 million to $ 26 million in the same four years.

The pattern of export growth suggests that regulatory reform was a factor. For one thing, fresh and frozen vegetable exports grew most rapidly at the end of the period. Also, we can correlate export growth for particular products with introduction of new varieties. For example, the increase in fresh and pickled cucumber exports can be linked to reform, since only one cucumber variety was allowed for sale in 1982 compared to more than 100 in 1992. Similarly, the number of potato varieties allowed increased very rapidly from 1988, while potato exports jump in 1991.

For some vegetable exports, Turkey's relatively low cost labor is a factor. For example, pickled and fresh cucumber exports depend on low cost labor to pick small, precisely sized cucumbers for processing. Further rapid increases in exports are likely for some vegetable products. However, Turkey's exports of tomato concentrate, currently about a fourth of total vegetable exports, are not likely to grow very fast, since Turkey is already the world's third largest producer, and world markets are highly competitive.

4.2.5 Seeds for Export

Seed exports depend on technology transfer almost in the same way garment exports depend on imports of zippers and cloth. Before reforms, when companies could not freely send seeds and other technology to Turkey, they did not arrange seed production in Turkey for international markets. In other respects --- climate, low-cost labor, skills --- Turkey is an attractive country for seed production. With the 1980s regulatory reforms, Turkey began to produce seeds for export, but from a zero base. Volume and value are still low.

We have data on the volume but not value of seed exports. Table 3.4 reports volume and estimates value of seed exports with some assumptions about seed prices. Annual total value of seed exports grows from zero in the early 1980s to an estimated $ 12 million in 1992-1993. Compared to other agricultural products and exports, seed exports are a small matter. Only a portion of this gross value can be considered net economic benefit from reform, since seed producers are taking resources away from other productive activities.

4.2.6 Poultry Meat and Eggs

Poultry technology transfer has had a significant impact on production and productivity from at least the 1970s. Reforms in the 1980s gave poultry farmers better access to vaccines and pre-mixes. At retail level, the annual value of poultry meat and eggs consumed in Turkey has exceeded $ 1 billion from the mid-1970s, with falling prices more than off-set by increases in volume consumed

(see Figures 4.5 and 4.8). With large declines in prices for poultry products. annual consumer surplus has increased several hundred million dollars from the mid-1970s.

Shifts in the supply curve that deliver this consumer surplus (see Figure 4.9) are presumably due to dissemination of a broad range of poultry technology and management practices, including changes that began in the 1960s and 1970s. Hence, only a portion of the increase in consumer surplus can be credited to supply shifts due to new post-reform technology.

Another issue is the extent to which taxes and trade controls have protected Turkey's poultry producers. With protection, Turkey has been self-sufficient in poultry products, with marginal exports and imports. However, it is not clear what would have happened without protection (and without other distortions in the exchange rate and trade regime). Despite trade controls, Turkey's poultry meat prices have moved with prices in the US (which is a large poultry exporter), peaking in the mid-1970s and then falling. At the end of the 1980s, the retail price for poultry meat in Turkey was below that in the US. However, if technology imports had not shifted the poultry supply curve, then Turkish production prices by the late 1980s would have been far above import parity levels, which would have created strong pressures for more poultry imports.

4.3 Costs of Regulatory Reform

The costs of regulatory reform in Turkey as in any other country depend on what changes are considered to be regulatory reforms and what are not. For example, someone might think that regulatory reform entails cutting fertilizer subsidies, and then try to estimate costs or benefits of doing so. To avoid some of these confusions, we clarify the definition of regulatory reform that has been used in this paper.

Defining Regulatory Reform: Changes which reduce government controls on introduction of new agricultural technology --- except for controls which address externalities --- are considered to be regulatory reforms. Regulatory reform:

(a) Focuses on liberalization rather than privatization. For example, ending a public monopoly by revising regulations to allow free entry and competition is regulatory reform. On the other hand, privatizing a government enterprise such as a seed company is not regulatory reform, except when privatization reduces government's ability to dominate choice of technology.

(b) Focuses on adding new channels for introducing technology rather than weakening existing public sector channels. Regulatory reforms say nothing about budgets for public sector research but do ask government scientists to focus more effort on research and less on regulations that do not address externalities.

(c) Does not attack subsidies. Although subsidies are a problem for those who manage government budgets, most subsidies do not seriously discourage the transfer and introduction of superior agricultural technology.

With this definition of regulatory reform, we consider the costs of 1980s regulatory reforms in Turkey.

Externalities from Imported Pests and Diseases: Regulatory reform does not entail doing away with phytosanitary restrictions, nor has than happened in Turkey. As of 1994, many experts argue than Turkey's phytosanitary restrictions are unnecessarily strict, suppressing seed trade more than necessary to limit losses from pests and diseases. The manager of a Turkish seed company reported that, notwithstanding phytosanitary controls, customs officials pay more attention to commercial import controls than to seed condition. Arguably, implementation of reasonable phytosanitary controls might be improved if government would go further with regulatory reforms, getting rid of extraneous seed import restrictions (eg, that only seed firms can import) that have nothing to do with realistic phytosanitary concerns.

Farmer Losses from Inappropriate Varieties: During government crash programs to introduce Mexican wheat in the 1960s and hybrid maize in the 1980s, government agencies decided which varieties of seeds to buy and where to distribute them around the country. Government offered incentives in the form of credit or subsidies to farmers buying government-selected seeds. In both these programs, farmer choice of varieties after several years showed major differences from initial government allocations, which suggests assignment of some inappropriate varieties and possibly some farmer losses (Frizzell 1968; also personal communications from maize seed experts during interviews in 1994).

With reforms, private companies working through markets select and promote new varieties, building sales over several years. Government no longer makes large commitments to new and unproven varieties, and we did not see private companies taking big risks promoting unknown varieties.

Before reforms farmers lost by planting inferior varieties available in Turkey when superior but illegal varieties were available in world markets. In some cases, particularly for high value vegetables, farmers smuggled seeds to avoid planting legal but inferior -- inappropriate -- varieties. In this respect also, regulatory reforms have reduced planting of inappropriate varieties.

Farmer Losses due to Poor Quality Seed: With regulatory reforms bringing rapid expansion of private seed production and trade, farmers have shifted a significant share of planted area for some crops --- notably maize, sunflower, many vegetables --- from own-seed to private commercial seed. This shift improves seed quality. Furthermore, reforms have broken crop-by-crop public and private monopolies and oligopolies in commercial seeds; more competitive commercial seed markets favor improvements in quality. Also, Turkey now produces seeds for export; improving quality to compete in export markets presumably has a positive impact on quality for domestic seed as well.

Although TIGEM's seed production has fallen by more than 100,000 tons, that is due to other policy decisions, not regulatory reforms. What happens to TIGEM, and what impact that has on wheat seed quality is tangential to the costs and benefits of regulatory reform. Indeed, regulatory reforms have brought in 10,000 tons of private wheat seed production, which by itself improves wheat seed quality.

The government continues compulsory seed certification. However, the one story we heard about poor seed quality shows that private companies take care of quality even without government involvement. In 1994, employees in one seed company stole expensive vegetable seed before packaging and replaced it with cheaper seed. Sale of mixed seed threatened the comany's reputation. Apprised of its error, the company paid damages to affected farmers. Turkish seed companies promote their brand names; this suggests self-policing for quality control.

Pesticide Externalities: With 1980s regulatory reforms, Turkey has expedited registration for new ai's, speeding introduction of new technology. At the same time, Turkey continues to de-register (ban) a growing list of older broad spectrum poisons (particularly organochlorines) based on environmental and health threats. These reforms show Turkey following developed countries away from persistent broad spectrum poisons toward newer ai's with more specific impact on pests and less persistence in the environment.

Taken alone, new registrations and de-registrations from 1980 suggest a shift toward safer products. However, value of pesticide sales has also increased -- 8 percent annual growth from 1988 to 1992 -- which increases externalities. Information is not sufficient to show the net balance of these and other changes.

An important aspect of 1980s pesticide reforms has been a shift from bulk purchase and distribution through cooperatives to private retail trade. This shift takes decisions about pesticide use away from bureaucrats and cooperative officials, giving farmers more latitude to decide which pesticides to use and when to apply them based on pest threats (consistent with integrated pest management [IPM]). In the old system, government and cooperatives promoted standard prophylactic practices, which are antithetic to IPM.

Regulatory reforms have stimulated horticulture exports to Western Europe. Developed country importers demand low pesticide residues, which forces government and farmers to pay attention to residues and to apply improved pest management practices. During the 1990s, government took steps to begin residue testing for local markets.

Impact on Domestic Input Industries: In some countries, a common argument against regulatory reforms is that imported inputs will damage domestic inputs industries. In Turkey, domestic input industries not only expanded after reforms but also boosted export sales. For example, Turkey's growing seed exports clearly depend on regulatory reforms that facilitate private technology transfer.

Weakening of Public Sector Research: During the 1980s, MARA cut the budget for the General Directorate of Agricultural Research (GDAR), and new private seed companies hired away 30-40 senior GDAR scientists, including leaders of plant breeding programs. In Turkey, experts argue about whether and how much 1980s changes in GDAR are a loss to the country.

Whether or not the 1980s changes in GDAR have been a major loss to the country, the loss is not due to reform. Regulatory reforms do not entail budget cuts for agricultural research; such budgets

are a separate issues. As for the loss of government staff to private companies, government's ability to recruit and retain staff depends on budgets; furthermore, an increase in employment options for agricultural scientists could be expected to reduce staff management problems by making it easier for people to move and for institutions, including government, to find people with particular skills.

High Seed Cost: Hybrid seeds are much more expensive than non-hybrid seeds; furthermore, farmers must replace hybrid seed every year, whereas they can often keep their own non-hybrid seed. The higher cost of seed has already been considered in estimating net income gains when farmers buy new inputs to boost productivity.

Also, information on seed costs can be misleading. In switching to hybrids, farmers are able to reduce the seed rate; for example, the seed rate for hybrid sunflower in Turkey is only 3 kg/ha compared to 20 kg/ha for OPV seeds; even though hybrid sunflower seeds are 5-10 times more expensive, the lower seed rate largely compensates for the price differential. For sugar beet, seed rate has fallen from 30 kg/ha with multigerm (non-hybrid) seed to 3 kg/ha with new monogerm (hybrid) seed.

Sugar beet area has shifted almost entirely to hybrids, as has sunflower area. Depending on region of the country, maize area has either shifted or not shifted to hybrids. These all-or-nothing adoption patterns suggest that all farmers, rich as well as poor, take advantage of new technology.

4.4 Lower Bound Estimate for Net Impact

Section 4.2 estimates $ 74 million in annual net economic benefits of regulatory reforms for maize and $ 24 million for sunflower. Evidence suggests additional large economic benefits for vegetable exports and large financial (if not economic) gains for poultry meat and eggs. Other economic benefits, such as gains in consumer welfare and producer incomes from vegetables marketed in Turkey, are hard to estimate. Also, benefits increase over time as farmers and inputs industries gain experience with new technology and business opportunities.

The costs of regulatory reform, as discussed in Section 4.3, have been non-existent to insignificant. For example, seed quality has most likely improved, and farmers have more information and choice, so there is less risk they will plant an inappropriate variety. For pesticides, which is the area where externalities are potentially the most serious, Turkey's regulatory reforms as implemented from the 1980s are consistent with a shift to newer pesticides, improved practices, and more attention to residues. Finally, regulatory reforms are separate from other reforms, such as privatizing parastatals or cutting subsidies; hence, costs of these other reforms do not have to be considered.

Subtracting total costs from partial net benefits(from yield increases for maize and sunflower only), annual net economic benefits of regulatory reforms exceed $ 98 million. This confirms the third sub-hypothesis in Section 1, that regulatory reforms have a "significant net positive impact on producer and/or consumer incomes."

5. CONCLUSIONS AND RECOMMENDATIONS

Testing Hypotheses: This study tested hypotheses about impact of regulatory reforms against Turkey's experiences. Results confirm the main hypothesis: regulatory reforms accelerated introduction of new technology which raised productivity and incomes. The study also confirms the three sub-hypotheses of Section 1: (1) appropriate technology was available in other countries; (2) the private sector introduced new technology when regulations allowed; and (3) new technology had a significant impact on productivity and incomes.

Both before and after 1980s reforms, most new technology in Turkey has come from foreign countries. This observation echoes a similar finding by Eduardo Venezian for Chile: "the overall most important innovations in Chilean agriculture post-1960 ... originate mainly abroad" (Venezian 1987, pp 107-108). While foreign research continues to provide most new technology, reforms changed channels for technology transfer and facilitated flow.

While this study confirms hypotheses for Turkey, some might argue that aspects of Turkish geography and economy favored strong response to reforms. Turkey shares latitudes with Western Europe and the US, which allows variety transfer. Entering the 1980s, hundreds of thousands of Turkish farmers had visited European countries. Much technology was already present in fertilizer and other domestic inputs industries. Turkey had hundreds of agricultural PhDs. Also, infrastructure such as roads, telephones, electricity, and ports was in place to handle increases in agricultural production. In short, people at all levels were ready to import and to adopt new agricultural technology when reforms allowed them to act.

On the other hand, these favorable conditions meant that Turkey had already closed some of the technology gap with West European and other developed countries. For a country that is poorer and less developed, response to reform would be measured from a lower base, so that a relatively weaker response in terms of flow of new technology could bring comparable percentage changes in input trade and output response.

Recommendations: To increase the flow of new technology to farmers in developing countries:

* donors and governments are encouraged to review input regulations to assess the extent to which they slow or block private sector introduction of new technology; these assessments can be attached to agricultural research projects, trade reform studies, inputs projects, etc;

* depending on the outcome of such assessments, donors and governments are encouraged to promote regulatory reforms as opportunities arise.

In Turkey after the 1980s reforms, most new agricultural technology comes from other countries through private inputs trade, technology licensing, investment, joint ventures, etc. Many developing countries continue to block these channels for new technology. It makes little sense to design and fund projects or programs to deliver new technology through public channels without first considering essentially costless regulatory reforms to un-block private sector channels. Once

regulatory reforms are in place to allow private technology introductions, public research and extension can also be more effective.

Taking this approach, programs and projects for agricultural research and extension can be re-cast as agriculture technology projects, with policy components to address regulatory obstacles that block channels for technology transfer through the private sector, and with continued funding for public research and/or extension. A 1992 Agricultural Technology Project for Mexico illustrates this pattern (WB 1992).

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Table 3.1: Crop Varieties Approved, 1982 to 1994

Crop	*harvested area in 1990 (has)*	*varieties available* as of 31/5/82*	*new varieties** 1/6/82-31/5/84*	*new varieties** 1/6/84-31/5/85*	*new varieties** 1/6/85-31/5/86*	*new varieties** 1/6/86-2/6/87*	*new varieties** 3/6/87-31/5/88*	*new varieties** 1/6/88-31/5/90*	*new varieties** 1/6/90-5/8/91*	*new varieties## 6/8/91-20/7/92*	*new varieties## 21/7/92-2/7/94*	*cf: new varieties added to OECD list in 1993#*
Wheat	9,400,000	21	1	10	9	2	16	5	16	1	2	164
Sunflower	715,000	3	5	8	10	6	7	20	11	7	0	127
Cotton	641,000	9	2	0	5	1	1	5	1	4	0	18
Maize												
Hybrid	155,000	24	35	24	9	22	22	48	23	1	1	406@
Other	360,000	20	1	0	0	4	5	0	0	0	0	
Sugarbeets	378,000	11	5	7	3	3	1	3	2	0	0	108
Tobacco	320,000	31	0	0	6	1	0	2	0	0	0	
Potatoes	192,000	8	3	6	3	1	0	14	13	8	3	
Tomatoes	126,000	43	14	10	0	8	11	122	67	3	2	
Soybeans	74,000	2	27	0	12	4	11	7	9	0	2	69
Cucumbers	16,000	1	2	0	2	4	5	57	50	3	0	

Note: The major reform that allowed an increase in number of varieties available, as shown in the table, was agreement on the part of key MARA officials from about 1983 to grant production permits (i.e., temporary registration) more expeditiously, and to sometimes waive in-country performance tests.

Other notes:

* Cumulative number of varieties available on 31/5/92 includes varieties either registered or with unrestricted production permits on that date.

** For all other dates, the table shows number of new varieties introduced from the previous date given in the table; number of new varieties is calculated as the sum of new varieties introduced with new registration or unrestricted production permits; lists have been scrutinized to avoid counting varieties that were, for example, newly registered but had previously been available with an unrestricted production permit.

\# The last column lists numbers of new varieties added to OECD's List of Cultivars Eligible for Certification in 1993. Since the US does not restrict varieties, US farmers legally have access to all of these new varieties. Farmers in EU countries, which share a Common Catalogue, have access to a large share of these varieties.

@ OECD gives no breakdown into hybrid and non-hybrid cultivars.

Sources: Harvested areas for field crops are from: SIS, 1990 Agricultural Structure and Production, p 4. Total areas for cucumbers and tomatoes are from : SIS, General Agricultural Census 1991, p 65. Available and new varieties for various years and periods are from: Resmi Gazette for 31 May 1982, 31 May 1984, 31 May 1985, 31 May 1986, 2 July 1987, 3 May 1990, 5 August 1991, 20 July 1992, and 20 July 1994. Numbers of cultivars added to OECD's list are from: OECD, List of Cultivars Eligible for Certification 1993 (Paris: OECD, 1993).

Table 3.2: Commercial* Seed Production, 1980 to 1993 (metric tons)

Crop	*Sector*	*1980*	*1985*	*1990*	*1993*
Wheat	Private	0	<1,000	7,000	10,000
	Public	49,000	188,000	124,000	103,000
Barley	Private	0	0	0	300
	Public	13,000	35,000	16,000	10,000
Hybrid Sunflower	Private	0	80	2,600	3,500
	Public	0	10	30	40
OPV sunflower	Private	0	na	na	na
	Public	2,500	na	na	na
			4,800	1,000	200
Hybrid maize	Private	na	1,800	4,500	7,200
	Public	na	300	200	200
	Total	900			
Sugarbeets	Private	na	3,400	na	3,300
	Public	na	0	na	3,300
Cotton	Private	0	0	500	300
	Public	35,000	27,000	30,000	31,000
Potatoes	Private	na	800	4,200	2,200
	Public	na	6,300	900	200
	Total	2,000			
Chickpeas	Private	0	0	0	90
	Public	0	200	200	70
Soybeans	Private	0	800	3,200	3,600
	Public	0	1,100	600	200
Vegetables	Private	na	300	600	700
	Public	na	30	30	30
	Total	191			

Notes: Data have been rounded off to two significant figures for hundreds and above; for hundreds and below, data have been rounded to one significant figure.

* Seed produced by registered seed companies.

Sources: Various publications of TEBD (Turkish Seed Industry Association).

Table 3.3: Seed Production Plans by Type of Firm, 1994

Type of firm	*Units*	*Maize*	*Sunflower*	*Soybean*	*Wheat*
Subsidiaries of foreign firms	Metric tons	6,200	1,500	0	2,500
	% share	50	48	0	1
Joint ventures	Metric tons	5,500	1,500	3,100	0
	% share	45	49	98	0
Other Turkish private firms	Metric tons	400	0	0	6,800
	% share	3	0	0	2
Turkish public firms	Metric tons	310	110	70	275,000
	% share	3	3	2	97
Total	Metric tons	12,400	3,100	3,200	284,000

Sources: Calculated from: MARA, Tohumluk Programi 1994 (Ankara: MARA, 1994).

Table 3.4: Seed Exports and Imports, 1980 to 1993

Crop	*Category*	*1980-82 average*	*1983-85 average*	*1986-88 average*	*1989-91 average*	*1992-93 average*	*Comments*
Wheat and barley	Export (tons)	0	0	600	2,000	700	Virtually all in the public sector
	Import (tons)	200	17,000	6,000	14,000	2,500	
Hybrid maize	Export (tons)	0	0	600	1,200	1,800	Mostly private, except for mid-80s imports
	Import (tons)	200	1,000	1,500	50	200	
Hybrid sunflower	Export (tons)	0	0	0	300	1,400	Private sector
	Import (tons)	0	500	1,400	300	0	
Vegetables	Export (tons)	0	90	90	110	140	Private sector
	Import (tons)	20	90	140	200	210	
Potato	Import (tons)	10	3,500	6,700	7,100	2,100	
Soybean	Import (tons)	1,300	3,400	5,000	2,500	0	
Cotton	Import (tons)	100	0	100	500	80	
Others	Export (tons)	0	50	40	300	40	
	Import (tons)	80	400	200	700	400	
TOTAL EXPORT VOLUME							
Vegetables	(tons)	0	90	90	110	140	
Others	(tons)	0	50	1,400	3,900	4,100	
TOTAL EXPORT VALUE*	($1,000)	0	5,000	5,000	8,000	12,000	
TOTAL IMPORT VOLUME							
Vegetables	(tons)	20	90	140	200	210	
Potatoes	(tons)	10	3,500	6,700	7,100	2,100	
Others	(tons)	1,900	22,000	14,000	18,000	3,200	

Notes:

* Value per ton of seeds exported has been estimated at $50,000 for vegetables, $1,500 for hybrid maize and sunflower, $250 for wheat and barley, and $500 for all other crops.

Source: Volume of exports and imports from various TEBD publications. Values are estimated.

Table 3.5: Exports and Imports of Selected Inputs, 1970 to 1992

Year	*Pesticide exports ($1,000)*	*Pesticide imports ($1,000)*	*Manufactured fertilizer exports ($1,000)*	*Manufactured fertilizer imports ($1,000)*	*Farm machinery exports ($1,000)*	*Farm machinery imports ($1,000)*	*Vaccine imports from US ($1,000)*	*Chick imports* (1,000s)*
1970	0	2,900	0	31,800	0	7,800	0	5,800
1971	0	6,700	0	31,500	0	4,600	0	6,400
1972	800	8,800	100	61,400	0	12,900	0	7,300
1973	1,000	9,000	0	130,400	0	27,200	0	8,300
1974	1,100	12,600	0	101,000	0	24,600	0	8,500
1975	500	22,600	0	48,400	0	68,900	0	9,700
1976	300	24,900	0	97,400	100	209,200	0	10,200
1977	1,000	31,200	0	212,100	100	215,600	0	11,600
1978	1,800	39,000	0	282,200	700	109,800	1.7	12,300
1979	700	35,400	0	353,400	600	15,200	0	13,300
1980	1,200	31,800	0	391,500	2,600	34,300	0	14,200
1981	1,300	26,000	0	240,000	11,400	40,700	0	14,400
1982	1,400	28,200	44,500	51,000	4,700	101,100	4.3	14,000
1983	4,500	22,300	14,400	120,000	5,500	40,000	0	14,400
1984	800	35,700	35,100	127,300	12,000	28,400	20	15,100
1985	4,100	37,500	70,600	183,200	7,600	39,000	2.4	15,400
1986	1,200	38,400	128,800	159,100	10,600	59,000	85	15,500
1987	5,100	43,400	131,000	299,100	21,700	41,700	198	15,900
1988	6,400	45,600	232,100	242,300	20,700	21,400	188	16,200
1989	2,800	46,600	101,400	270,500	12,300	22,500	184	16,500
1990	4,100	60,900	71,200	247,900	3,900	41,100	154	16,800
1991	12,500	59,000	54,600	264,800	13,500	65,300		
1992	20,100	66,900	38,200	215,500	12,600	65,000		

Notes:

* The table shows volume of chick imports, not value.

Sources: Data on pesticides, fertilizers, and farm machinery are from FAO, Agrostat-PC. Data on vaccine imports are from USDA. Data on chick imports are from FAO.

Table 3.6: New Registrations for Pesticide Active Ingredients, Formulations, and Products, 1959 to 1992

Year	*Number of new active ingredients# registered (period averages)*	*Number of new formulations# registered (period averages)*	*Number of new products# registered (period averages)*	*CF: number of new active ingredients registered in the US (period averages)*
1959	1	1	1	na
1960-64	4	4	6	na
1965-69	4	6	10	16*
1970-74	7	10	19	13
1975-79	7	9	23	14
1980-84	9	11	44	14
1985-89	20	27	100	12
1990-92	20	28	67	10
Total through 1992	307	423	1,218	ca 700

Notes:

* Average new registrations for 1967-1969 only.

\# An active ingredient (ai) is the chemical that does the job. A formulation is any mix or form in which an ai is to be sold; there are commonly many formulations for each ai. A product is a formulation with a specific brand name. Numbers in the table are based on registrations current in 1993; new registrations in early years may be somewhat understated, since some registrations have been withdrawn due to environmental and health concerns.

Source: TISIT (Association of Pesticide Manufacturers, Importers and Agents), Registered Agrochemicals in Turkey 1993 (Istanbul: TISIT, no date); and Rob F. Esworthy, Jihad A. Alsadek, and Donald R. Stubbs, "Chemicals Registered for the First Time as Pesticidal Active Ingredients Under FIFRA," mimeograph, Office of Pesticide Programs, U.S. Environmental Protection Agency (EPA, (Washington, DC: EPA, 1993).

Table 4.1: Average Annual Growth in Inputs Use and in Production, Area, and Yield for Key Crops, 1961 to 1991 (in percent)

Input or crop	*1961-71*	*1971-80*	*1981-91*
Fertilizer (nutrient use)	26	14	2.9
Irrigated area	3.8	1.1	1.3
Tractor (number operating)	11	17	4.4
Wheat			
Production	3.06	5.08	1.54
Area	1.03	0.82	0.26
Yield	2.01	4.22	1.28
Barley			
Production	0.64	5.07	1.46
Area	-0.83	1.07	1.23
Yield	1.49	3.96	0.23
Maize			
Production	1.23	2.31	5.20
Area	-0.60	-0.86	-1.25
Yield	1.84	3.20	6.53
Sunflower			
Production	19.76	2.65	4.83
Area	16.18	0.96	2.92
Yield	3.07	1.67	1.85
Soybeans			
Production	11.21	-17.03	16.99
Area	7.43	-8.34	11.76
Yield	3.52	-9.59	4.68
Chickpeas			
Production	2.73	5.12	13.80
Area	1.00	4.51	15.27
Yield	1.71	0.59	-1.27
Sugarbeet			
Production	4.56	5.16	2.23
Area	-1.70	8.11	0.80
Yield	6.38	-2.72	1.42
Cotton			
Production	7.49	-1.10	2.07
Area	-0.79	-1.37	-0.43
Yield	8.34	0.28	2.11
Potato			
Production	3.31	4.30	4.34
Area	1.12	0.29	0.68
Yield	2.16	4.00	3.64
Tomato			
Production	4.51	8.20	5.89
Area	2.67	3.48	4.71
Yield	1.80	4.56	1.13

Source: Growth rates estimated by Pray with data from: SIS, The Summary of Agricultural Statistics, various years.

Table 4.2: Maize Yield Response Function, 1961 to 1991

Specification	*% Hybrid*	*ln % hybrid*	*Fert/ha (kgs)*	*ln fert/ha (kgs)*	*Rainfall*	*Trend*	*Adjusted R2*
1.	3.40		0.011		2.44E-04		0.916
	(0.474)		(0.0019)		(7.37E-04)		
2.	2.888		1.38E-03		4.58E-04	5.34E-02	0.924
	(0.522)		(5.30E-03)		(7.14E-04)	(2.73E-02)	
3.		0.056		0.161			0.868
		(0.009)		(0.031)			

Note: Numbers in parentheses are standard deviations for the variables.

Sources: Percent of maize area planted to private or post-reform hybrids was calculated from TEBD data. Fertilizer use is from FAO data on 1980 percent of fertilizer use on maize (Ange 1994, p. 10) multiplied by FAO annual data on national fertilizer use. Rainfall is from national annual data.

Table 4.3: Net Financial and Economic Benefits from Hybrid Maize, 1990 to 92

Item	*Before reform: 1980-82*	*After reform: 1990-92*	*Counter factual: 1990-92*	*Change due to reform (private hybrids)*
Average yield				
Volume (mt/ha)		4.13	2.70	1.43
Financial value @ $178/ton* ($/ha)	2.18	735	481	255
Economic value @ $148/ton** ($/ha)		611	400	211
Average fertilizer use on maize				
Volume (kg/ha)	87	120.8	120.8	0
Financial value @ $178/ton* ($/ha)		21.5	21.5	0
Economic value @ $335/ton** ($/ha)		40.5	40.5	0
Seed for representative hectare				
OPV seed volume @ 37 kg/ha#	37	26	37	
Hybrid seed volume @ 28 kg/ha#		8.4	0	
Financial OPV seed value @ $178/ton ($/ha)		4.6	6.6	
Economy OPV seed value @ $148/ton ($/ha)		3.9	5.5	
Financial and economic hybrid seed value @ 2,970/ton ($/ha)		25.0	0	
Total financial seed value for representative hectare		29.6	6.6	23.0
Total economic seed value for representative hectare ($/ha)		28.9	5.5	23.4
Harvesting and drying costs, calculated as one-sixth value of production ($/ha)				
Financial value		123	80	43
Economic value		102	67	35
Net impact for hectare maize				
Net financial benefits ($/ha)				189
Net economic benefits ($/ha)				153
Total area planted to maize (hectares)	581,000	515,000		
Net impact for all 1992 maize planted area				
Net financial benefits				$97,000,000
Net economic benefits				$79,000,000

Notes:

* Actual farm-level market prices for maize and fertilizer (nitrogen nutrient) are from CIMMYT, 1993/94 World Maize Facts and Trend (Mexico: CIMMYT, 1994).

** The economic price for maize is calculated as average FOB US GULF for 1990-92 plus $41 for transport. The economic price for fertilizer is calculated as the FOB price for nitrogen in urea; Turkey both imported and exported urea during 1990-92.

\# Seed rates from CIMMYT, op cit.

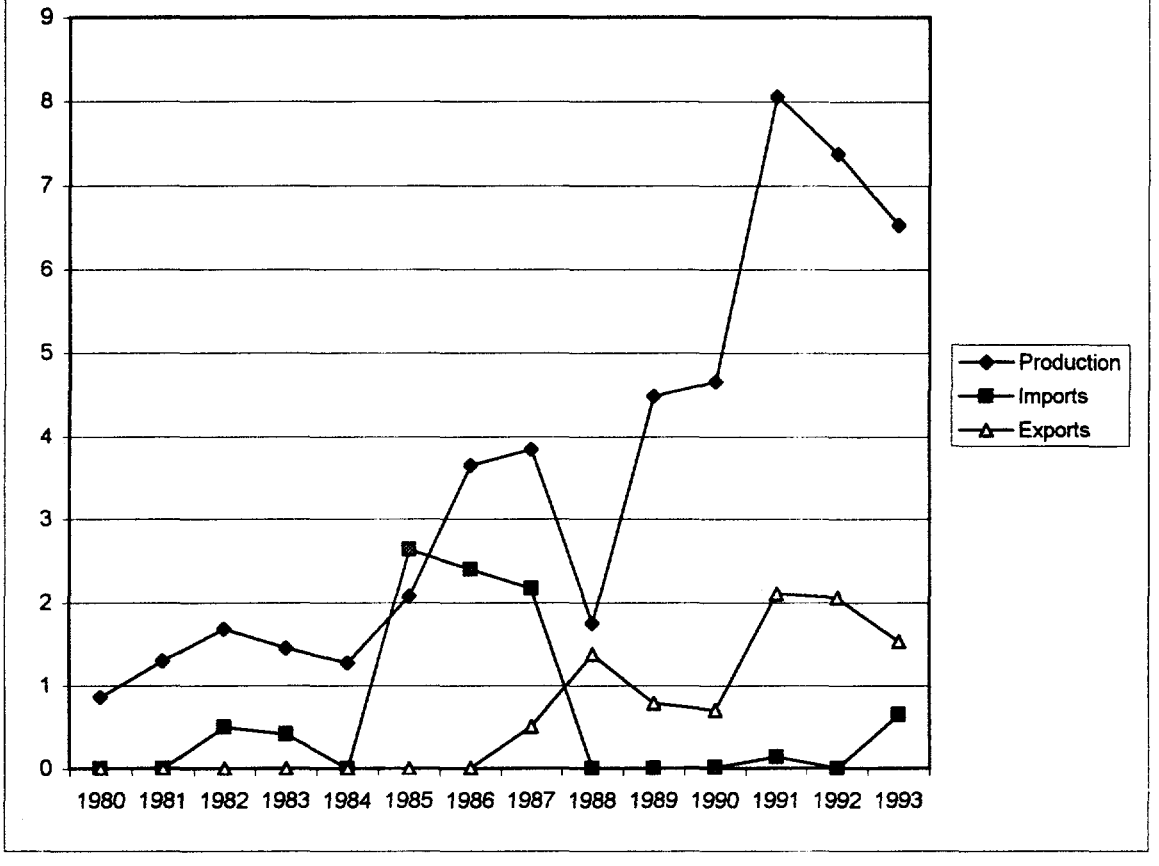
Table 4.4: Vegetable Production and Export, 1979 to 1992

Crop and category	*1979-81*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*
Tomato												
Production (1,000 tons)	3,550								5,750	6,000	6,200	
Fresh export (1,000 tons)	42								78	34	107	
Fresh export ($1,000,000)							30	24	13	13	29	
Tomato concentrate												
Production (1,000 tons)				155	150	105	164	198	290	250		
Export (1,000 tons)										124	149	
Export (see bottom of table)												
Potato												
Fresh export (1,000 tons)							44	48	40	22	219	
Fresh export ($1,000,000)							5	5	6	5	43	
Onions												
Production (1,000 tons)	1,071								1,360	1,550	1,700	
Fresh export (1,000 tons)							133	164	148	85	202	
Fresh export ($1,000,000)							12	15	17	13	33	
Cucumbers												
Production (1,000 tons)	503											
Fresh export (1,000 tons)							3	7	12	23		
Fresh export ($1,000,000)							1	4	7		13	
VEGETABLE EXPORTS ($1,000,000) of which:	ca 100*										379	
Tomato concentrate										74	89	
Canned vegetables									< 50		98	
Other vegetable exports of which:	60@	72	65	81	96	126	96	98	89	109	192	163
Fresh vegetables							65	69	65	55	149	
Frozen vegetables							7	15	15	25	26	
Dehydrated vegetables							12	12	6	8	13	

Notes:
* Estimated.
\# Data from SIS, reported in GATT, 1994.
@ Data for 1981 only.

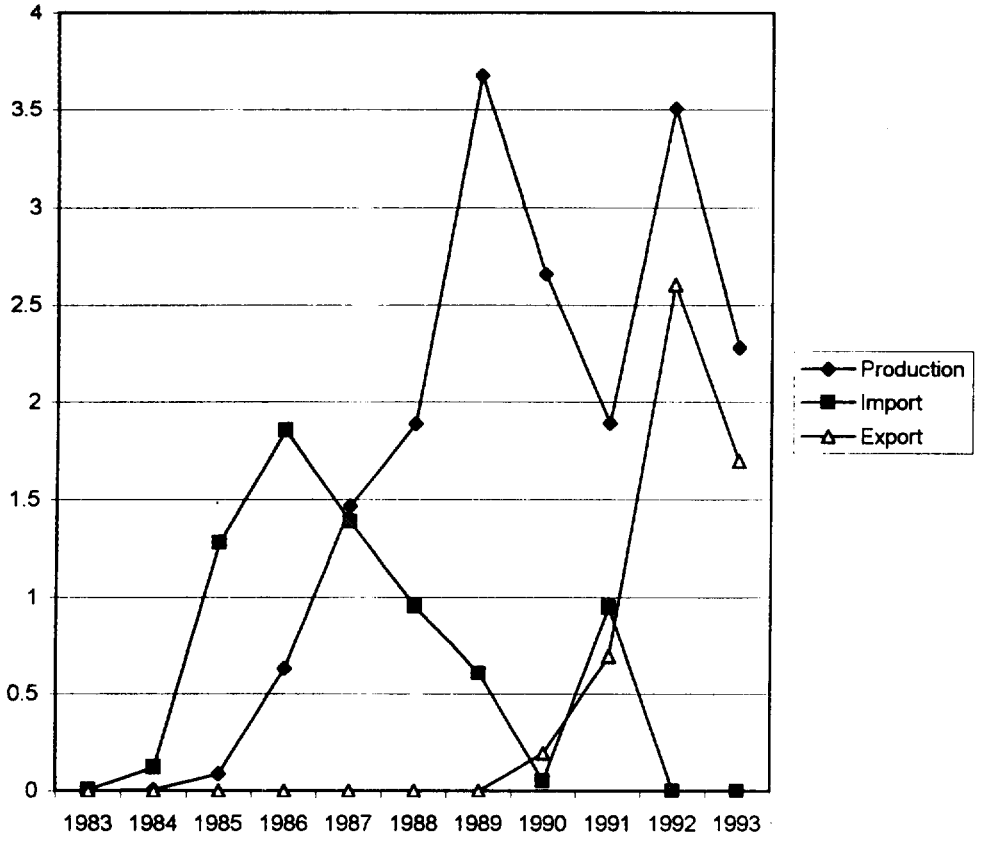
Sources: FAO and MARA, Turkey Horticulture Subsector Review: Approaches to Market-led Development (Rome: FAO, 1994), tables 7 and 9, and annex 4, p 9 and table 1; and GATT, Trade Policy Review: Republic of Turkey (Geneva: GATT, 1994), vol. 1, pp 59-60.

Figure 3.1: Hybrid Maize Seed Production, Imports, and Exports, 1980 to 1993 (1,000 tons)



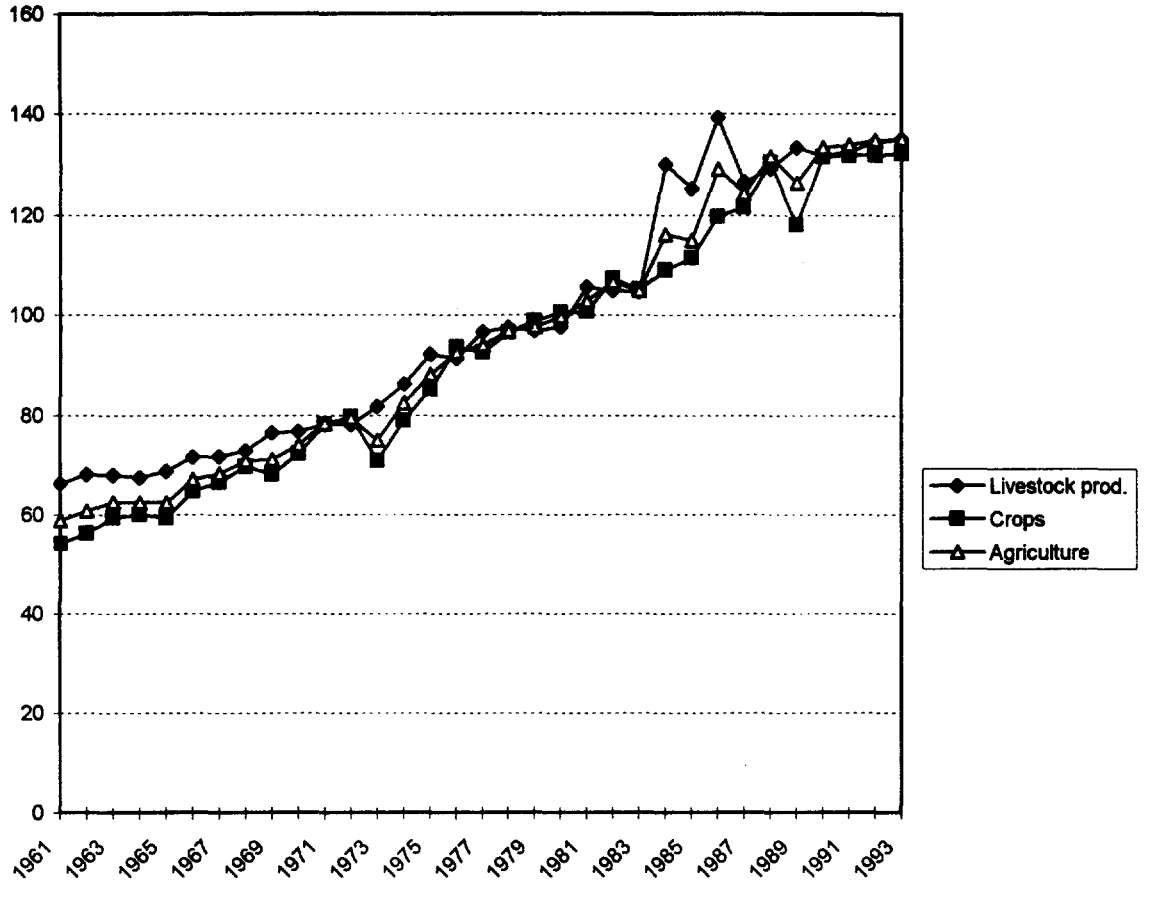
Source: Government of Turkey and Turkish Seed Industry Association.

Figure 3.2: Hybrid Sunflower Seed Production, Imports, and Exports, 1980 to 1993 (1,000 tons)



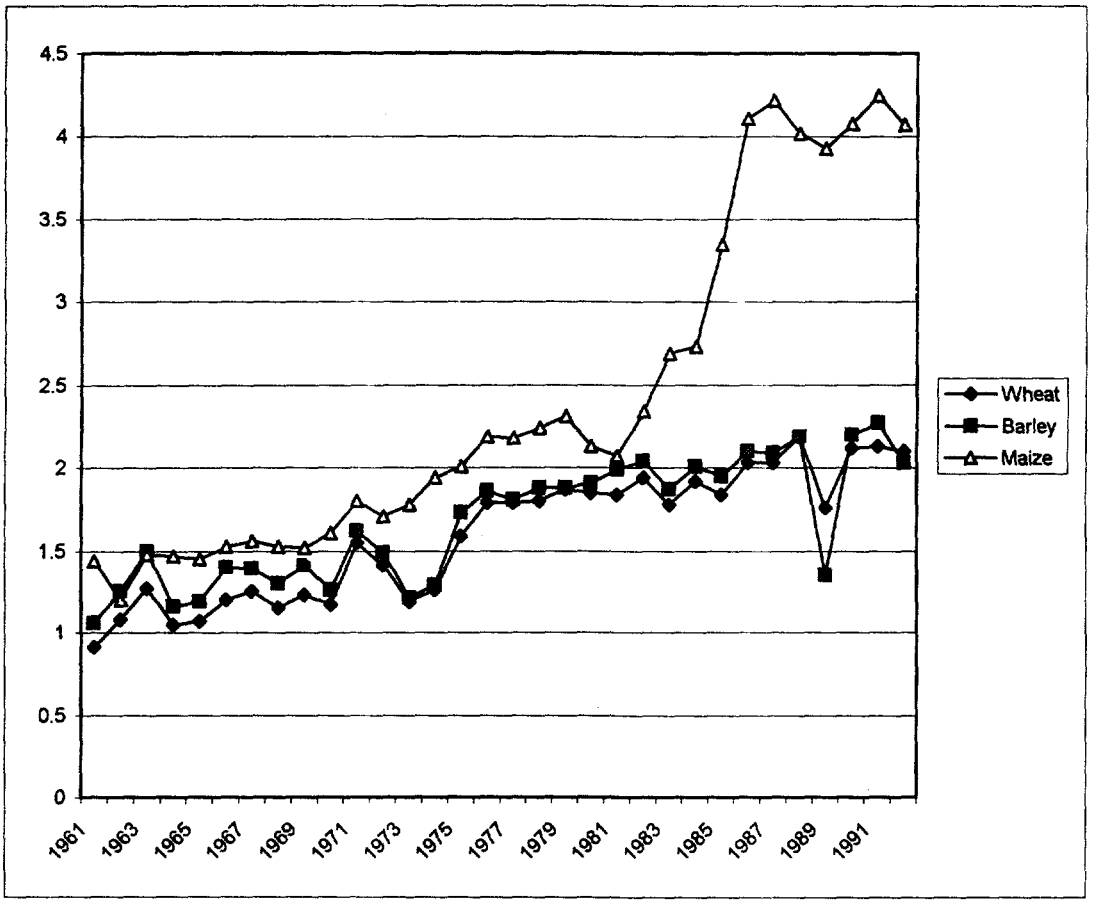
Source: Government of Turkey and Turkish Seed Industry Association.

Figure 4.1: FAO Production Indices for Turkey, 1961 to 1993
(1979-81 = 100)



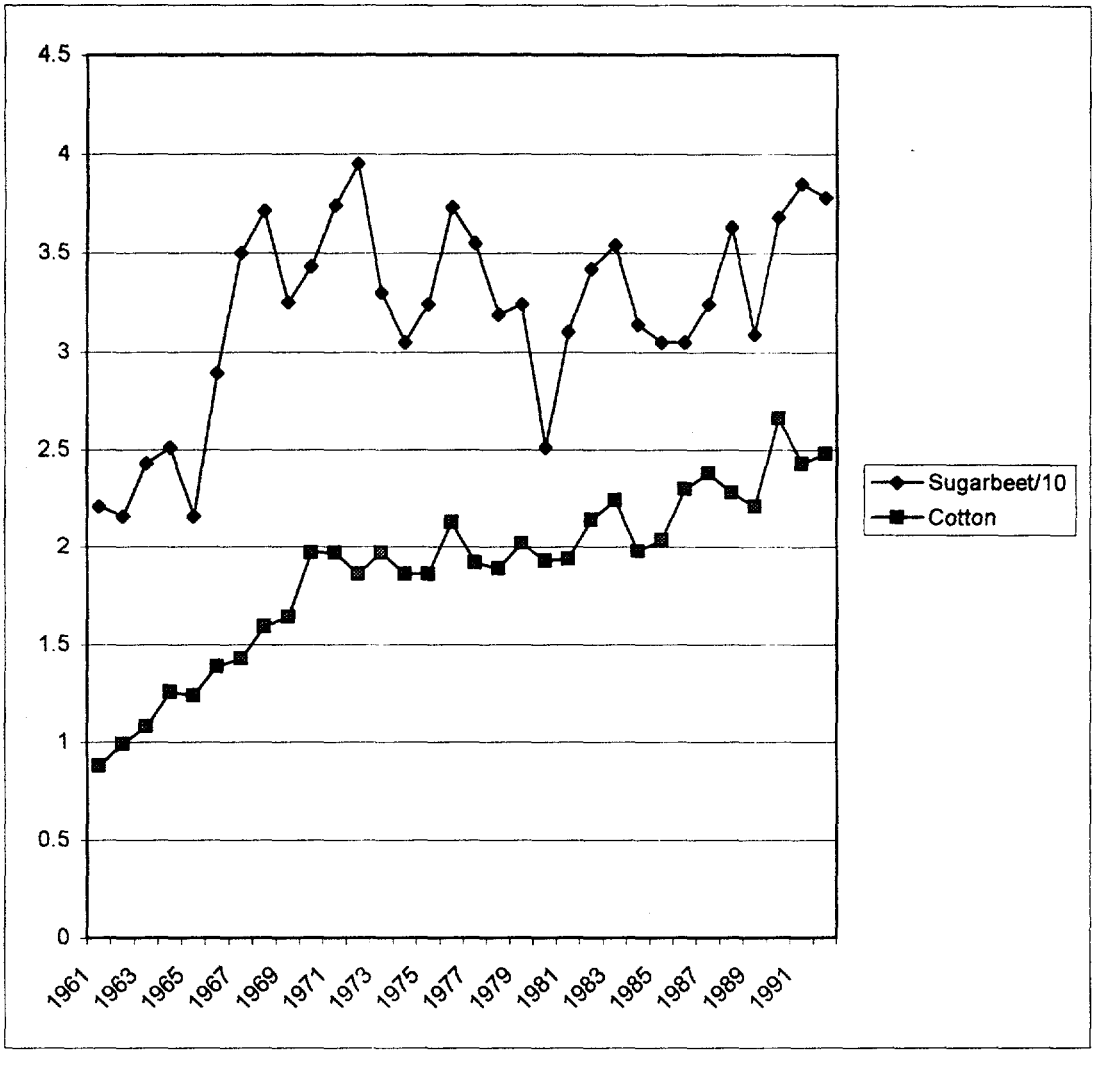
Source: FAO Agrostat-PC (Rome: FAO, 1993)

Figure 4.2. Yields of Wheat, Barley, Maize, and Sunflower, 1961 to 1992 (t/ha)



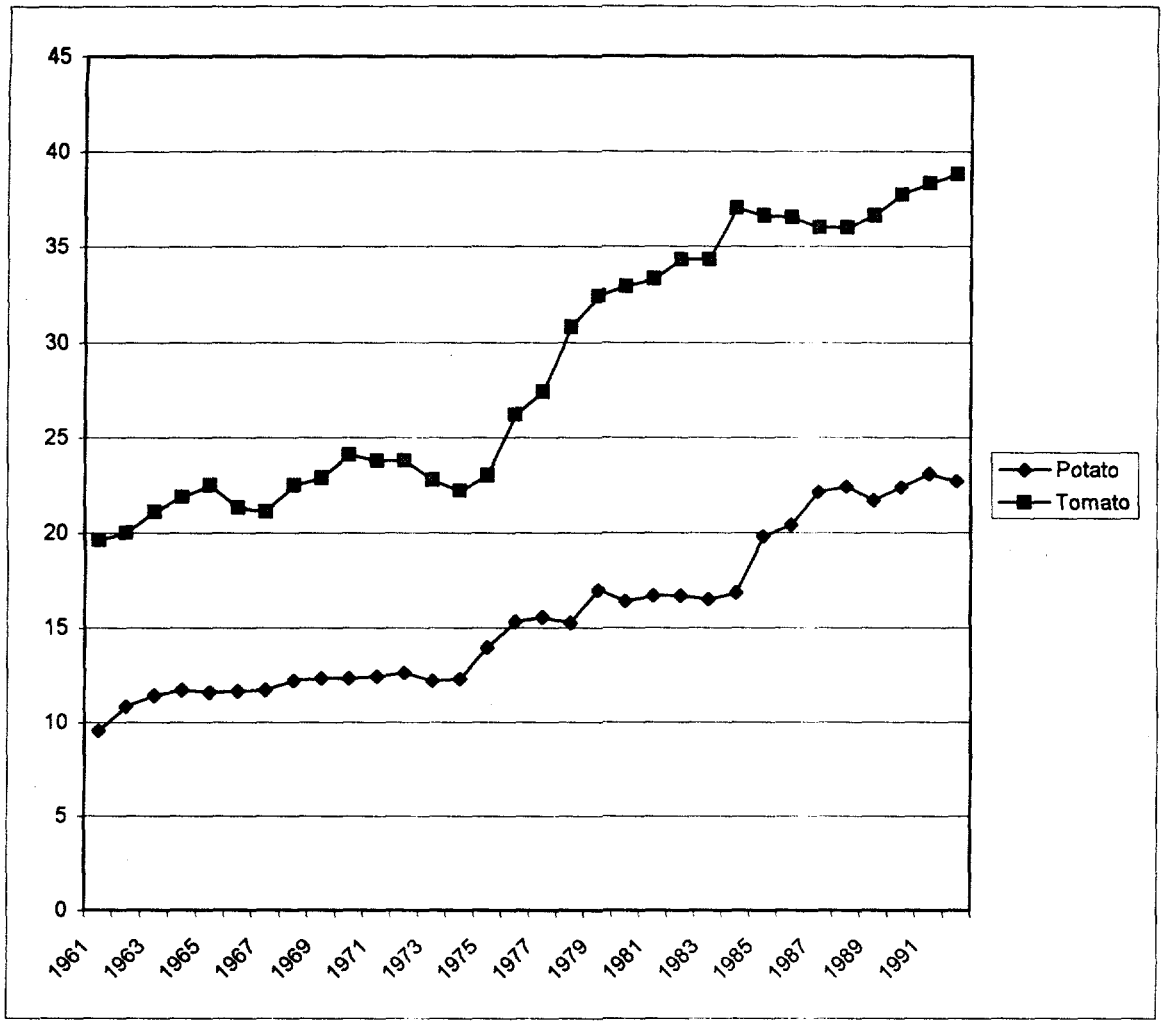
Source: SIS, The Summary of Agricultural Statistics (Ankara: SIS, various years).

Figure 4.3. Yields of Sugarbeet and Cotton,
1961 to 1992 (t/ha)



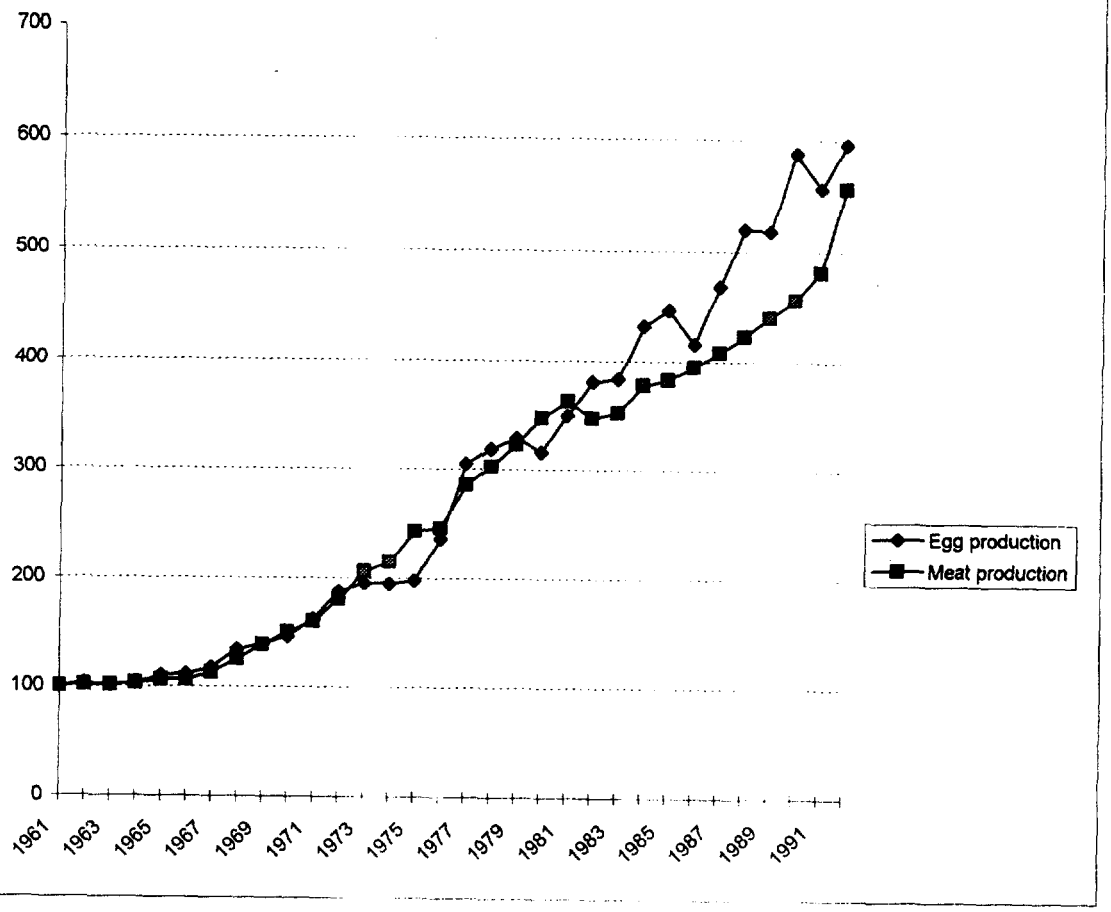
Source: SIS, The Summary of Agricultural Statistics (Ankara: SIS, various years)

Figure 4.4. Yields of Potato and Tomato,
1961 to 1992 (t/ha)



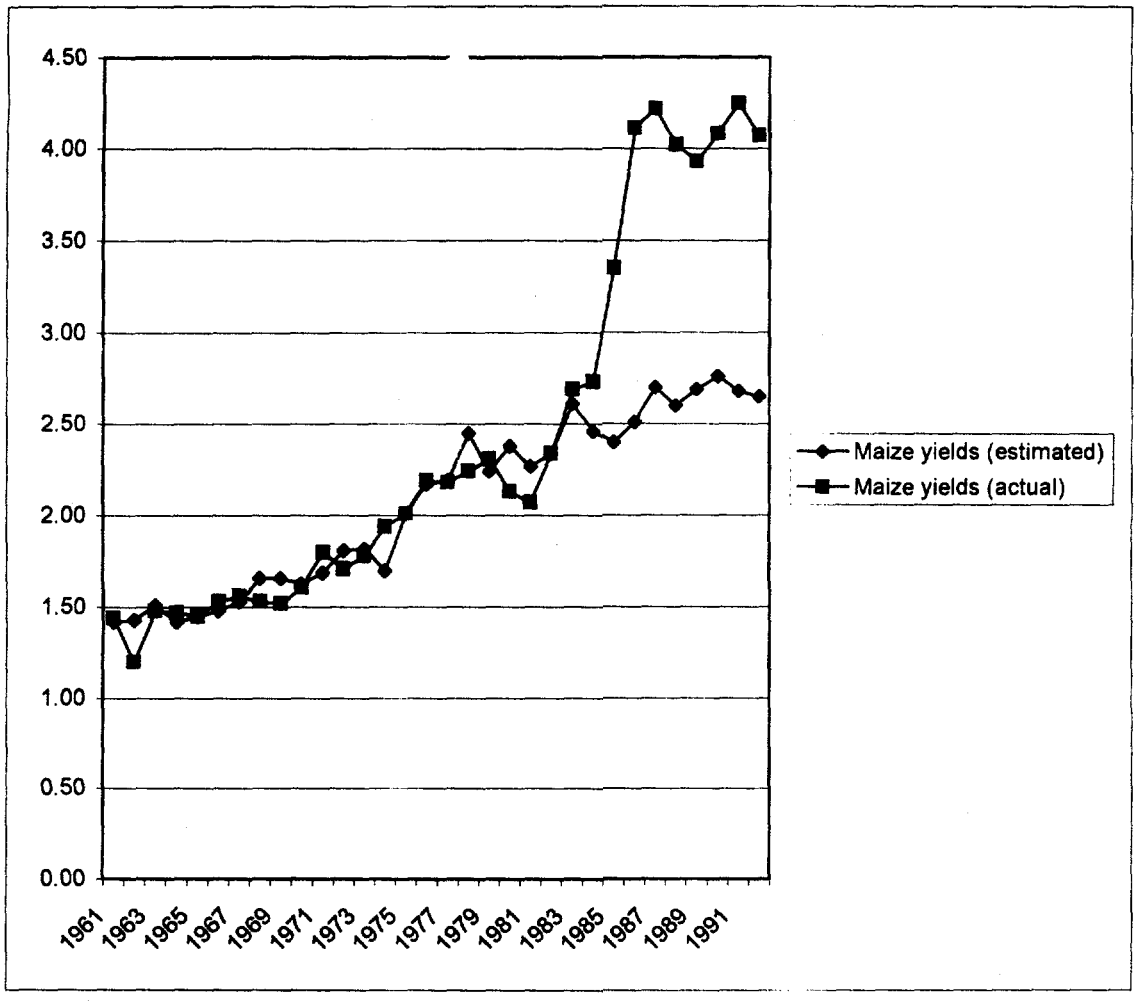
Source: SIS, The Summary of Agricultural Statistics (Ankara: SIS, various years).

Figure 4.5: Poultry Production Index, 1961-1992 (1961 = 100)



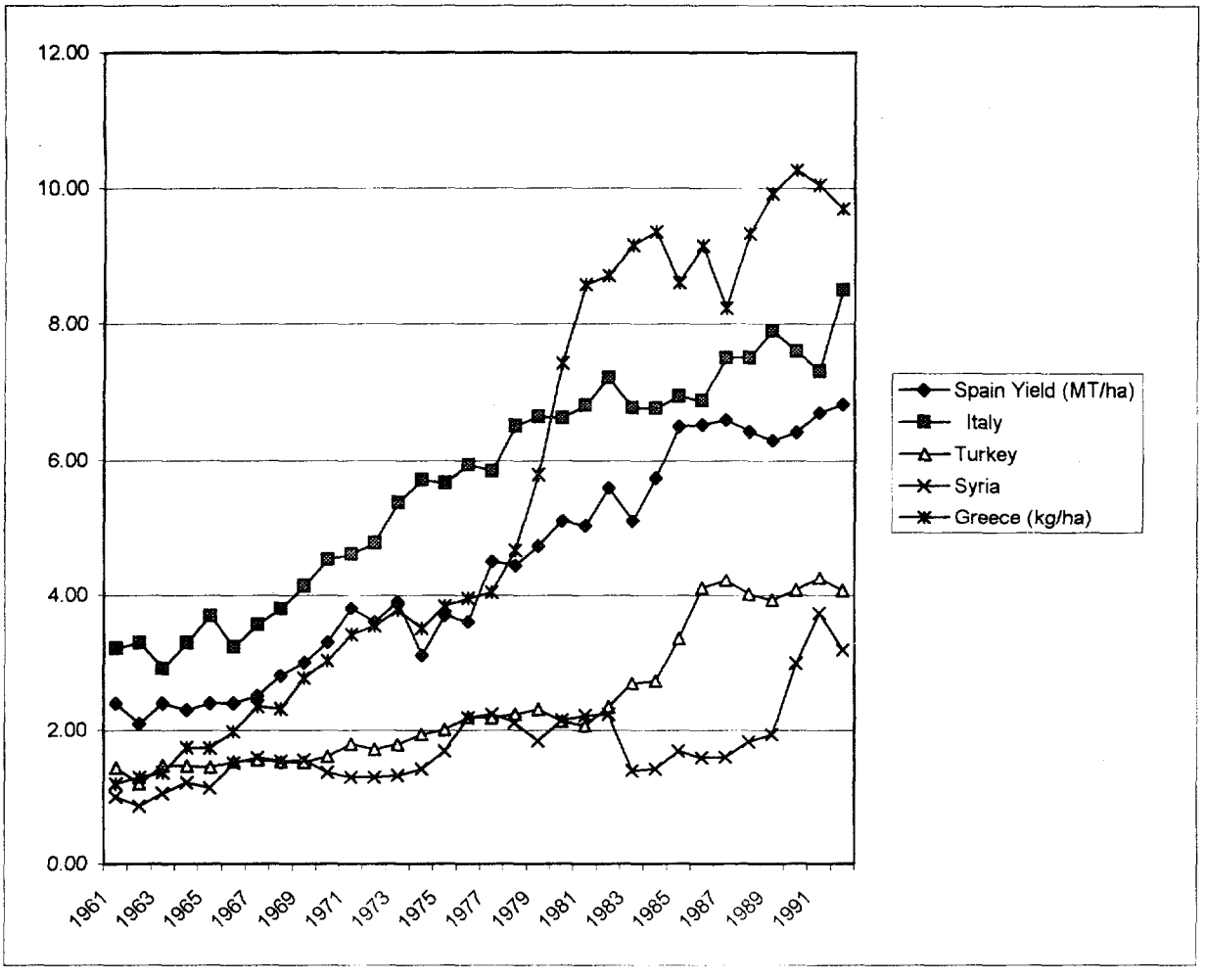
Source: FAO

Figure 4.6. Maize Yields: Actual and Projected, 1961 to 1991 (t/ha)



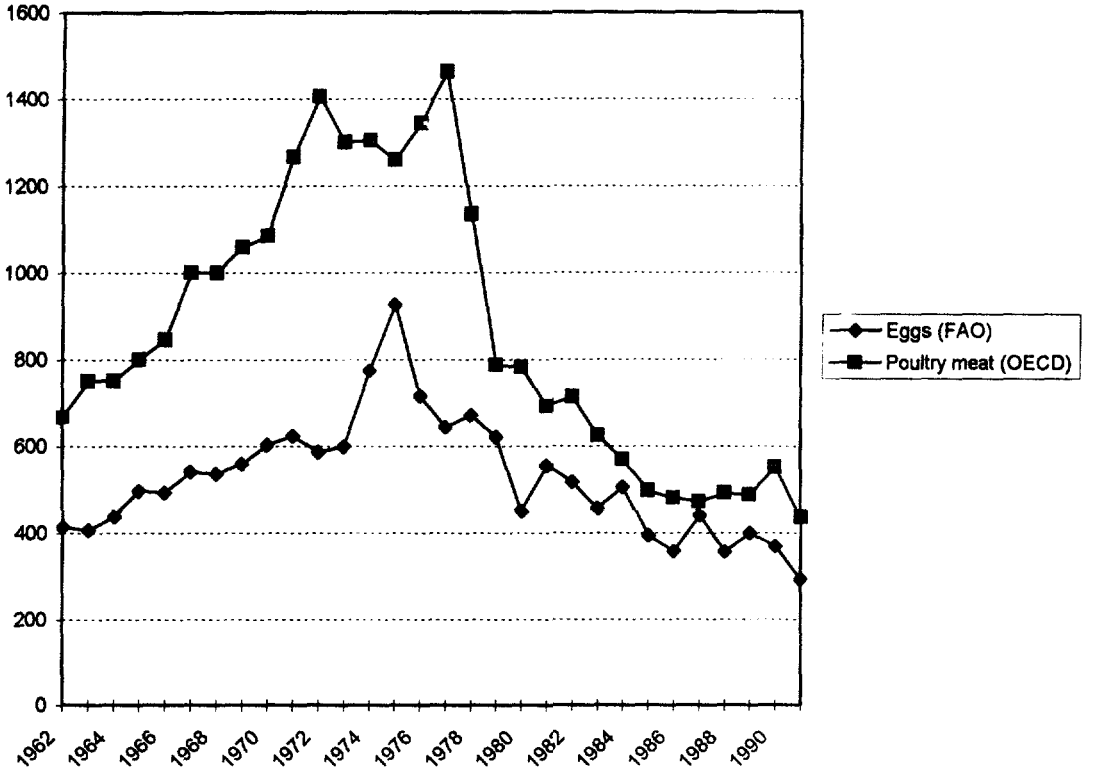
Source: Actual from SIS, The Summary of Agricultural Statistics (Ankara: SIS, various years). Projected using coefficients from Table 4.2.

Figure 4.7. Maize Yields in the Mediterranean Region, 1961 to 1992, (t/ha)



Source: Data from USDA.

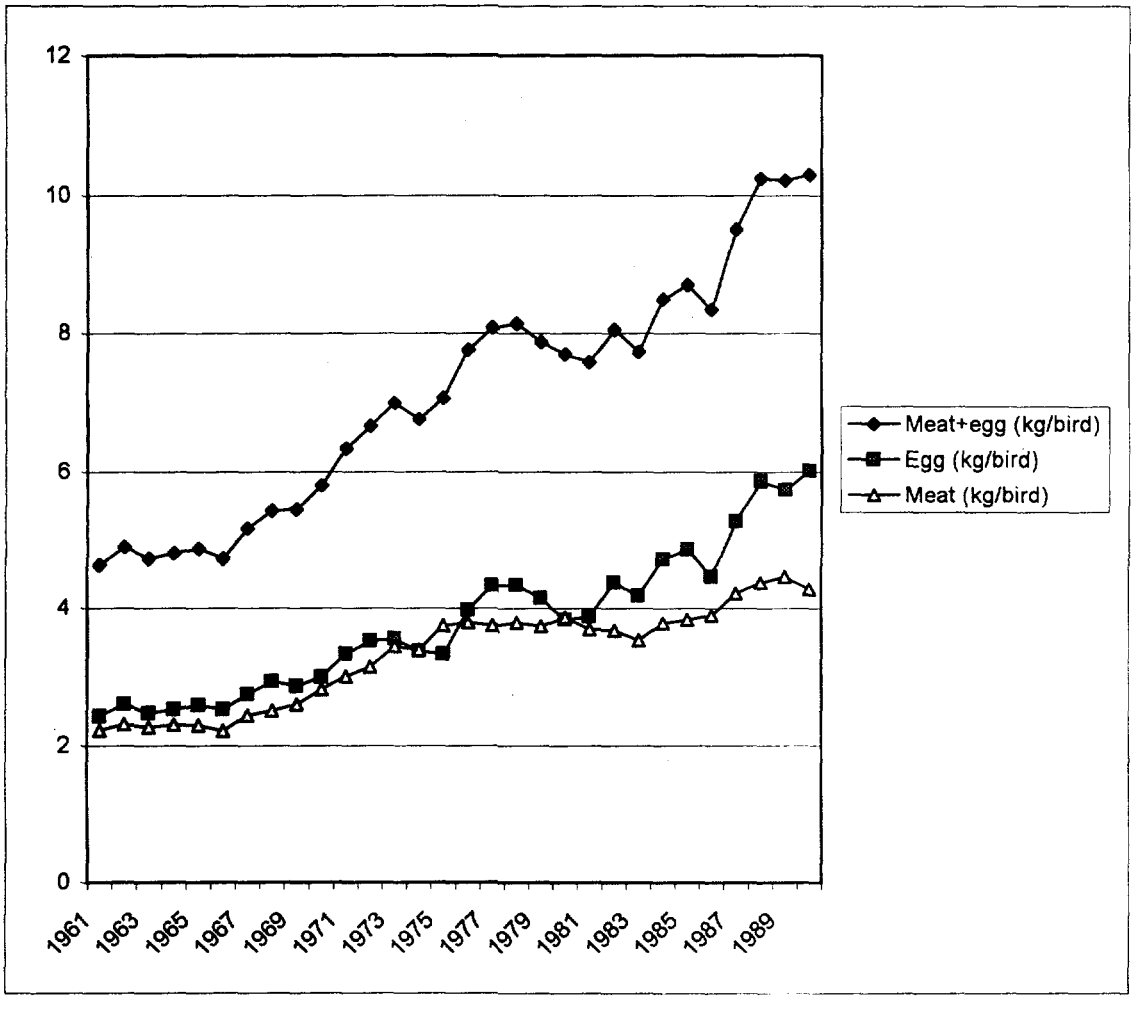
Figure 4.8: Real Prices of Meat and Eggs, 1962 to 1992
(1,000 TL per metric ton)



Note: Prices are current farmgate prices in TL/ton divided by (CPI x 0.01), where CPI is the consumer price index with 1985 = 100. FAO prices for poultry meat agree with OECD prices to 1977, then sharply diverge. We take OECD poultry meat prices, which are consistent with other poultry meat price series (e.g., Ankara consumer prices). Ideally, we would use national consumer . price series for poultry products, but these are not available. However, urban consumer price series which are available show the same pattern of rising then falling prices, so using wholesale prices does not appear to be introducing any bias in estimates of consumer price trends or changes in consumers' surplus

Sources: FAO and OECD.

Figure 4.9. Poultry Productivity: Output Divided by Year-End Birds, 1961-1990 (kg/bird)



Source: FAO

Note: During 1990-92, FAO data show number of birds doubling, which does not agree with relatively stable production and real prices for meat and eggs. The figure above omits data for 1991-92.

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