EMERGENCE OF PLANT BIOTECHNOLOGY IN TURKEY:

A Long-term Look on the Conditions of Diffusion of Technologies in Agriculture

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Introduction

This paper will draw attention to the conditions of diffusion of plant biotechnologies in Turkey, indicating that they are very much related to the characteristics of the evolution of agriculture and adoption of agricultural technologies in the long-run, and also to the social configuration forming the background to agricultural research.

I will first look into the characteristics of structure and development of agriculture in Turkey. This will show how rapid tractorization in less than 30 years determined the development path in agriculture mainly around cereals, the dominant crop group. On the other hand, fruits, nuts and tobacco produced largely by the small farmers have stayed to a great extent outside this mechanization process. However, these marginal crops have been the major export items.

I will then look into the evolution of agricultural research in Turkey. It is clear that the state has been the major actor in agricultural research. Nevertheless, research objectives have not been fully accomplished. Research has been carried out mainly on cereals and on the selection and adoption of local or imported varieties. Pioneering farmers and the private sector with foreign connections have been the other two forces in agricultural technologies, but more on the trade side rather than research.

Finally, the characteristics of plant biotechnology research in Turkey will be outlined and the two major cases of commercialization of the technology – namely virus-free citrus and micropropagated flowers – will be analyzed in detail. In the case of virus-free citrus, the state's dominant role in the development and adoption of this technology is apparent. In the case of micropropagated flowers, it has been the profit oriented initiative of foreign capital that has played the determining role.

On the whole it is my contention that: a) plant biotechnologies in Turkey started to be adopted for the marginal crops that have been largely excluded in the earlier rapid tractorization phase; b) biotechnology undertaken by the state is directed toward fulfil-

ment of farmers' needs, yet inefficient in achieving this; and, c) foreign capital that operates with modern technology has no benefit for the local production whatsoever.

Agricultural Development around Mechanized Cereals Production

Rapid change from Artisanal Practices to Green Revolution

The Ottoman economy had been largely self-sufficient before the 19th century using artisanal technology in agriculture. The 19th century witnessed the opening up of the existing structures to the West. The Ottoman-European trade that accelerated following the 1820s increased the export oriented agricultural production. By the end of the century, around 90% of the Empire's exports were agricultural products produced by a majority of small and medium scale producers besides some large farms using wage-labour (Pamuk, 1990).

The Turkish Republic established in 1923 started off as a basically agricultural economy with the share of agriculture around 48% of the GDP in the mid-1920s; and, 80% of the 13 million population lived in the rural areas with 6 million working in agriculture (Pamuk and Toprak, 1988). Until the 1950s Turkey's agriculture almost totally relied on labour and animal power and three quarters of the cultivable land lay idle.

The first breakthrough in crop production started by the importation of tractors under the Marshall Aid Plan in 1954. Increase in the prices of agricultural products due to the boom created by the Korean War and the agricultural support policies of the government were effective in the high rate of diffusion of mechanization in agriculture. As can be followed from Table 1, between 1950 and 1960 the number of tractors increased by almost 3 times. This brought about a 60% increase in the cultivated land and an increase of 69% in crop production (Kazgan, 1986). Kazgan calculates that only 9% of the production increase in this period was due to yield increases.

Table 1. Some Main Indicators on Agricultural Development in Turkey

Years	Total Area Sown (000 Hectares)	Number of Tractors (Units)	Production of Wheat (000 tonnes)	Yield of Wheat (Kg/Hectares)
1925	5,520	500	1,075	344
1930	6,149	—	2,586	921
1935	7,231	—	2,521	735
1940	9,372	—	4,068	928
1945	6,991	1,750	2,189	585
1950	9,868	16,400	3,872	865
1955	14,205	40,282	6,900	977
1960	15,305	42,136	8,450	1,097
1965	15,294	54,668	8,500	1,076
1970	15,591	105,865	10,000	1,163
1975	16,241	243,066	14,750	1,595
1980	16,372	436,369	16,500	1,829
1985	17,908	583,974	17,000	1,818
1990	18,868	692,454	20,000	2,116

Source: Statistical Indicators 1923-1991, State Institute of Statistics, Ankara, 1993.

This rapid mechanization continued in the decade of 1960-70 with the number of tractors increasing more than twice and sowing 33 % of the agricultural land. Mechanization brought about a significant growth in yields as 17 % and a modest increase in production as 21 %. The Green Revolution entered the country towards the end of the 1960s by field trials of imported cereals. The fertilized land area was only 0.07 % of the total cultivated area by 1970.

The 1970s were the years of technological advance with the extensive introduction of the package of mechanized techniques into Turkish agriculture. By 1978, fertilized land had reached 47.2 % and irrigated land 10.5 % of the total cultivated land. The number of tractors increased more than 3 times between 1970 and 1980. Together with the certified seeds, pesticides and insecticides were widely used. As a result, in the decade the growth in crop production and per-hectare yields both reached the peak of 41 % (Kazgan, 1986).

The negative conditions for agriculture started with the changes in the international and domestic terms of trade after 1978. The situation was worsened by the withdrawal of the government support from agriculture from January 1980 onwards. This was due to the liberalization policies undertaken by the government. The result was a fall both in the rate of increase of production and the rate of yield increases (Kazgan, 1988). Tractorization still continued although at a much slower pace (SIS, 1993). From 1986 onwards various support policies were re-introduced or changed more to the favour of agriculture. As a result, in more recent years there have been moderate increases in the consumption of mechanized packages of technologies (Tzob, 1990).

Over the long time span, it can be said that the use of land through tractorization has been the major source of production increases in Turkey. Cultivable land was taken up to a great extent by the early 1960s. However, it has still increased by around 23 % since then, mainly at the expense of fallow land. Comparing the figures of 1963 and 1988, it is seen that the production increases in most crops – except maize, tobacco, cotton and grapes – were much higher than the yield increases (SIS, 1993). This indicates that production increases were more confined to the increases in the cultivated land, rather than yield increases in these 25 years as a whole.

Dominance of Mechanized Cereals Production

This high mechanization is not evenly distributed among the regions and thus among the crops. Almost 50 % of the land cultivated by tractors is in Central Anatolia (Ögüt, 1989) which is the major dry-farming region of cereals. The coastal regions which benefit either from irrigation or rains are using more «water and light» than «land» in Byé and Fonte's (1992) terms. They are specialized in the production of fruits, nuts, vegetables, tobacco – which are the major agricultural export items – and tea.

«Land using» cereals which constitute 55.6 % of the cultivated land around 1990 is in the leading position. The shares of the other crop groups in the total cultivated land are as follows: pulses 9.3 %, industrial crops 5.8 %, oil seeds 6.9 % and tuber crops 1.1 %. As such the total cultivated area for field crops constitutes 39 % of the agricultural land including forests. Share of orchards in the total agricultural land is 3.3 %, olive groves 1.8 %, vegetable gardens 1.3 % and vineyards 1.2 % (SIS, 1993). Thus, cereals

have been the single dominant item in the agricultural production of Turkey. This fact has hardly changed since the 1950s as the figures delineate: percentage of area of cereals production in total crop area was 75% in 1955 and 64% in 1985, with wheat and barley holding around 60% of the cereals area (SIS, 1993).

Looking at the farming structure in Turkey, it is seen that the larger farms which are more tractorized are the major producers of the dominant crops. 14.1% of the farmers in Turkey who cultivate 56% of the arable land are medium – and large-scale farmers owning lands greater than 10 hectares (Table 2). However, the very big farms with lands greater than 50 hectares are in the minority with less than 1% of the total farms. These large farmers are the better-off producers with incomes increasing sharply as farms get bigger. They own one or more tractors, have easier access to subsidized credits and modern inputs, and lease their lands to tenants and/or sharecroppers, and/or hire workers. There are also farmers in this group who hire others' land in order to enjoy higher income levels (Öncüglu, 1992). These larger farms are the major producers of wheat, barley, sugarbeet and cotton (Kasnakoglu *et al.*, 1987).

Less Mechanized Production for the Marginal Crops

As can be followed from Table 2, a majority of 86% of the farmers in Turkey have remained small-sized family farmers with farms of less than 10 hectares, holding 44% of the cultivated land in 1991. By comparison with the corresponding figures of 1952, it is seen that their share even shows an increase.

The small producers are in general short of operating capital and thus use less chemical fertilizer, pesticide, imported seed and fewer tractors (Sirman-Eralp, 1988; Aruoba, 1988). Among these small family units there may be mec hanized farmers, and farmers with off-farm incomes who hire tractors or use them in exchange for their labour. This group also comprises the subsistence farmers who have shown a continuous decrease in number, due to migration to the cities (Aksit, 1988). In the Aegean-Marmara, Black Sea and Mediterranean regions, small producers constitute over 80% of the total farmers; in the Eastern and Central Anatolia their proportions are lowest with 76% and 71% respectively (Balkir, 1984).

Table 2. Distribution of Cultivated Land by Farms

Land Size	**Number of farms** (1000)		**Cultivated land** (th. hec.)		**Average cultivated land** (hectares)	
	1952	**1991**	**1952**	**1991**	**1952**	**1991**
0-5	1,570.2	2,644.2	3,626	5,139	2.3	1.9
5-10	552.0	684.9	4,012	4,478	7.3	6.5
10-20	259.0	353.2	3,757	4,534	14.5	12.8
20-50	107.4	160.7	3,232	4,300	30.1	26.7
50+	38.4	33.1	4,825	3,348	125.7	101.1
Total	2,527.0	3,876.1	19,452	21,799	7.7	5.6

Source: Tekelioglu (1992)

The small farmers, like the larger farmers, produce the characteristic local crops. However, there are some differences in the area distributions among agricultural products. Among field crops the principal producers of tobacco are small producers (Kasnakoglu, *et al.*, 1987). In the case of fruits, we see the dominance of small producers for many of them. With 1980 figures, almost all of the hazelnut cultivated area belongs to farmers with land sizes smaller than 10 hectares. To a lesser extent, small producers also dominate in the production areas for apples, pears, olives and grapes (SIS, 1985).

Thus, it can be said that most of the marginal crops are produced by small producers who are less mechanized. These marginal crops, on the other hand, are largely the major export items which have to compete with the quality and health norms of the international markets.

Agricultural Research Mainly on Selection of Cereals

Early Research Efforts

The history of agricultural research in Turkey is quite short compared to the Western countries. One could hardly talk of any agricultural research in the Ottoman period. The first agricultural school was established in 1848 near Istanbul taking Grignon Agricultural School of France as its model. This school, where professors were largely French and the Ottomans educated in France, lasted two years. The number of agricultural schools increased in the last years of the Ottoman Empire leaving two agricultural, one forestry and one veterinary schools to the Turkish Republic (Toprak, 1988).

In the Turkish Republic the importance of agricultural research in a large agricultural economy was realized quite early. With the aim of attainment of «self-sufficiency» in the shortest time, the first agricultural research institutes were established in 1924, and between 1924 and 33 their number increased to 5. Also, many specialized institutions were established during the period for the development and production of new varieties. By 1948 there were nine breeding stations, three testing fields and eight production farms (Tekeli and Ilkin, 1988). Responding to the high demand for seeds, in order to produce and distribute the qualified seeds of the seed production farms, State Farms were established starting from 1942 with their number reaching 13 in 1945. In 1950, all these institutions were collected under the name «State Production Farms» to serve more efficiently the growing demand. These institutions worked both on the identification of standard varieties of existing crops and on the introduction of new crops. However, in general the research results could not be extended in full to the farmers due to inefficiency in extension, as well as the low levels of capacity. In this regard, industrial crops which constituted the inputs of agroindustries on which the industrialization efforts concentrated, were to some degree exceptional.

For wheat, a significant contribution of these institutions started in 1928 with the introduction of an adopted Italian wheat variety to agriculture. The selection work in these farms also resulted in the development of three barley varieties, one oat and one rye variety, and five genuine wheat varieties that were 20-30 % more productive than the traditional wheat varieties. However, the relative success of these efforts made minor contributions to agriculture as a whole. The average yield per decare of wheat

was 75.6 kg, 86.9 kg, 105.9 kg, 83.9 kg and 86.1 kg during 1927-30, 1931-35, 1936-40, 1941-45 and 1946-50 respectively.

For cotton, while adopted American varieties constituted the large portion of production, the selection research introduced a pure local variety from 1947 onwards. Yet, the standardization efforts in cotton could contribute very little to increases in productivity.

Tobacco benefited most from the selection work. Being one of the major export items, the problem of the tobacco crop in the 1930s was the use of seeds of very many different varieties resulting in unstandardized production. From 1943 onwards, standard Turkish varieties specific to regions started to be introduced, yet the results were not satisfactory due to the dispersion of small producers.

The productivity increases were most pronounced in sugar beet, namely from 8.72 tonnes/hectare in 1926 to 14.81 tonnes/hectare in 1948. The sugar factories working in close contact with the farmers contributed to the extension process.

For fruits, «sample gardens», «nurseries» and «stations» were the major units for distributing the planting material that increased standardization and productivity in order to further increase exports. Among them, the highest success was attained with hazelnuts, figs and stoneless grapes that have remained the major export items. The fact that these trees could be propagated vegetatively – which is easier compared to the method of grafting of mature trees required for other fruits –, was the main reason for this distinction (Tekeli and Ilkin, 1988).

Research Concentrates on Cereals

The results of these early research efforts bore fruit from the 1950s onwards in parallel with the mechanization of agriculture. Following the «Seed Registration, Control and Certification Law» of 1963, the seeds produced and distributed were differentiated according to their qualifications and state guaranty was reassured in the production and distribution of qualified seeds. Still many foreign seeds could enter the country illegally in suitcases. The importation of a high-yielding Mexican wheat variety in 1969 by the state, in response to the persistent demand of the powerful farmers of the South, was a turning point in this regard.

Research on cereals and especially on wheat constituted the major part of agricultural research in the 1960s and 1970s. Following on from 1966, Mexican spring wheat seeds formally entered the country covering over half of the spring wheat area by 1972 and doubling the spring wheat yield figures to 2,300 kg/ha in 1976. In the meantime, The Turkish Wheat Research and Training Project started in 1969 which later became the National Winter Cereal Research Project with 12 research institutes and 2 agricultural faculties. Between 1969 and 1980, 20 types of wheat cultivars were given out, some of which found high demand from the farmers. Also, during the mid-1960s research intensified on the production methods for the dry-land Anatolian plateau-methods to store more moisture during the fallow period, reduce weeds and raise soil fertility, which resulted in dramatic changes after 8 years, causing Turkey to be called «a dry-land success». The yield in winter wheat increased to 1,896 kg/ha in 1979 from 1,097 kg/ha in 1960 (Hanson *et al.*, 1982).

Agricultural Research in Decline

In line with the government's liberalization policies, by a law dated December 1985, the entrance of local and foreign private sector into the seed business was encouraged. The established companies grew rapidly reaching 56 in number by 1992, 30 of them having foreign partners or wholly owned by foreign companies such as Pioneer, Ciba-Geigy, Sandoz and Cargill among others. Since some companies have been collaborating with more than one foreign company, the number of foreign interests involved was 56 (TKB, 1992). By 1990, the private companies accounted for more than 10% of the total seed sales. This figure reached 80% for soybean, 96% for hybrid maize, 99% for hybrid sunflower, 50% for potatoes and 71% for vegetables (Srivastava and Jaffe, 1993). In spite of this significant share in the seed business, only 13 of the companies had researcher certificates by 1992 and the rest have only been importing. In the case of hybrid seeds, the parents are imported and production of seeds are undertaken with contract farmers in Turkey. A considerable amount of these seeds is exported. In 1992, 91% of the hybrid sunflower seed production, 28% of the hybrid maize seed production, and 19% of vegetable seed production were exported (TKB, 1993).

With the major role of the private sector thus confined to imports, agricultural research in Turkey is still mainly conducted by the public sector, under the roof of the Ministry of Agriculture and, at an accelerating pace, at the universities. From 1980 onwards, the status of agricultural research within the Ministry deteriorated. By 1983, there were 115 research units and 1336 researchers in the Ministry's research institutes (Devlet Bakanligi, 1983). After a change of organization in 1987, the number of the research institutes decreased to 67 and the number of researchers to 1191 by 1988. Around 70% of the researchers in these institutes have been working on crops (Akbay, et al., 1989). The cut in personnel recruitment, the ageing and retirement of the researchers and the frequent changes of management due to political appointments have been the other factors with negative impacts on research. The low level of research capacity can be traced by the small number - less than 10 in total - of hybrid varieties of corn, sunflower and vegetables developed in Turkey .

Like the other public bodies, the universities had an increasing role in agricultural research, competing with the Ministry in many cases. Still, education in agricultural sciences have stagnated in recent years. By 1988, related to 18 universities there were 14 faculties of agriculture. By 1991, the number of universities increased to 28, while the number of the faculties of agriculture remained the same. In addition to the neglect of agriculture in general, the fact that agricultural engineers constituted one of the largest groups of unemployed among the university graduates accounted for this.

Plant Biotechnology Creeping in

Plant Biotechnology Research on Marginal Crops

Plant biotechnology research in Turkey started in the early 1980s within this general structure of agricultural research. The research was carried out in the state research institutes and universities with experiments using the simple techniques of tissue culture. It depended largely on individual initiatives and foreign project funds such as

Table 3. Main Public Plant Biotechnology Research in Turkey in 1990. State Research Institute.

Institute	Crop	Technique	Objective
-Tübitak/	barley	RAPD	identify the variations
Istanbul	tobacco	microprop.	obtain virus-free plants
-Aegean Agr.	potato	callus cul.	select high quality lines
Res. Inst./	ornament.	tissue cul.	multiplication
Izmir	plum	shoot-tip cul.	multiplication
	grape	shoot-tip cul.	multiplication
	strawberry	shoot-tip cul.	multip., virus-free plants
	cauliflower	shoot-tip cul.	multiplication
	cucumber	shoot-tip cul.	multiplication
	orchis	embryo cul.	multiplication
	fruits/grapes	In-vitro storage	germplasm conservation
-Atatürk	rose cvs	shoot-tip cul.	multiplication
Horticulture	walnut	shoot-tip cul.	multiplication
R.I./Istanbul	chrysanthemum	shoot-tip cul.	virus-free varieties
-Olive R.I./Izmir	olive	shoot-tip cul.	multiplication
-Citrus R.I./			
Antalya	citrus	shoot-tip cul.	virus-free plants
-Grape R.I./			
Manisa	grape	tissue culture	virus-free plants
-Plant Prot.			
R.I./Adana	citrus	tissue culture	virus-free plants

Source: Gözen (1993)

those of the FAO and NATO/ASI. Considerable plant tissue culture research has been done, but there has so far been only one national program for citrus. There was almost no coordinated division of labour among the various laboratories.

Tissue culture research in Turkey can be grouped into four according to its objectives: multiplication, quality improvement, virus-free plant cultivation and germplasm conservation. The research has been conducted on fruits, vegetables and ornamental plants (Tables 3 and 4). These choices of plants were mainly due to the ease of their application for the tissue culture techniques. The desire to find solutions to some of the problems related to the production and the potential marketing prospects of these crops are the two other reasons for choosing them as subject for research.

By 1990 there were mainly 15 public laboratories in Turkey with varying levels of research capability, working almost wholly with tissue culture techniques. A survey conducted in 1994 showed that the number of laboratories working with plant biotechnology increased to around 30, 4 of which also integrating genetic engineering techniques (Gözen, *et al.*, forthcoming).

Employing few qualified personnel and working with insufficient infrastructure, very few of the laboratories working on plant biotechnology have reached the stage of getting the results out to production. Also, the weak links between the research and business, and the lack of confidence of business in local research, when put together with the lack of any legislation on plant breeders' rights until 1994, gave rise to a low incentive to move out from the laboratories or the nurseries.

From 1990 onwards the state started to encourage the diffusion of this technology by including biotechnology investments among the special priority high technology areas and by bringing tax reductions and import duty exemptions. In 1992, the state also started to encourage the diffusion of the new planting material in agriculture by applying the 25% reimbursement scheme of the total investment in the new gardens built.

In spite of the above-mentioned difficulties, but also benefiting from the government incentives, lately there have been some cases of commercialization of plant biotechnology in Turkey. The cases of virus-free citrus and micropropagated flowers illustrate how the importation of the technology by the foreign capital went parallel with the national research, however serving different interests (Personal interviews).

State Initiated Virus-Free Citrus Research

In the 1920s orange was a luxury fruit in Turkey and lemon was largely imported. The research on citrus started in 1936 with the establishment of Antalya Garden Cultures Station. Working on more than 100 citrus varieties, the Station finally determined around

Table 4. Main Public Plant Biotechnology Research in Turkey in 1990. Universities.

Institute	Crop	Technique	Objective
-Aegean Univ. Fac. of Agr.	tobacco	anther cult.	improve new lines; test iron and sucrose impacts
(Horticu.+	tobacco	callus cult.	improve doubled haploid
Field Crops)/	potato	anther cult.	obtain haploid
Izmir	sunflower	anther cult.	obtain haploid
	citrus	callus cult.	somaclonal variation
	african violet	leaf cult.	multiplication
	cucumber	stem piece cul.	multiplication
	potato	meristem cult.	multiplication
-Ankara Univ.	grape	meristem cult.	multiplication
Fac. of Agr./	tomato	meristem cult.	multiplication
Ankara	garlic	meristem cult.	multiplication
	walnut	shoot-tip cult.	multiplication
	eggplant	anther cult.	improve haploid
	tomato	embryo culture	method improvement
-Çukurova Uni.	almond	shoot-tip cul.	multiplication
Fac. of Agr.	artichoke	shoot-tip cul.	multiplication
(Plant Protect.	lemon	callus culture	resistance to pathogens
+ Horticult.)	strawberry	shoot-tip cul.	multiplication
/Adana	pepper	anther cult.	resistance to pathogens
	watermelon	gynogenesis	improve haploid embryos
	sour orange	callus cult.	resistance to pathogens
	citrus	protoplast cul.	method improvement
	tomato	callus culture	resistance to pathogens
	eggplant	anther cult.	improve haploid
-Dicle U./ Diyarbakir	tobacco	anther cult.	improve new lines
-Istanbul U./ Istanbul	barley	anther cult.	plant regeneration

Source: Gözen (1993)

10 varieties, – almost all with foreign origins – to provide saplings to the market during 10 months a year. A nursery and a sample garden were also established. This activity contributed greatly to the improvement of production, increasing the number of citrus trees from 1 million in 1936, to 2.7 million in 1944 and 5.1 million in 1950. Lemon imports stopped in 1944 and exports started in 1950 (Tekeli and Ilkin, 1988). By the 1960s the production of citrus had increased from its level of the 1930s by 10 times to 300.000 tons. The increase continued by around 100% every ten years reaching 656.000 tons in 1970 and 1.158.000 tons in 1980 and recently stabilized around 1.350.000-1.450.000 tons (Hizal, *et al.*, 1988).

However, the spread of viruses together with the saplings was a major problem not handled until the 1960s. In 1961, the Citrus Virus Diseases Commission was established within the Ministry of Agriculture. With the decision of this Commission, certified citrus saplings were first imported from California in 1967 and secondly in 1973. However, the use of this introductory material caused the spread of the Stubborn disease on epidemic scales. The research with traditional techniques for obtaining certified saplings started in 1965 in the Antalya Citrus Research Institute and research on obtaining improved lines started in this institute together with the Çukurova University in 1969. In realizing that these techniques were insufficient for obtaining virus-free material, the National Citrus Training and Research Programme was established in 1979 in order to produce internationally recognized certified saplings with blue label (Çinar, 1991). This meant introducing the in-vitro culture techniques.

The research progressed very slowly. The project benefited from the FAO and the World Bank project funds for the importation of the equipment, training abroad and construction of glass houses mainly during 1982-1987. While the Citrus Research Institute (C.S.I.) of the Ministry of Agriculture, in Antalya, and the Faculty of Agriculture of Çukurova University (Ç.U.) in Adana worked in close collaboration in the beginning, they later on broke apart due to conflicting opinions on the varieties to be worked with and the future steps to be taken.

C.S.I. started working with adopted traditional and some new varieties of citrus and sold the first saplings in October 1992. With high demand from the farmers that resulted in long queues, it sold 23.000 units the first year and 12.000 units the second year to around 100 farmers, although the price of the saplings were more than 3 times higher than the traditional saplings. It also sold graftings to the Production Station in Alanya and to the Research Institute in Alata.

Ç.U. started selling the virus-free citrus saplings in 1990 at a price more than 4 times the current traditional sapling prices. From around 1.000 units in 1990, the sales rose to 40.000 units in 1993, extending to a total of around 150 farmers. The University also made contracts with 3 private companies for the production of saplings obtained from the virus-free graftings of Ç.U.. Thus, the virus-free sapling distribution in the Adana region was expected to reach 250.000 units by the end of 1994. Besides the traditional varieties, Ç.U. also worked with new varieties with export potential, however not tested in production in Turkey. Due to the previous conflicts with the Ministry, Ç.U. was unable to put the blue labels on the trees. Lately, there has been an attempt to resolve this conflict.

In spite of the much higher prices of the virus-free material, the high demand can be explained by the experiences of the farmers with the diseases and productivity losses of around 35-50%, reaching 100% in severe cases. The technology clearly satisfies a need. Also, the fact that on the average citrus producers are better-off farmers who can undertake the expenses of building a garden from other sources such as field crops or professional work facilitated the diffusion of the technology. These farmers also considered it a life-long investment or insurance for their future.

Yet, there are some obstacles against the diffusion of these new technology products. Firstly, the existing capacity is very low compared to the potential demand. In order to increase the capacity, the Ministry and the University can collaborate in complementary work instead of duplications. However, that seems to be hard to attain with the mindset of the individuals involved. Secondly, the very large citrus farmers and the private sapling producers who are used to making large profits through traditional and/or foreign material, are reacting against this technology. They claim that there is no need to invest more money in the virus-free material since diseases are everywhere and they will spread among these new trees anyway. As long as the virus-free trees are in the minority this is a high probability which can only be solved by growing more virus-free trees.

Technology Import for Micropropagating Flowers

In the private sector, two-three companies started working on micropropagation of mainly flowers in the early 1990s, however did succeed in running the laboratories profitably. As we have seen above, research on micropropagating flowers have been undertaken in laboratories of some universities and research institutes. But, although some results were readily applicable to production, they have not been offered to the market yet. The main reason was that these research units lacked sufficient facilities to start production at commercial scales. Also, the private sector did not show any interest in commercializing these results, preferring imports as the easier way. Thus, extension of the national research on flowers has not been attained so far.

In 1993, a Japanese firm started micropropagating flowers directly for export. The company was bringing the patented tissues of flowers from Japan, propagating them and selling them to Europe, either as rootstocks in jars or as carnation rooted cuttings. The start-up capacity was 10.000 units/month of root stocks and 400.000 units/month rooted cuttings.

The company enjoyed a wide incentive scheme including tax exemptions and credit facilities extended to the foreign capital, as well as to investors in the flower sector, to utilizers of new technology and to exporters. With low labour costs, a guaranteed market in Europe and patented flower varieties from Japan, the company had prospects of increasing its capacity and the number of the varieties.

Employing all Turkish people except the two managers and training some in Japan, the company contributes to the transfer of technology to Turkey. However, the fact that it is only exporting the material that local flower farmers are eager to buy and are actually importing, shows an extreme case of total neglect of the local farmers' needs.

There is a very interesting phenomenon here. The company exports all the material that has been produced in Turkey to Holland. The same material is in great demand

by the Turkish farmers. Yet the local farmers are unable to buy them from this firm. Thus, it may very well be the case that the rooted cuttings that the Turkish flower producers import from Holland are the very same exports from Turkey. This shows that, not only do Turkish farmers have to pay a higher price for material already produced in Turkey, but also that such production is in no way a solution to their input problems. It can thus be stated that, importing micropropagation technology in that manner has not benefited the Turkish farmers or the farming quality at all.

Conclusion

Turkey enjoyed self-sufficiency in agriculture following the 1960s and especially in the 1970s, which was attained largely through rapid mechanization around cereals and exploitation of the natural resources, especially in terms of land.

As we have seen above, with a weak science base, state initiated agricultural research has been largely the inland development of local and mostly foreign seeds of higher yields in the field crops and especially cereals. The inefficiency of the local research became more pronounced with the formal importation of hybrid seeds in the 1970s. Very few of the foreign and domestic seed companies which started operations in the mid-1980s undertook research activities. Most of them have been importing the seeds and doing only partial field reproduction in Turkey. As far as the fruits and vegetables were concerned, the inland variety improvement efforts of the state made minor contributions to the production when compared to the brought in material from abroad.

What we see in the case of plant biotechnologies is that both the research and applications are concentrated on the marginal crops, such as fruits, vegetables and tobacco, that have been excluded by the dominant technological mode. These crops, on the other hand, are more sensitive to the demand for health and quality of the international markets being the major agricultural export items.

The state has been the sole technology actor in plant biotechnology in Turkey until the early 1990s. The private sector has recently shown some interest in the field. The two cases of commercialization of this new technology in Turkey illustrate that plant biotechnology adopted by the state responded to the farmers' problems, whereas the interest of the foreign capital was largely confined to importing the technology in order to operate more profitably in the European market. In this respect, importing biotechnology to Turkey had no effect of improving the local production.

Similarly, it is the state's weak research system that is geared towards solving local production problems, while the multinational firm with strong biotechnology ties operates with completely other interests. This clearly shows that a more planned and objective oriented research and technology transfer programme must be designed and applied; introduction of the necessary legal framework as well.

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