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Review Article

Environmental Management of Field Crops: A Case Study of Turkish Agriculture

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ABSTRACT

Agriculture has a central role in the life of Turkish people. According to the most recent statistics, the share of field crops within total agricultural production in Turkey is 15.5% of which, 7.1% is from vegetable and fruit production. Cereals, industrial, tuber, oil seeds, pulses and odder and forage have 44.0, 20.0, 8.1, 4.0, 2.0 and 0.01-12.80% contribution, respectively. During the period, 1925-2006 the yields of many field crops declined. For example, the comparative production level (PL) of some field crops (as a percentage of 1925 levels) was recorded as: flax (*Linum* spp.) 50,032 t (99%); green lentils (*Lens* spp.) 157,674 t (79.9%); soybeans (*Glycine* spp.) 152,700 t (76.4%); broad beans (*Vicia* spp.) 58,684 t (73.4%); tobacco (*Nicotiana* spp.) 70,343 t (44.4%); sesame (*Sesame* spp.) 18,455 t (41%); green hay in sainfoin (*Onobrychis* spp.) 85,157 t (40.1%); rye (*Secale* spp.) 79,000 t (23%); alfalfa (*Medicago* spp.) 390,080 t (17.7%); chickpea (*Cicer* spp.) 78,254 t (12.4%) and red lentil (*Lens* spp.) 69,702 t (11.0%). In 2007, climate change negatively influenced area under field crops. According to statistical estimates, these areas were estimated as 15.5% (in cereals); 8.4%-36.7% (in pulses); 3.2% (in tubers) and 23.6% (in oil seeds). It may be suggested that this pathetic panorama results entirely from the negative impacts of many restrictive factors on plant growth and development in the agricultural sector. There are a number of reasons why meteorological factors may have influenced yield positively or negatively, but it is certain that accelerated development was reduced of crop yield level.

Key Words: Agronomy; Field crops; Field crops production; Global warming; Turkish agriculture; Yield

INTRODUCTION

Turkey's geographical area, including lakes, is 814.578 km^2 of which 790.200 km^2 is in Asia and 24.378 km^2 in Europe (Anonymous, 2009). She is located between temperate and sub-tropical zones at latitude of 36-42°N, 26-45°E asl 1132 m. A coastline of 8.333 km extends along the Black Sea, the Marmara Sea, the Aegean and Mediterranean Seas. Turkey's Asian side is called "*Anatolia*" and the European area is called "*Thrace*". Its population decreased by 16.6% from (1914) to (1927), non-etheless it was increased by more than 510.0% from (1927) to (2007) (Anonymous, 1982-2001 & 2008a). The population of Turkey was determined as 71.517.100 in 2008, with a growth rate of (0.131%) (Anonymous, 2008a). The eastern region features rich, mountainous landscapes and is home to Lake Van and towering Mount Ağrı with its peak at 5.166 m. Important rivers like the Fırat (Euphrates) and Dicle (Tigris) rise from Eastern Turkey. More than 59% of the country's total land has slopes over 12% (Kün, 1983). Only 24% of the land area is suitable for cultivation and nearly three quarters of it is prone to erosion (Çeliker & Anaç, 2003). According to Aslan *et al.* (2008), Turkey is under the effect of different climates. But, basically country has two climates. Mediterranean climate is characterized by high temperature, dry summer, mild and wet winter. These climatic characteristics and other specific, hydrological, topographic conditions make Turkey quite susceptible to desertification (Anonymous, 2006a & 2006b). Furthermore, due to the latitude difference of (6º), temperature changes occur between the north and east of the country and this phenomenon causes a Mediterrenean type of climate (Çakmak *et al.,* 2005). The aim of this paper is to discuss production and consumption of some main field crops from (1923) to (2005) by considering certain agricultural parameters (the SA & PL) in light of agronomical trends and agricultural input(s) usages.

Developments of the sowing areas according to their use. Turkey is one of the world's few agriculturally self-sufficient countries and has many agricultural systems and (minor-major) ecologies in agroecological, geographic and topographic terms (Altay, 1987; Anonymous, 1998). During the Otoman Empire times 80% was allocated for cereals, 7% for vegetables, 7% for industrial crops and 4% for fruits (Oral, 2003). But, today we find that SA and PL have increased two fold, with a 3.4 times increase in cereals, a 6 times increase in industrial crops, 9 times in pulses and 44.1 times in fodder and forage crops (Kün & Genç, 1973). It is completely due to the followed economical polycies. Examine of the relationship between cultivated lands in terms of cultivated crop area, showed a greatest increase in the SA

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of fodder and forage crops followed by cereals and industrial crops (Figs. 1 & 4). There was a minimum increase in the cultivation of other types of pulses during that period. Similarly, about 73-86.5% of cultivated lands in agricultural land, fallow and total cultivated lands showed 3.5, 2.2 and 4.2 times increase, respectively with 3.4 because of factors such as mismanagement of cultivated areas, socioeconomic reasons, wind and water erosion, etc. (Kün & Genç, 1973; Taysun *et al.,* 1995; Anonymous, 2003b; Ulukan, 2005).

Anatolian lands are subject to increased wind erosion approaching 506,000 ha and 25.4 × 10^9 t $year^{-1}$ in the world (Anonymous, 2001a; 2001b & 2003a; Çeliker & Anaç, 2003). Soil erosion has also negative effects such as reducing the life of dams, because of silt accumulation. Research findings show that 31-32 x 10^6 t $year^{-1}$ of eroded soil accumulates in the Keban and Karakaya dam basins each year (Anonymous, 2003b). Although erosion prevention programs began several decades ago, the control measures have been applied only in 2.2 Mil ha of area so far (Anonymous, 2006b). Massive abatement or improvement programs were started 25 years ago by the Turkish Republic's Ministry of Agriculture and Rural Affairs (TKB), Ministry of Environment and Forestry, General Directorate of State Hydraulic Works (DSİ) and General Directorate of Agricultural Enterprises (TİGEM) in a 22 Mil ha area (Anonymous, 1998). Researches show that erosion has resulted in a loss of 90.0 x 10^6 t plant nutrients, which is equivalent to losing 500 x 10^6 t of soil or 2.5 cm of soil layer from 400.000 ha of land; or loss of 1.4 x 10^9 t upper soil layer (Anonymous, 2003b; Çiftçi, 2004). Besides, for the optimum agricultural application of soil processing, cultivated fields should not have a gradient higher than 12% (Kün & Genç, 1973; Çiftçi, 2004). Arable or cultivated lands are also becoming marginal, resulting in an increase of 26.6-27.9 x 10^6 ha. This includes soils belonging to Class I-IV (Table I), which constitutes 1.5 x 10^6 ha of forests and heathery and 61.0 x 10^6 ha of which is used for agriculture despite being un-suitable for cultivation (Cangir & Boyraz, 2005). According to research findings, incorrect and inappropriate land use, or mismanagement of cultivated agricultural area, accounts for 2.239,467 ha. Approximately 1.9 x 10^6 ha can be re-earned by using the fallow lands (Cangir & Boyraz, 2005). The overall figure for cultivated fields excluding fallow lands was 18 Mha in 2001 and 18.148 ha in 2005 in Turkey, with an increase of 61 ha (Table I) (Anonymous, 1986-2005; 2001a). Around 20 Million ha of land is lost and some 75% is degraded due to erosion in Turkey (Anonymous, 2006b). Likewise, it affects 81% of the total land surface at varying levels of severity, including 73% of cultivated land and 68% of prime agricultural land (Classes I-IV) (Table I) (Çiftçi, 2004; Anonymous, 2006b).

Similarly, stream bank erosion affects 57.1 Mil ha, while wind erosion degrades another 466,000 ha, resulting in shifting of more than one billion tons of soil each year in Turkey (Kün, 1983; Anonymous, 2003b & 2008b). The proportion of areas open to erosion is at a critical level in some provinces of Turkey such as "Konya". This indicates that agricultural land in such provinces mostly consists of difficult-to-hold soils on steep slopes, where agricultural plots have been created through deforestation. According to literature, soil erosion is very high in Asia, Africa and South America averaging 30-40 t ha^{-1}/years (Barrow, 1991; Flanagan *et al*., 2008). Therefore, more agricultural extension (education) is necessary in order to prevent extreme grazing, irrigation, salinity, degradation, illegal deforestation and illegal construction of houses on deforested land, all of which leads to increased erosion (Kün & Genç, 1973; Cangir *et al.,* 1995). Better education can also promote the correct use of cultivated lands. In order to increase yield, we must not encourage monoculture with emphasis on crop rotation, rather promote selection of proper production methods and design supported by appropriate labor force; proper cultivation planning; marketing of agricultural produce; use of modern agricultural techniques at the appropriate level, time and stage (s); appropriate and effective price policy/subsidies at the level of agricultural input (s) and growers agricultural activity (ies).

The share of total agricultural fallow and cultivated lands, during the investigated periods are given in Table I and Fig. 1. The general trend shows that agricultural product requirements have always been met mostly by expansion of the SA. There has been a constant increase in the SA and PL from (1944) onwards. Because of its implications for the contribution to agricultural production, the major aim is to maintain the soil humidity in fallow lands and keep the soil free from weeds (Tekinel & Benli, 1981; Tosun *et al.,* 1987) and movement of plant nutrients from soil to the plants (Keçecioğlu, 1981; Kün, 1983). Therefore, only 20% of the humidity could be retained in fallow lands, which again is insufficient (Yeşilsoy, 1981). Leaving land to lie fallow is percieved as an obligatory application in the arid zones, where amount of rainfall is lower than 400 mm. On the other hand, fallow applications make it necessary to separate 2.0-5.0 Mil ha lands every year and sometimes this increase can be much higher than the irrigated cultivated areas (Kün, 1983). Similarly, the following measures will better explain this issue: (i) to prevent fallowing, soil should be carefully plowed at the depth of (0-90 cm) without removing the upper soil layer, preferably at cultivation stage (Genç, 1976; Kün, 1983; Taysun *et al.,* 1995; Anonymous, 2004; Çiftçi, 2004) and all cereals must be cultivated in a crop rotation so that the crops sown in the following year receive an appropriate amount of fertilizers; (ii) the stubbles must not be burned after harvest; (iii) crop rotations should be preferred to proper types with their proper agricultural inputs (Bakır, 1981; Yıldız & Doğan, 1981).

Periodical agricultural analysis in terms of SA and PL according to selected field crops. These parameters can be examined in the 17 periods within the historical perspective

Table I. Land use in Turkey

Soil class	Total area (000 ha)	(%)
I	4 97 - 5 10	6.50 - 6.53
II	6 70 - 7 00	8.70 - 8.81
III	7 55 - 7 50	9.30 - 9.89
IV	7 16 - 7 50	9.41 - 9.50
V	165 10 - 130 00	0.20 - 0.22
VI	10 90 - 11 00	13.39 - 13.90
VII	36 25 - 36 80	47.59 - 40.00
VIII	3 20	4.16
TOTAL	**76 20**	**100.0**

Source: Ananda and Herath (2003); Cangir and Boyraz (2005)

Table II. Certified seed demand and distribution in selected field crops in between 2005-2007

Selected field crops	Renewal period (Year)	Needed seed (t)	Last 3 years average (t)	Distributed/ needed (%)
Wheat	3	66.00	183.65	32.44
Barley	3	243.33	23.08	9.48
Hybrid Maize	1	16.10	15.83	98.8
Rice	2	9.91	1.83	18.4
Chickpea	5	12.59	151	1.2
Dry Bean	5	2.58	4.0	0.2
Sunflower (Hybrid)	1	2.34	2.36	100
Potatoes	2	239.0	60.06	25.1
Soybean	1	1.07	440	41.0
Rapeseed	1	54	129	100
Peanut	1	1.14	55	4.9
Cotton (delint)	1	11.8	10.3	86.8
Vegetable	1	-	2.4	-
Alfalfa	4	2.22	2.20	96.7
Sainfoin	3	3.14	1.8	57.7
Vetch	5	6.95	2.3	36.6
Sudan grass	2	12	12	9.8
Sorghum x Sudan grass	2	-	180	-
Feed beet	2	48	50	100
Turf and Fescue	3	-	4.0	-
Sugar beet	1	1.302	1.71	100
TOTAL		**554.3**	**312.3**	**56.4**

Source: Anonymous (2008a)

(Tables I & III; Figs. 1-5). At the beginning of republic (1925-26), out of total arable land 65.8% (19.92 ha) was used for cultivation with a 34.2% (7.85 ha) share of fallows. This proportion changed to 78.6% (23.800 ha), 21.4% (4.91 ha) in 2001, 78.7% (23.830 ha) and 21.1% (4.87 ha) in (2005), respectively (Anonymous, 1923-1992 & 1986-2005). In earlier years, more emphasis was given to cereal cultivation followed by industrial crops and pulses with shares of 94.2, 5.2 and 2.6%, respectively (Figs. 2-4). But during 2001, this ratio changed to 7.6%, 7.5% and 8.6%, respectively and an increase was registered in irrigated lands from 8.8% to 24.9% (Anonymous, 1923; 1982; 1992; 2001 & 2003a). SA showed a fluctuating trend between (1925-26) and then (1942-46). The basic possible reason for these variations could be climatical conditions, legal regulations followed by agricultural policy (ies) and prices. A similar pattern was observed from (1957-61), with effective use of irrigation and fertilization. Especially due to the very negative impact of the agricultural machinery introduced as part of the Marshall Aid after 1954, many fields were opened for cultivation, mostly for cereals (Figs. 2 & 8). Possible reasons of these developments may be extreme

Table III. Three years comparison of the production and changing ratio in selected field crops

Field crops	Production years			Changing (%)
	2006	2007	2008	
Wheat	20.01	17	18	3
Maize	4	4	4	18
Rice	700	648	766	18
Barley	10	7	6	-18
Rye	271	241	256	7
Oats	209	189	209	11
Potatoes	4	4	4	-1
Dry Onion	1.8	1.9	2.1	12
Chickpea	552	505	536	6
Bean	196	154	160	0.3
Red Lentil	580	50	110	-78
Green Lentil	42	27	26	-2
Sunflower	1	854	1025	20
Tobacco	98	75	100	34
Sugarbeet	15	13	15	23
Seeded Cotton	3	2	3	-9
Capsule Popy	27	8	10	23

Source: Anonymous (2008a)

expansion or widening of the cereals' SA during (1957-61) and (1967-71) (Figs. 1 & 2).

Similarly, positive effects of the climatic conditions, irrigation facilities/possibilities and increased fertilization played a dominant role between (1972-76) but not during the years (1977-81) (Fig. 1). The cereals' SA was not expanded, because of insufficient agricultural practices until (1997-01) (Fig. 2). Their SA decreased (-3.0%), but not for the PL (8.4%) for the periods (1997-01) and (2002-05) (Fig. 2). The main reason for this can be explained as "*increase in yield*". The findings for yield observed within this period support this view. Certainly, GAP, GLP, agricultural input usage, etc. were also affected. Within the same period, the pulses exhibited an opposite case (Fig. 4). Their SA was increased (125.0%), but PL was reduced (-67.1%). The reason for this reverse case can be explained with their "*yield sensitivity*". If there were any stress or restrictive factor in the growing medium, pulses may respond negatively; consequently, PL values can easily decrease. But industrial crop values' SA and PL (-17.0% & -18.0%, respectively) were recorded as negative and decreased (Fig. 4). Fodder and forages generally showed a negative reduction due to use of agricultural input (s), which varied between -65.0% and 178.0% (Fig. 5). Due to un-available data for the comparison with (2002-05) and subsequent years, related comparisons were not possible. In addition, due to the negative effect of global warming on all cereals, SA, PL and yield levels of these were diminished noticeably in (2007) (Table II & Fig. 5). This effect is being estimated generally as known 0.7-39.1% for the SA and PL (Anonymous, 2008a). According to statistics, these values were calculated as 15.5% in cereals; 8.4-36.7% in pulses; 3.2% in tuber crops; 23.6% in oil seeds; 0.7% in vegetables and 8.4% in fruits. As for main field crop groups, they were calculated as 13.9% in wheat; 23.5% in barley; 7.2% in maize; 6.9% in rice; 21.3% in beans; 8.4% in chickpeas;

Fig. 1. Agricultural land distribution

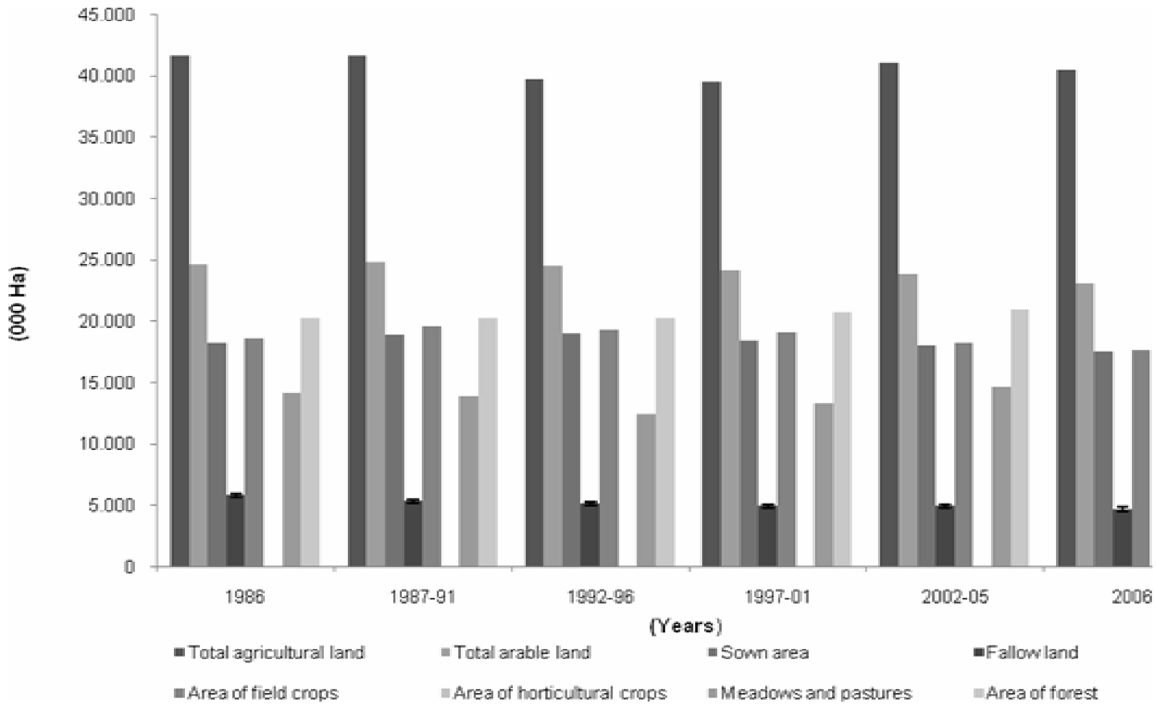
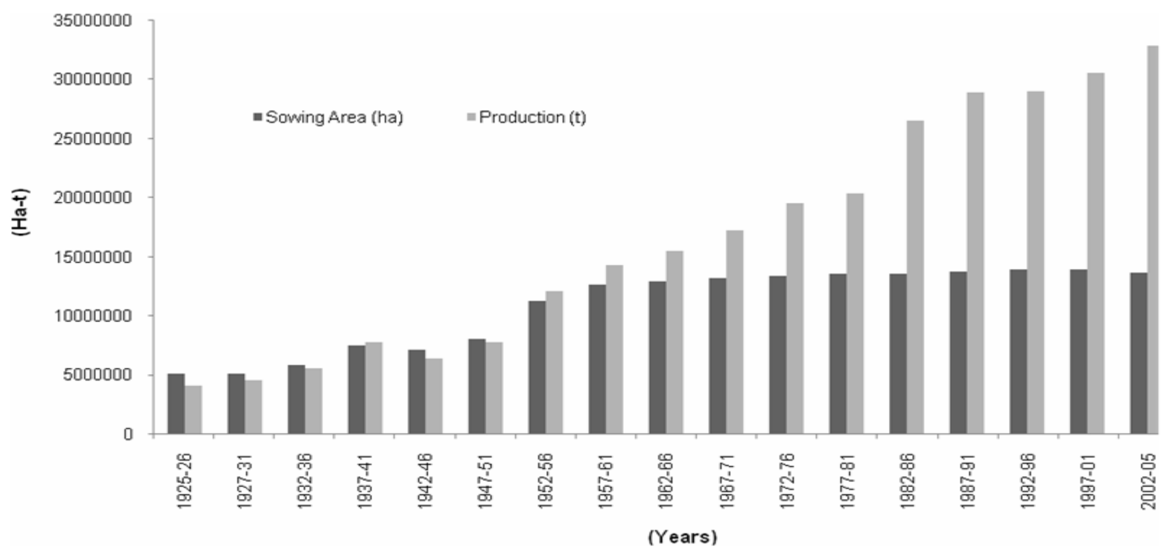


Fig. 2. Area under cereals in Turkey during 1925-26 and 2002-05



12.4% in red lentil; 36.7% in green lentil; 3.2% in potatoes; 23.6% in sunflower; 18.5% in tobacco; 14.1% in sugar beet and 10.8% in seeded cotton (Anonymous, 2008a). During the transition period of (1947-51), SA increased, but afterwards gradually decreased.

It was dramatically reduced to the investigated parameters and a similar declining trend was observed from (1992) to (1996). The situation is interesting for the pulses. Between [(1925-26) & (1927-31)]; SA was decreased mainly due to insufficient agronomic practices, but parameters of the (1932-36) and (1937-41) were also negative (Fig. 5). The most possible reasons for these negative developments could be market size and availability, agricultural practice inadequacies and lack of knowledge regarding their proper cultivation. Within 12 years between (1942-46), (1947-51) and (1952-56); SA increased then became steady and again increased up to a positive level. Some reasons for these fluctuations were better agricultural practices, sufficient knowledge of the cultivar (s) or genotype (s) and adequate water use for irrigation. After this period, SA gradually reduced to (1962-1966) levels due to the selection of appropriate cultivar (s)

Fig. 3. Area under industrial crops in Turkey during 1925-26 and 2002-05

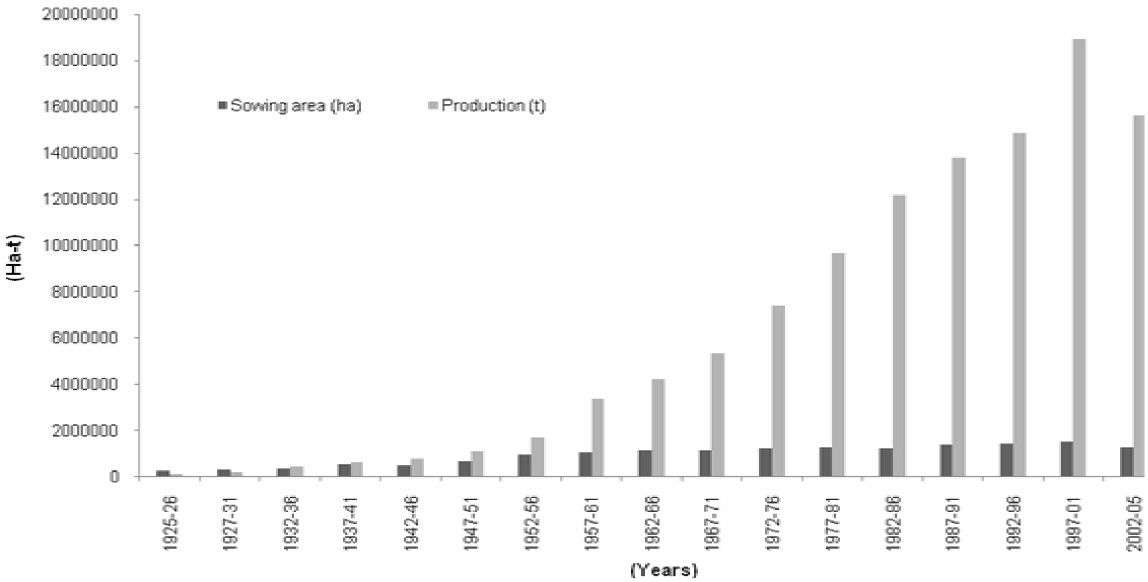
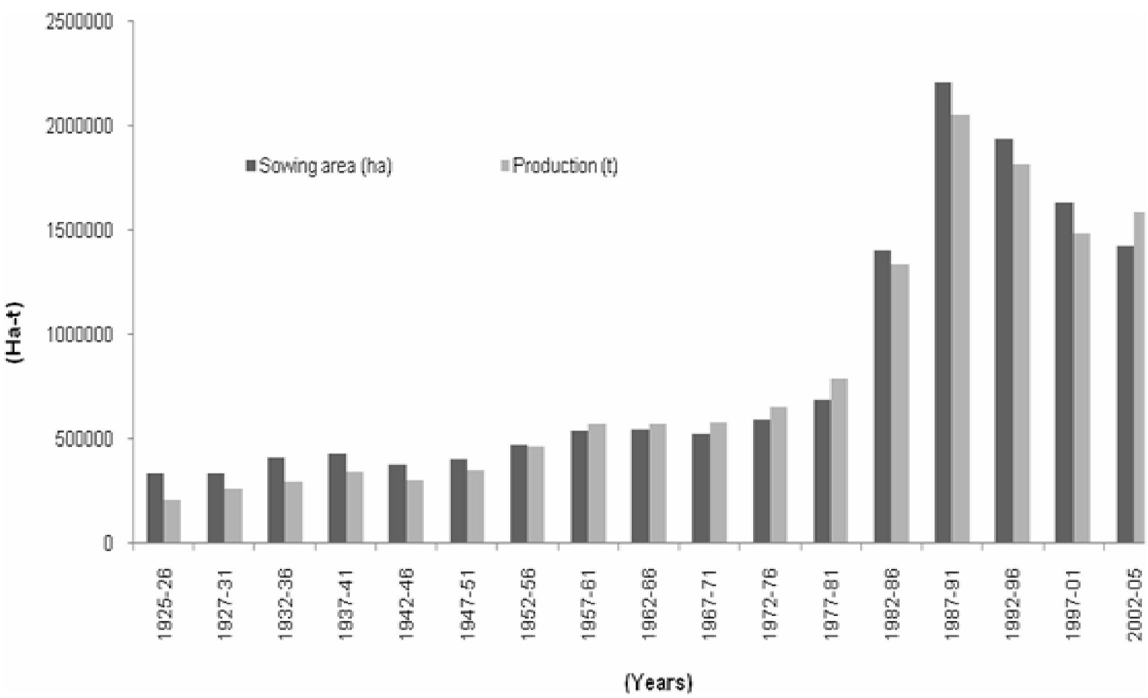


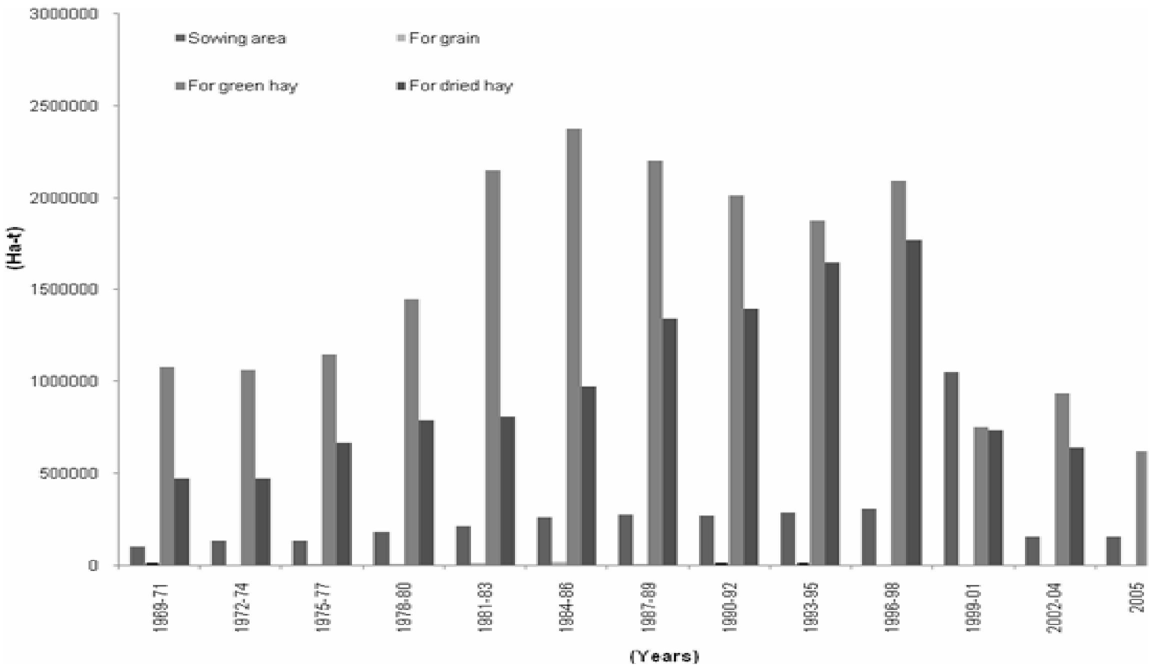
Fig. 4. Area under pulse crops in Turkey during 1925-1926 and 2002-2005



and un-favourable weather conditions. Generally, PL progressed at a regular trend from (1957-1961) with similar increments, except for (1937-1941) (Fig. 1). For fodder and forage cultivation, SA showed an increase in the first seven-year periods [(1952-1956) & (1977-1981)], then declined in the second four-year periods [(1982-1996), (2002-2005)] due to irrigation, price, fertilization, pesticide use, support policies, etc. PL generally increased except for (1952-1956), (1977-1981) and fell during the subsequent period. Irrigation facilities and possibilities, good agricultural/laboratory practices (GAP & GLP) and price/support/marketing policies were especially effective instruments during the aforementioned eras.

Cereals. Turkish agriculture, especially cereal production is heavily dependent on seasonal rainfall. Because most of the fields depend on rainfall, production varies considerably from year to year. Therefore, farmers traditionally leave fallow for a year to allow water to accumulate in the soil (Kün, 1983). However, the government encouraged soybean, fodder and forage cultivation in 1987 by asking

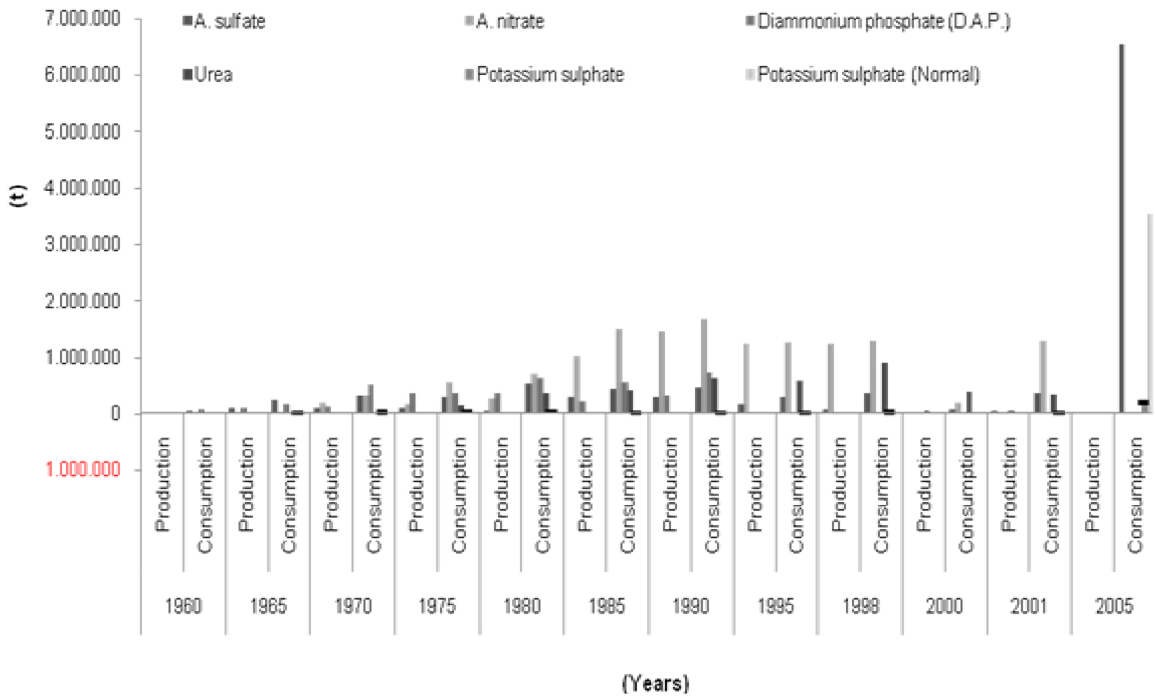
Fig. 5. Area under fodder and forages in Turkey during 1925-1926 and 2002-2005



growers to join in a partnership known as the "*Secondary Crop Research and Extension Project*" (Anonymous, 1989; Açıkgöz *et al.,* 2005). With these accelerative techniques implemented by growers, the SA and PL values increased rapidly and were recorded as 112 ha and 250 t, respectively in (1987) (Table I; Figs. 1 & 2). When these subsidies were discontinued for soybean cultivation as a secondary crop, the SA and PL values decreased noticeably (Anonymous, 1989 & 1986-2005). The integration of forage crops into crop rotation and the elimination of fallow periods offer the possibility of increased soil fertility and moisture retention. During (1925-2001), we find increased cultivation of small and coarse grain cereals (wheat, oat, rye, barley, maize, rice, pearl millet, proso millet, foxtail millet & canary grass) from 62.9% to 86.4% (Fig. 2). There is an increase of 71.0% during 1930-2001 in SA of wheat, which is now cultivated on 9.4 Mha of land. If we consider the parameters of (1925-26) as 100, then we find an increase of 288.0% in the SA during (1992-1996) and increase of 1.666% in the PL during (1997-2001) (Fig. 2). This increase was mainly stimulated by agricultural mechanization, use of chemical fertilizers by opening wide areas of land for wheat cultivation and sowing high-yield, certified seeds using modern agronomic practices. We find an increase in wheat production during this era; we do not find a clear increase during (1957-1961). However, during (1977-1981) we found an increase of 52.0% with a PL of 16.8 x 10^6 tons. There was a further increase of 14.0% with a PL of 19.5 million tons during (2001) (Fig. 2). As a result of the researched time periods, especially after (2001), but not (2007), the SA and PL values clearly showed an increase. Analysis of the period showed that increase in production was mainly affected by genotype, agricultural practices, manpower utilisation and economic factors to cultivate the crop. In terms of yield, an 80-years period showed a general trend similar to production. Trends in wheat yield can be better understood by analysing data in the periods post (1925-1936), (1952-1961) and (1977-1981). During (1925-1936), cultivation was severely influenced by natural conditions, whereas the (1952-1961) was influenced by intensive farming, afforestation and cultivation on heath lands. The cultivation during the (1977-1981) was supported by favourable climatic conditions and use of better agronomic practices according to region and aim, subsidies, price and marketing activities, etc. Farming distribution in Turkey depends on ecological and climatic conditions, proper agricultural applications, irrigation sources/facilities and market prices and/or effective agricultural policy (ies).

Industrial crops. Agricultural trend for these crops has been given as the SA and PL in Fig. 3. As seen for the SA and PL values, they were followed closely from (1942-1946), 61.3-41.5% and 82.0-48.1%, respectively. After this period the PL value clearly increased by 56.9% between (1952-1956). Later it increased very noticeably (102.0%). This increase continued until reaching a peak point during the 1997-1901 and immediately decreased (-83.0%) later. In terms of the SA, the agricultural trend was not different from the PL in (1942-1946). After this period, the SA slightly increased (34.2%) during (1952-1956) (Fig. 3). For the 9 periods, the SA changed much more, but slightly decreased after the (1997-1905) (-17.0%). A greater diminution in the production parameter was recorded compared to the SA. This implied that all of the industrial crops are very sensitive to agricultural inputs. Their yield

Fig. 6. Certain fertilizer usage in Turkey during 1925-26 and 2002-05

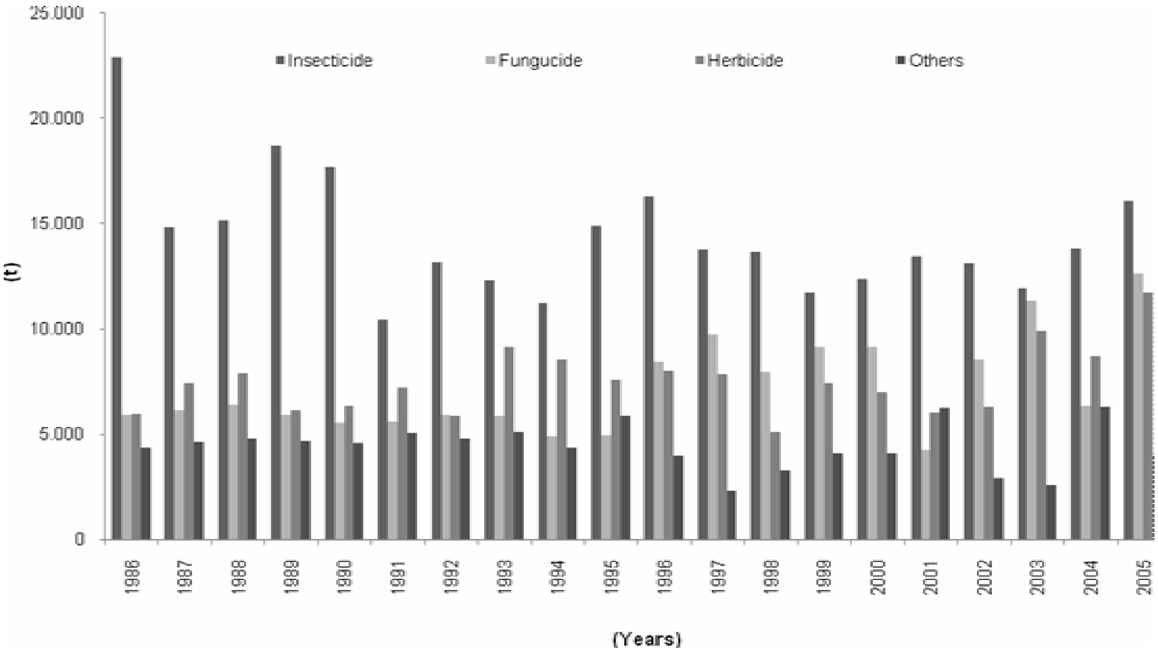


level is very high. GAP, with its provinces, is a great possibility for the industrial crops (especially oil crops) (Kolsarıcı *et al.,* 2005). Similarly, cultivar or seedling or a seed system must be clearly established according to regions (Günel *et al.,* 2005).

Pulses crops. Turkey is the main producer of pulses in the Middle East (Biçer *et al.,* 2004; Özgün *et al.,* 2004). There was an increase in the SA and production of common beans, which was made possible by an increase in yield per unit area (Fig. 4). There was a very sharp increase in yield during (1962-1966) and (1982-1986). The SA of peas shows a fluctuation during (1962-1966) and general yield reduction thereafter. The main factors affecting reduced yield were farmers' lesser knowledge of the agronomy of the crop, followed by poor storage and knowledge of cultivation techniques, sowing under improper ecological conditions, poor fertilization and irrigation (Çiftçi, 2004). We noted lower production of the crop before (1952-1956); however, post (1962-1966) shows an increase. During (1925-1926), it yielded 835 kg/ha, which increased to 1.752 kg ha^{-1} during (1952-1956). Increased yield was made possible by use of high-yield, quality seed and adaption of modern farming practices with increased demand. We find constant increase in the SA and PL of chickpea before (1967-1971). The mean yield of chickpea during (1947-1951) was 794 kg ha^{-1}, which increased to 1.092 kg ha^{-1} during 1982; however, this was followed by a fall to 931 kg ha^{-1}. Important factors contributing to yield erosion of this high protein crop are failure to use high-yield, certified seeds; sowing at improper time; inadequate farming practices and un-availability of a proper market for the produce's sale (Fig. 4) (Kutlu & Açıkgöz, 1980; Şehirali *et al.,* 1995). Another important protein rich crop is lentil (Biçer *et al.,* 2004) and all values for the SA and PL parameters were realized very limited until (1947-1951). Thereafter, this crop showed a constant increase in the two parameters and reached its maximum during (1987-1991); un-fortunately, a sharp fall occurred in both parameters (Fig. 4). This was mainly due to non cultivation of high-yield varieties, harvesting and threshing losses, change in eating habits, effects of socio-economic and marketing conditions, lack of awareness of export potentials, insufficient labor force, cultivation on marginal lands, etc. There was no sharp difference in the production of broad bean and cowpea; however, broad bean is more promising, when compared to cowpea. The PL reached its maximum during (1937-1941) and (1992-1996). It fell thereafter due to reduced demand resulting in lowering of sowing and production. We found a sharp decrease in the SA and PL of cowpea, but with increased yield until (2001) (Fig. 4).

Fodder and forage crops. There was no distinct progress in the production of fodder and forage crops before (1975-1977), but a sharp rise after the (1981-1983) period and a slight increase in grain yield after (1981-1983) (Fig. 5). We can divide the production of hay into two periods: (1969-1980) and (1980-1998). The production level of the former was equivalent to half of the latter period (Fig. 5). However, straw production showed an increase after (1969-1971), reaching its maximum during (1987-1989) and the potential was maintained until (1993-1995). It fell thereafter but showed an increase in recent years once again. These fluctuations in yield level are mainly due to reduced

Fig. 7. Certain plant protection chemical(s) usage in Turkey during 1925-26 and 2002-05



orientation, socio-economic conditions, ecological conditions, failure to use high-quality and high-yield seeds, irregular fertilization, crop protection measures, characteristics of the cultivated lands, etc. (Fig. 5).

Some Vital Factors Governing Agricultural Input Use

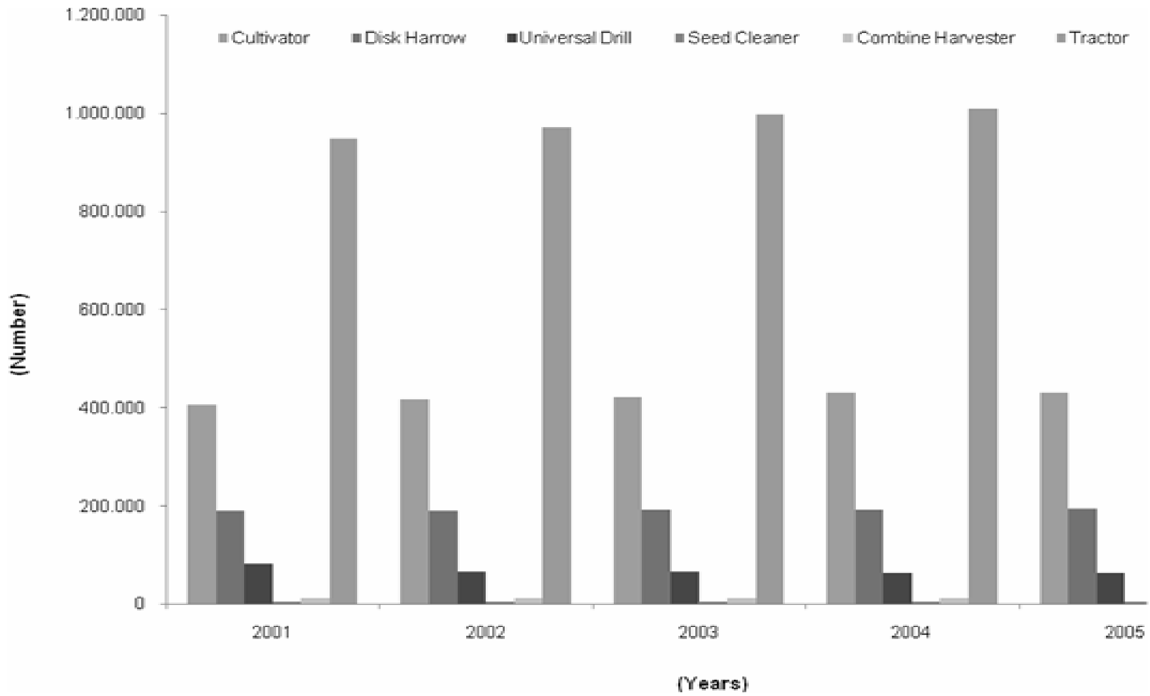
Seed and seedling. The Turkish National Seed and Seedling System was officially governed by the Ministry of Agriculture and Rural Affairs (TOK) for the production and supply of all crops. They list the "*The National Seed and Seedlings Catalogue*" with their scientific names and recommended regions and publishes every may each year in the official journal.

In rural areas, villagers generally grow local varieties, landraces or a combination of these; consequently, they achieve a lower yield level (Şehirali & Özgen, 2007), but research findings showed that high-quality seeds increase the yield by at least 20.0% - 30.0% (Kün, 1983). In the early of 1980s and even as late as the mid 1980s, the national seed industry was dominated by the state sector and seed trade was heavily regulated. Government deregulation has dramatically changed both the composition and structure of the seed industry. The private sector is encouraged to participate and invest in plant breeding, infrastructure development and technology transfer (Anonymous, 2001b).

Irrigation facilities/possibilities. Turkey is quite a poor country compared with the world averages, but it is the richest country in the Mediterranean and Middle East regions for water sources. However, the distribution of water is generally irregular and costly; therefore, the country is seriously affected by dry weather conditions, especially in the summer (Anonymous, 2006b). Turkey's annual precipitation mean value is 640-678 mm, with an evaporation of 245 mm (Kanber *et al.,* 2005). A proportion of 41 x 10^9 m^3 leaches to underground water reservoirs and 18.605 x 10^9 m^3 flows to lakes or seas (Tekinel *et al.,* 1981). According to studies, these values remained more or less the same to this day (Kendirli *et al.,* 2004; Çakmak *et al.,* 2005). Furthermore, except for Black Sea-Belt, which receives 95% of precipitation in Anatolia, there is great water deficiency throughout (Kün & Genç, 1973). Only 4.0% of land area was irrigating in (1946-1947), this value was increased to 20.672.817 ha in 1980, to 4.747.000 ha in (1999) and to 4.95 Mil ha in 2000 (Yüksel *et al.,* 1995; Anonymous, 2003a). Records indicate that 2.672,817 ha of irrigated land in (1980) were raised to 4.747,000 ha by 1999 (an increase of 67.5%). Out of 85 Mil ha of land, the state could only open 49.0 x 10^6 ha land to irrigation in (2006) (Çelik *et al.,* 2008). From (2007) up to now, only a 4.8 Mil ha land could be irrigated. While there are about 8.5 Mil ha of land under potential perennial irrigation, only about half of this area, 4.5 Mil ha, has been equipped with the required irrigation infrastructure. In the mid-1980s, observers estimated that private irrigation, relying on weirs and small barrages to direct water into fields, reached up to 1 Mil ha. In addition, some farmers pumped water from wells to irrigate their own fields. There was no large-scale irrigation system in Turkey until the (1960s).

Irrigation projects are dispersed throughout the country, but most are concentrated in the coastal regions of the Aegean and Mediterranean seas, where the longer growing seasons are particularly favorable for crops. The most important project of the late (1980s) and early (1990s) was the Southeastern Anatolia Project (GAP), which was linked with the 2,400 megawatt Atatürk Dam on the Dicle River and is expected to irrigate 1.7 Mil ha, when completed in (2020) (Ulukan & Güler, 2000). GAP irrigation is also

Fig. 8. Certain agricultural mechanisation usage in Turkey during 1925-26 and 2002-05



expected to increase wheat and barley production by more than 50% and cotton by more than four times by (2005), thus increasing national cotton production by 60%. The GAP covers 9 provinces (Namely, Adıyaman, Batman, Diyarbakır, Gaziantep, Kilis, Mardin, Siirt, Şanlıurfa & Şırnak) with more than 35.000 ha in the Fırat and Dicle rivers' basins and upper Mesopotamian plains (Anonymous, 1998; Taşdemir, 2008). Tekinel *et al.* (1981) reported that 26 Mil ha land could be irrigated in Turkey, but as a result of poor planning, this is declared as 28 Mil ha and includes all those irrigation sources un-suitable for irrigation. Irrigation water was available to 3.7 Mil ha in the mid-1990s, although the irrigated area is about 4.9 Mil ha (57%) (Çelik *et al.,* 2008). The average rainfall is about 640-678 mm, varying considerably from region to region: the central plateau and southeastern plateau receive an average of 250 mm; the northeastern Black Sea coast receives 2,500 mm (Çiftçi, 2004). In addition, the amount and duration of rains vary sharply from year to year, thus causing sharp fluctuations in harvests. Due to non-availability of irrigation water, farmers in that region can only harvest one crop per year. Irrigation will probably enable expansion to two or even three harvests. Rainfall tends to be relatively abundant and regular in the coastal areas, because of the mountains behind them. However the bulk of agricultural land on the Anatolian plateau receives less rainfall because the plateau is ringed by mountains. Although rainfall on the plateau varies considerably among regions, it is barely adequate over large areas. Crop rotation, which is largely un-known in areas without irrigation, has been introduced in GAP region.

Fertilizer and fertilization. In Turkey, commercial organisations or factories produce fertilizers. Use of chemical fertilizers during (1946-1947) was 230.000 kg. This increased to 16.7 x 10^6 t during (1951-1952) and 5.1 x 10^6 kg during (1962-1963) (Fig. 6). In addition, the amount and duration of rains vary sharply from year to year, thus causing sharp fluctuations in harvests. Due to non-availability of irrigation water, farmers in that region can only harvest one crop per year. Irrigation will probably enable expansion to two or even three harvests. Production and consumption of fertilizer was high during the early development period, but slowed down later on. During the seventh five-years plan, it was reduced due to a decrease in acquisitive power and gradual with drawal of government support (Aktaş & Kaplan, 1985). Use of 3.4 kg d^{-1} fertilizer for cereals during the early period of (1973-1977) increased to 8.1 kg d^{-1} and 13.1 kg d^{-1} and then to 13.9 kg d^{-1} for industrial crops during (1993-1997), with maximum use of ammonium nitrate followed by urea, diammonium phosphate (DAP) and ammonium sulfate (Fig. 6). The greatest consumed of fertilizer is observed in the industrial and vegetable crops. It is expected that this will increase further once GAP is completely implemented. In terms of field crops, the highest fertilizer use per unit area is observed in the case of cereals. Its use was limited to 41.4 kg ha^{-1} during, 1980. This increased to 82.5 kg ha^{-1} during the 1999. Although a considerable increase in fertilizer use can be observed. The research shows that production could be increased by 50% and occasionally up to 80% with the aid of fertilizers (Fink, 1991; Anonymous, 1999; Çolakoğlu *et al.,* 2003). For example, about 40% of wheat produced in developing countries is irrigated. However, efficient use of water and nutrients (especially nitrogen fertilizer) under irrigated conditions in these countries is low compared to international standards. In (1997), developing countries used more than 50.10^6 m^3 of nitrogen fertilizer, worth more than 16.0 x 10^9 U.S. dollars (Anonymous, 1997).

Plant protection. Change in the status of any of the biotic and abiotic factors could result in an outbreak of disease, consequently affecting the yield (Ulukan, 2006; Ulukan & Özgen, 2008). This makes it necessary to breed insect, pest and disease resistant varieties as well as, adopt integrative crop protection techniques to remove these factors (Kün, 1983; Anonymous, 2004). Areas with intensive mechanised farming use agricultural chemicals extensively, resulting in improved yield quality and quantity (Delen, 2002). Most of these chemicals leave behind polluting residues that affect humans and wildlife in one way or another. Furthermore, pesticides are manufactured on a small scale in Turkey and generally prepared and sprayed under un-controlled conditions without taking precautions. This behavior results in un-healthy control of insects, pests or weeds. Similarly, care must be taken against the residual effects of thiophanatemethyl, carbendazim, methyl bromide and other chemicals that may last from 6 months to 2 years (Edwards, 1975; Seiler, 1975; Anonymous, 1987; Van Wanbeke, 1992; Delen, 2002). In Turkey during (1986-05), only insecticide use was clearly shown to diminish during the nineteen years (Fig. 7). Within the same period, fungicide use evidently increased. Herbicide use also greatly increased, especially in 2005. Generally, we observe an increased use of fungicides and herbicides, which showed the preference of farmers to combat diseases and un-wanted plants (weeds) mainly during the production.

Agricultural mechanisation. The number of wooden plows dramatically decreased, but the number of cultivators clearly increased. This increment has been the main cause of soil erosion in the agricultural field in Turkey (Fig. 8). However, the number of disk harrows, seed cleaners and tractors does not follow the same trend and they also evidently increased until (2005). Some reasons of this increase could be good agricultural practice, achievement of higher agricultural, ecological and technological levels; requisite labour force or marketing/production processes chain; grower's education and level of income. Beyond its contribution to national agriculture, this vital input is expected to further develop with the development and completion of the GAP. Poor foreign investment in the tractor industry resulted in tractor production during (1950s). During the 1950s, out of the total cultivated land only 9.0% was cultivated by tractors. This percentage increased to 15.0% in (1962) (Fig. 8). Agricultural mechanisation covers every type of energy source, system or technique for crop production. All machines like tractors, threshers, plows or the like used in agriculture make a set; any problems in any of these also affects performance of the others. World tractor demand has reduced during the last ten years; it was 550.0 x 10^3 per year as of 1989. Support for agricultural machinery, crop rotation, the use of quality, multifunctional tools and equipment as a part of modern agricultural techniques are necessary for improved performance (Kün, 1998; Evcim *et al.,* 2005). But, financial constraints always undermine agricultural machinery use in Turkey (Zeren *et al.,* 1995).

CONCLUSION

According to examined parameters and selected periods with their maximum (negative), we review the following values: For the SA (ha): (a) In the pulses -125.5% during (1997-2001) and (2002-2005); (b) In the industrial crops -61.3% during (1925-1926) and (1927-1931); (c) In the cereals -40.7% during (1947-1951) and (1952-1956); (d) In the fodder and forage -36.0% during (1962-1966) and (1967-1971). For the PL (t): (a) In the fodder and forage 366.0% during (1992-1996) and (1997-2001); 180.0% during (1957-1961), (1962-1966), 148.1% during (1967-1971) and (1972-1976) (dry hay, grain, green hay, respectively); (b) In the pulses crops 166.0% during (1992-1996) and (1997-2001); (c) In the industrial crops 103.0% during (1927-1931) and (1932-1936) and (d) In the cereals 35.0% during (1932-1936) and (1937-1941) (Anonymous, 1923-1992; 1982-2001; 1986-2005 & 2008a).

World agriculture faces a serious decline in this century due to global warming unless emissions of carbon dioxide and other greenhouse gases such as CH_4, CFC, O_3, etc. are substantially reduced. In terms of this phenomenon, Australian agriculture is a good example (Rajin *et al.*, 2007). Factors limiting crop responses to climatical parameters may include plant adaptation to CO_2, source-sink relationships, pest-crop interactions, monocultures and site-specific characteristics such as soil structure, salinity, pH value, etc (Patterson & Flint, 1990; Bindi & Howden, 2004). In (2007), due to global warming's adverse effects, nearly all agricultural activities were seriously and negatively affected in Turkey. Exceptions were the peanut (groundnut), sour-cherry, walnut, grape and green tea crops. Similarly, in the cereals 15.5% (in wheat 17.200.000 t with 13.9%, in barley 7.300.000 t with 23.5%, in grain maize 3.500.000 t with 7.2% & in rice 648.000 t with 6.9%); in some major pulses 8.4 - 21.3% (in bean with 21.3%, in chickpea with 8.4%, in red lentil with 12.4% & green lentil with 36.7%); in major tuber crops 3.2 - 23.6% (in potatoes 4.200.000 t with 3.2%, in sunflower 854.000 t with 23.6%); in major industrial crops 10.8-18.5% (in tobacco 80.000 t with 18.5%, in sugar beet 12.4 x 10^6 t with 14.1%, in unginned cotton 2.2 x 10^6 t with 10.8%); in vegetables with 0.7% and in fruits with 4.3% were found as decreasing amounts and percentages (Anonymous, 2008a). These decreasing percentages were realized as follows, but the PL in the peanut was increased approximately as 86.000 t with 11.6% (Anonymous, 2008a). Likewise, a foundation for advanced agriculture has been laid and progress is constant, no matter at what speed. In addition to modern farming techniques, Turkey also needs to introduce and establish agricultural crop insurance, producer unions with the network system, agricultural exchange, organic farming, bio-systems, bio-informatics, good agricultural practices (GAP), good laboratory practices (GLP), Geographical Information Systems (GIS), Global Positioning Systems (GPS), etc. (Evcim *et al.,* 2005). As a result of the drought; there will be an inevitable diminution of production capacity. When climate change is taken into consideration, possible drought (or excessive hot weather effects, regional or local doughtiness, stress conditions, natural disasters such as pests, epidemics, earthquake, hail, fog, etc.) must be included in the agricultural insurance system. If possible, agricultural inputs should be distributed by these unions directly. Immediately, a "*Water Law*" should be accepted; the size of the agricultural enterprises must be increased and their capital problems must be solved; effective agricultural production planning must be made and soil mismanagement must be prevented; effective measures must be introduced to combat erosion; necessary measures must be taken to increase yield levels; grower's organisations must be promoted and the sector must be supported significantly, sufficiently and promptly; related investments must be increased; obligatory agricultural insurance must protect growers from losses due to natural (heavy rains, lightning, drought, earthquake, etc.) and non-natural disasters; sources of soil and water pollution must be eliminated; marketing channels must remain open between producer and consumer; research and development activities must be carried out with collaboration among authorised organizations according to requirements and improved, modern, effective agricultural trainings, demonstrations and extension programmes must commence using suitable methods.

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