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ORIGINAL PAPER

Turkish seed sector: Current situation and future directions

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Abstract

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Seeds are the main factor in agricultural production both affecting yield and also productivity and profitability. Turkey exists in top ten agricultural economies in the world. Turkish seed sector has got so much progress in last ten years and seed companies and also certified seed production have been increased triple since 2007. In addition to recent improvements and development in agriculture, the foundation of Turkey Seed Union (TÜRKTOB) based on Seed Law No.5553 prepared by Ministry of Agriculture played very important and key role for this progress. Turkey Seed Union is a professional, legal and public organization to design and regulate seed sector with the authority granted by this law in Turkey. TURKTOB consists of seven sub unions: Plant Breeders (BISAB), Sapling Manufacturers (FUAB), Seedling Growing (FIDEBIRLIK), Ornamental Plants Producers (SUSBIR), Seed Distributors (TODAB), Seed Industrialists and Producers (TSUAB) and Seed Growers (TYAB), which serve as an umbrella and have the legal power to ensure cooperation and solidarity among themselves, to provide professional solidarity among those operating in the industry with the development of the seed sector and to fulfill the tasks assigned by the legislation. After forming this organization, many new local seed producer companies were set up and reached 858 in July of 2018 in Turkey, while many big international seed companies have been merging in the recent years worldwide. In 2017, Turkish certified seed production reached over one million tons (it was 300.000 ton in 2007). Furthermore, local seed companies conducting breeding programs reached over 100 tons too, mostly working on field crops, especially cereals. Turkey has very suitable climate and large lands to produce higher quality and healthy seeds, so many international seed companies prefer producing basic and certified seeds in Turkey, then export them to other countries, especially hybrid seeds, both of field and vegetable crops. Because of both the geographical location advantages and the young generations in Turkey, Turkish seed sector is very dynamic and has big potential to increase rapidly and steadily with big supports and subsidies by the government. The main future goal of the Turkish Seed sector is existing in top five countries and has more rates in world seed trade in the next 5 years.

Key words: Seed, Turkey, Seed Sector, Seed production, Seed Legislation, Plant Breeding

Introduction

Turkey is a bridge between Asia and Europe and has variable landscape, ecology and climatic conditions. Therefore, it has different agro ecological zones where many kinds of crops and plants are grown. Furthermore, Turkey is in the top ten agricultural economies based on these advantages and having large arable lands, meadows, etc.

Agricultural Production in Turkey

Turkey's surface area is 81.5 million ha, and is 1,660 km long and 550 km wide. Agricultural lands are more than 38 million ha in Turkey and 24 million ha of arable land is used for 40% of field crops, mainly cereals; 9% for fruit; 2% for vegetable; 10% fallow lands; 14 million ha of meadow-pasture lands (Tables 1 and 2).

Turkish agricultural production value is more than 32 billion USD; field crops 13 billion USD, fruit production 11 billion USD, vegetable production 8 billion USD. The Turkish agricultural sector is an internationally competitive seed industry based on the private sector which has a strong and sustainable infrastructure and the higher level of professional organization and a corporate identity (Aksoy et al., 2017, Anonymous 2017a, b).

Table 1. Main figures in agricultural lands (1000 ha)

Years	Total utilized agri-cultural land	Cereals and other crop products		Vegetable and Gardens	Orna-mental plants	Fruits, beverage and spice crops	Land under permanent meadows and pastures
		Sown area	Fallow land				
2010	39 011	16 333	4 249	802	-	3 011	14 617
2011	38 231	15 692	4 017	810	4	3 091	14 617
2012	38 399	15 463	4 286	827	5	3 201	14 617
2013	38 423	15 613	4 148	808	5	3 232	14 617
2014	38 558	15 782	4 108	804	5	3 243	14 617
2015	38 551	15 723	4 114	808	5	3 284	14 617
2016	38 328	15 574	3 998	804	5	3 329	14 617
2017	37 992	15 532	3 697	798	5	3 343	14 617

Source: Ministry of Food, Agriculture and Livestock, 2017

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Table 2. Agricultural lands *(excluding meadows-pastures and ornamentals)* (1000 ha)

Agricultural land	1990		2002		2014	
	(000 ha)	%	(000 ha)	%	(000 ha)	%
Field Crops	18.868	67,7	17.935	67,5	15.789	66,0
Fallow land	5.324	19,1	5.040	19,0	4.108	17,2
Vegetable	635	2,3	930	3,5	804	3,4
Fruit	3.029	10,9	2.674	10,1	3.243	13,5
TOTAL	27.856	100,0	26.579	100,0	23.944	100,0
Agricultural land	2015		2016		2017	
Field Crops	15.723	66,0	15.575	65,7	15.532	66,4
Fallow land	4.114	17,2	3.998	16,9	3.697	15,8
Vegetable	808	3,4	804	3,4	798	3,4
Fruit	3.284	13,7	3.329	14,0	3.343	14,3
TOTAL	23.934	100,0	23.706	100,0	23.370	100,0

Source: Ministry of Food, Agriculture and Livestock, 2017

Wheat is the main crop grown in Turkey, followed by barley, sunflower, corn, cotton and sugar beet among the field crops (Table 3). On the other hand, tomato, water melon, onion, melon and cucumber are the essential vegetable crops in Turkey (Table 4).

Table 3. Area and production of cereals and other crops (for selected products) (1000 ha)

Year	Wheat	Barley	Maize	Sunflower	Cotton (raw)	Sugar beets
Sown area (Da: 1000 m2)						
2011	80 960 000	28 688 331	5 890 000	6 557 000	5 420 000	2 972 648
2012	75 296 394	27 487 664	6 226 094	6 046 160	4 884 963	2 806 945
2013	77 726 000	27 205 100	6 599 980	6 097 839	4 508 900	2 913 282
2014	79 192 084	27 872 973	6 586 450	6 574 576	4 681 429	2 887 851
2015	78 668 874	27 835 830	6 881 699	6 853 174	4 340 134	2 744 873
2016	76 719 448	27 400 521	6 800 192	7 201 081	4 160 098	3 224 477
Production (Ton)						
2011	21 800 000	7 600 000	4 200 000	1 335 000	2 580 000	16 126 489
2012	20 100 000	7 100 000	4 600 000	1 370 000	2 320 000	14 919 940
2013	22 050 000	7 900 000	5 900 000	1 523 000	2 250 000	16 488 590
2014	19 000 000	6 300 000	5 950 000	1 637 900	2 350 000	16 743 045
2015	22 600 000	8 000 000	6 400 000	1 680 700	2 050 000	16 022 783
2016	20 600 000	6 700 000	6 400 000	1 670 716	2 100 000	19 465 452

Source: Ministry of Food, Agriculture and Livestock, 2017

Table 4. Production of vegetables (for selected products) (1000 ha)

Year	Tomatoes	Cucumbers	Melon	Water melon	Onion (Dry)
Production (Ton)					
2011	11 003 433	1 749 174	1 647 988	3 864 489	2 141 373
2012	11 350 000	1 741 878	1 688 687	4 022 296	1 735 854
2013	11 820 000	1 754 613	1 699 550	3 887 324	1 904 846
2014	11 850 000	1 780 472	1 707 302	3 885 617	1 790 000
2015	12 615 000	1 822 636	1 719 620	3 918 558	1 879 189
2016	12 600 000	1 811 681	1 854 356	3 928 892	2 120 581

Source: Ministry of Food, Agriculture and Livestock, 2017

Biodiversity in Turkey

Turkey is the land of origin of many crops, with huge genetic resources and very rich variability. There are seed and non-seed plant species in Turkey amounting to 11.707 (75% of Europe), 31.12% of them (3.649) are endemic. There are some economically important crops originating from Turkey, such as *Allium* (onion*), Avena (*oat), *Beta* (sugar beet*), Cicer (*chickpea*), Lens* (lentil), *Linum (*linen), *Medicago* (alfalfa), *Pisum* (pea), *Secale* (rye), *Trifolium* (trifolium), *Triticum* (wheat), *Amygdalus* (almond), *Cucumis* (cucumber), *Malus* (apple), *Pistachia* (pistachio), *Prunus* (plum), *Pyrus* (pear) and *Vitis* (grape).

On the other hand, some other crops also originated from Turkey, such as micro gene center too: *Amygdalus* spp., *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Cucurbita moschata* (pumpkin), *Cucurbita pepo* (squash), *Lens culinaris* (lentil), *Lupinus* spp. (lupen), *Malus* spp. (apple), *Medicago sativa* (alfalfa), other annual *Medicago* spp., *Onobrychis viciifolia* (sainfoin), *Phaseolus vulgaris* (bean), *Pistachia* spp., *Prunus* spp., *Pyrus* spp., *Trifolium* spp., *Vicia faba* (faba bean), *Vitis vinifera* and *Zea mays* (corn).

Seed Sector in Turkey

Turkish major structural reforms and adoption of free market economic policy in the early 1980s affected both the agricultural sector generally and particularly the seed sector. The national seed industry dominated by the public sector and seed trade was more liberated and started to developed (Bozkurt and Engiz, 2001).

Ministry of Food, Agriculture and Livestock **(MARA) is responsible for both regulating and controlling the seed sector in Turkey. The national seed industry operated within the framework of Seed Law No. 308 (21 August 1963) and Seed Law No. 3976 (21 February 1994) and The Crop Protection and Plant Quarantine Law No. 6968 of 1964 have regulated until 2008.**

In addition to recent improvements and development in agriculture, the foundation of Turkey Seed Union (TÜRKTOB) based on Seed Law No.5553 prepared by

MARA played very important and key role for this progress in 2008. Turkey Seed Union is a professional, legal and public organization to design and regulate seed sector with the authority granted by this law in Turkey. TURKTOB consists of seven sub unions: Plant Breeders (BISAB), Sapling Manufacturers (FUAB), Seedling Growing (FIDEBIRLIK), Ornamental Plants Producers (SUSBIR), Seed Distributors (TODAB), Seed Industrialists and Producers (TSUAB) and Seed Growers (TYAB), serving as an umbrella and having legal power to ensure cooperation and solidarity among themselves, to provide professional solidarity among those operating in the industry with the development of the seed sector and to fulfill the tasks assigned by the legislation (Aksoy et al., 2017, Anonymus 2017a, b).

Based on this law, the seed organization in Turkey is controlling via these key regulations in the Turkish seed sector:

- Regulation on the Registration of Plant Varieties (2008)
- Regulation on Authorization and Control in Seed Sector (2009)
- Regulation on Cereal Seed Certification and Marketing (2008)
- Regulation on Seed Potato Certification and Marketing (2011)
- Regulation on Beet Seed Certification and Marketing (2008)
- Regulation on Oil, Fiber, Medicinal and Aromatic Plant Seed Certification and Marketing (2008)
- Regulation of Fodder Crops and Pulses Seed (2015)
- Regulation on Vegetable Seedling Production and Marketing (2008)
- Regulation on Seed Controller (2010)
- Regulation on the Delegation of Authority in Seed Services (2008)
- Regulation on Characteristics of Specific Production Areas Where Growing Seeds and Determining the Principles to be Followed in These Areas (2008)
- Regulation on Plant Quarantine (2011)
- Regulation on the Plant Passport System and the Registration of Operators (2011)
- Regulation on the Transfer of Plant Variety, Candidate Variety and Breeding Material to Seed Institutions, the Sales of Seed Production and Marketing Right (2014)
- Regulation on Vegetable Seed Certification and Marketing (2008)

TSUAB, which is a professional organization with a public legal person, has the key Union consisting of the main seed companies. After constituting this organization, many new local seed producer companies were set up and reached 858 in July of 2018 in Turkey, while many big international seed companies have been merging in the recent years worldwide (Table 5). TSUAB members have

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the major share in the evolution of the Turkish seed sector to its actual situation today, and the organization was founded in line with the provisions of the Seed Law in 2008. There are 799 companies, which are national (93,4%), 33 multinational (3,8%) and 21 domestic-foreign partnerships (2,7%) (Aksoy et al., 2017, Anonymous 2017a, b).

Table 5. Number of TSUAB member companies by species

Crop groups	Quantity of member
Cereals	446
Industrial Crops	157
Potatoes	152
Fodder crops	129
Corn	83
Vegetable	234
Edible Pulses	97
Sunflower	53
Grass and ornamental plants	39
Sugar beet	15
Rice	37

Plant Variety Protection in Turkey

Turkey signed and put into practice the Plant Variety Protection (PVP) Law in 2004 (No. 5042); and Turkey became the 65th member UPOV member in 2007 with the approval of the Turkish Parliament. Turkey has administrative regulations compatible with the EU and other countries, having developed seed industries in the areas of registration and distribution, seed certification and seed trade. Plant breeder rights and registered cultivars are protected by PVP based on Law on the Protection of Breeder's Rights for New Plant Varieties in Turkey. There are also some regulations to apply practically in the sector, too (Anonymous 2017a, b).

These are: Regulation on Protection of Plant Breeders' Right of New Varieties (August 12, 2004), Regulation on The Implementation Principles of Farmers' Exception (August 12, 2004), Regulation on Payments to Plant Breeders in Public Institutes (April 30, 2005). Rights of holder has breeder's right shall confer to the holder following exclusive rights on protected variety: production or reproduction, offering for sale, selling or other marketing, exporting or importing and stocking seeds. On the other hand, there is farmer exception to protect small farmers. Farmers can use the propagation material obtained from their own production with the exception of hybrid and synthetic varieties. However, this exception can only be performed by the small farmers who have the land to produce 92 tons or less wheat or equivalent crop (Aksoy et al., 2017, Anonymous 2017a, b).

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Plant Variety Registration and Certified Seed Production System in Turkey

Based on the Seed Law in Turkey, public research institutes, universities, private companies or private plant breeders can register their developed varieties both in Turkey and abroad. After registration and releasing in the National Variety List, they can produce and market their cultivars officially in Turkey. The Variety Registration and Seed Certification Center (VRSCC) is officially responsible both for performance (VCU) of trials and description (DUS) tests in Turkey. Both seed registration process and seed production process in Turkey are presented in Figures 1 and 2.

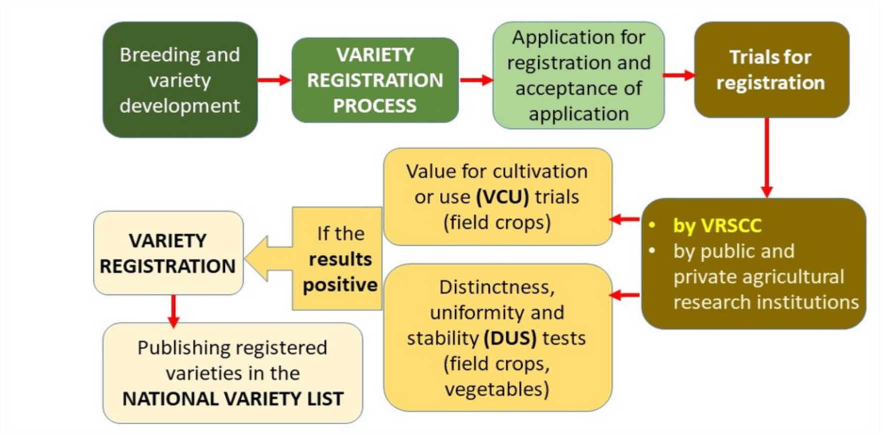


Figure 2: Seed registration system in Turkey

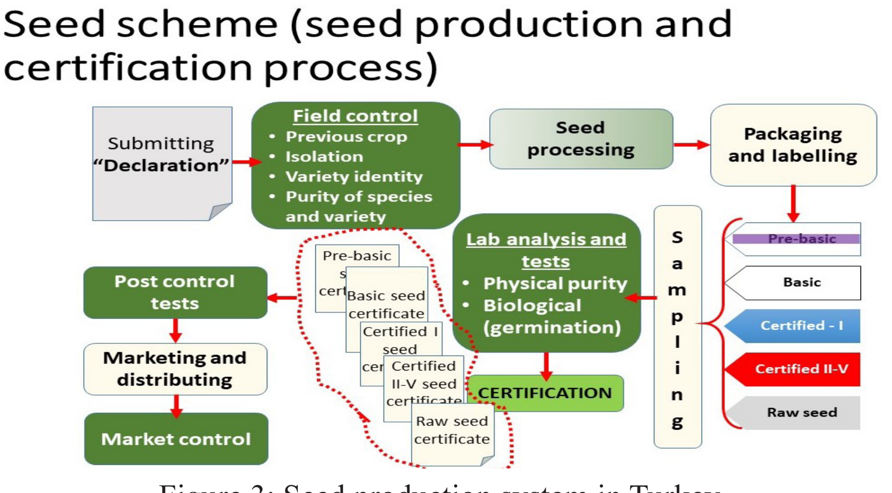
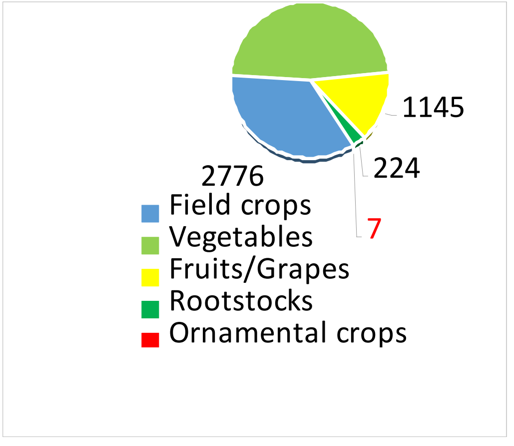


Figure 3: Seed production system in Turkey

After settling seed law, the number of varieties developed and registered by both public and private seed companies was accelerated. Registered varieties come mostly from private companies. Public research institutes under MARA also play important roles especially in self-pollinated crops (Figure 3).



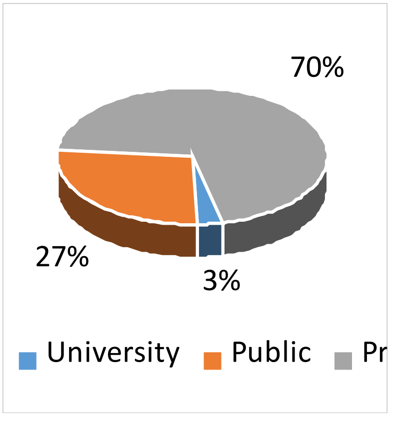


Figure 3: Variety registration by crops and sectors in Turkey

After establishing the Turkish Seed Union, many private seed companies were set up and exist actively in the sector (Figure 5). Due to the contribution of these companies and also to government subsidies, the certified seed production reached over 1 million tons in 2017 (Figure 4). The main seed production is in self-pollinated crops, and some certified seed production increased more than ten times from 2000 to 2017 (Table 5). There are some certified seed production areas as bread wheat 1.374.969 da, durum wheat 420.980 da, corn 97.000 da, potatoes 70.267 da, sunflower 142.134 da.

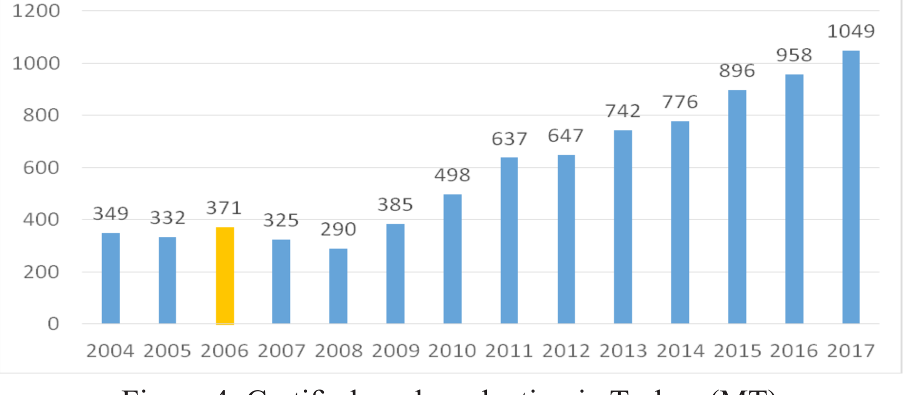


Figure 4: Certified seed production in Turkey (MT)

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Table 5. Certified seed production in Turkey (Metric Ton)

Crop	2000	2005	2010	2015	2016	2017
Wheat	116.083	176.202	315.676	484.24	485.225	508.191
Potatoes	23.275	63.901	70.654	175.397	231.592	258.180
Barley	19.203	22.307	34.416	125.018	99.628	119.474
Corn	11.987	30.167	35.234	56.671	52.791	58.094
Sunflower	2.600	6.522	11.854	17.494	21.757	28.022
Lentil	-	285	107	1.140	14.505	12.290
Cotton	9.165	19.581	15.679	8.883	14.379	19.929
Rice	1.021	3.505	5.521	8.945	12.958	10.491
Chickpea	699	157	253	2.305	4.059	10.658
Soybean	981	201	1.982	2.443	3.664	4.101
Vegetable	855	1.942	2.500	2.782	3.291	3.832
Sugar beet	3.438	2.720	466	1.448	1.168	1.195
Vetch	1.425	2.050	858	974	1.114	1.139
Alfalfa	381	476	349	634	794	887
Safflower	-	-	397	644	772	975
Peanut	0	101	70	139	206	197
Sorghum	1	160	180	308	192	78
Sainfoin	621	1.232	56	31	188	385
Dry bean	45	30	-	109	179	623
Meadow grass	303	636	56	236	107	167
Others	13	-	1.523	6.333	9.219	-
TOTAL (ton)	192.096	332.190	497.964	896.298	957.925	1.049.366

Source: Ministry of Food, Agriculture and Livestock, 2017

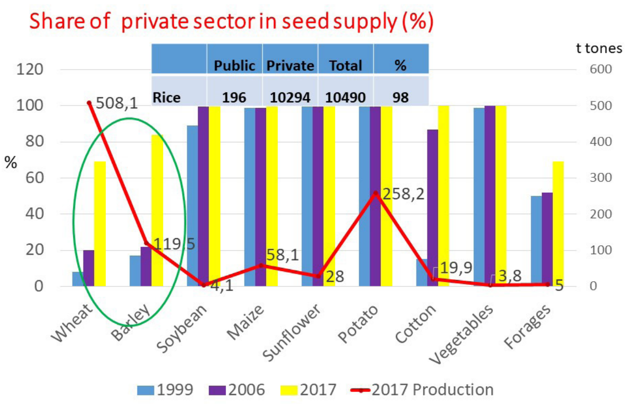

Figure 5. Seed share by private sector of some main crops in Turkey (%)

Seed Trade in Turkey

Turkey exists in the top 10 countries in World Seed Sector with producing over 1 million tons of certified seeds in 2017 (Table 6,7 and 8). Turkish seed import is 40.000 tons and amounted to $ 185 million in 2017. On the other hand, Turkish seed export reached 44.000 tons, or $ 136 million. Based on these values, Turkey's seed exports cover 73% of import. Turkey has increased 3 times its production and 8 times its export since 2003 (Figure 6).

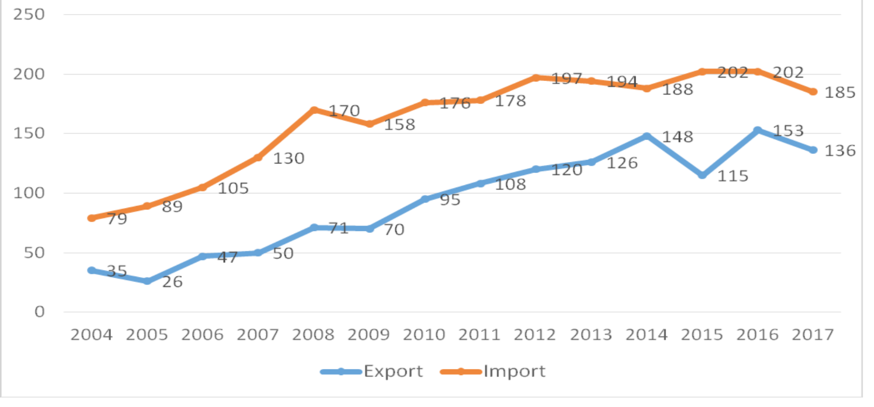

Figure 6. Seed Exports and Import in recent years in Turkey

Table 6. Seed Exports in recent years in Turkey

Crops	Seed export quantity (Ton)			Seed export value (000 $)		
	2015	2016	2017	2015	2016	2017
Wheat	964	19.800	4.513	776	7.764	1.872
Barley	127	1.727	224	52	697	80
Corn	12.250	15.698	8.945	30.730	39.058	23.657
Rice	6	6	0	9	8	0
Cotton	958	1.413	2.833	2.245	3.778	7.453
Sunflower	10.719	16.312	19.385	48.866	73.399	76.308
Canola	0	0	0	0	0	0
Soybean	89	93	614	150	103	1.213
Peanut	0	0	0	0	0	0
Potatoes	0	833	4.751	0	393	1.395
Sugar beet	161	237	124	1.717	1.847	876
Fodder crops	589	473	740	1.306	1.069	992
Turf and grass	101	72	100	505	270	372
Vegetables	141	362	333	14.754	22.433	19.602
Others	604	1.195	1.197	1.607	2.630	2.441
Total	26.708	58.222	43.758	102.717	153.449	136.261

Source: Ministry of Food, Agriculture and Livestock, 2017

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Table 7. Seed Import in recent years in Turkey

Crops	Seed import quantity (Ton)			Seed import value (000 $)		
	2015	2016	2017	2015	2016	2017
Wheat	756	1.193	589	809	981	619
Barley	106	106	317	809	981	239
Corn	1.938	3.535	3.004	12.363	17.787	14.001
Rice	1.276	47	205	537	69	233
Cotton	31	8	38	126	40	145
Sunflower	571	1.292	752	5.636	13.260	12.032
Canola	87	130	52	687	1.102	406
Soybean	0	0	0,2	1,7	3,9	2,1
Peanut	0	0	0,02	0	0	10
Potatoes	38.440	26.386	16.255	24.162	19.286	10.857
Sugar beet	622	772	409	13.928	9.451	8.445
Fodder crops	4.134	6.387	9.028	8.577	11.111	13.474
Turf and grass	4.198	4.765	5.818	8.705	9.572	11.607
Vegetables	811	1.057	972	115.162	111.380	108.730
Others	3.570	3.813	1.854	11.346	7.911	4.452
Total	56.539	49.491	39.294	202.848	202.933	185.252

Source: Ministry of Food, Agriculture and Livestock, 2017

Table 8. Turkey imported/exported seeds of different crops in 2017

Seed Imports	**ton**	**000 $**		**Seed Exports**	**ton**	**000 $**
Tomato	8	41380		Sunflower	19385	76300
Corn	3004	14001		Corn	8945	23657
Paper	2	13425		Cotton	2833	7453
Sunflower	16255	12032		Tomato	4	5539
Potato	29	10857		Cucumber	10	5055
Cucumber	29	9362		Onion seed	72	2766
Alfalfa	2014	9206		Water/Melons	11	2509
Sugar beet	409	8445		Wheat	4513	1872
Water/Melons	36	8338		Potato	4751	1395
Lettuce	49	5098		Paper	4	1243
Meadow grass	2005	4777		Soybean	614	1213
English ryegrass	2457	4692		Faba bean	378	1024
Sweet Corn	186	4672		Sweet Corn	69	1020
Eggplant	0	4537		Sugar beet	124	876
Squash/pumpkin	51	4255		Pea	171	411

Source: Ministry of Food, Agriculture and Livestock, 2017

Turkey exports seeds to 80 countries in the world with paying 136,3 million $ in 2017. Ukraine, Russian Federation, Romania, Azerbaijan and Italy are the main exporter countries (Figure 8). On the other hand, Turkey pay 185,3 million $ from importing 61 countries certified seeds (Figure 7). France, USA and Peru are the main important countries for seed exports in recent years.

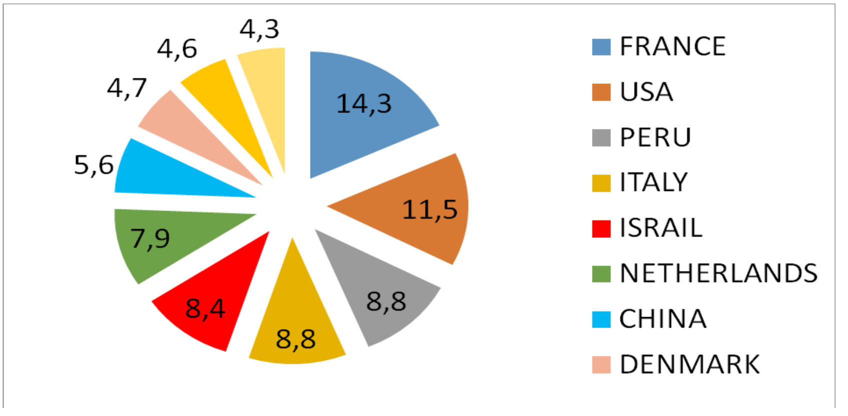

Figure 7. Seed Import in main countries in Turkey in 2017

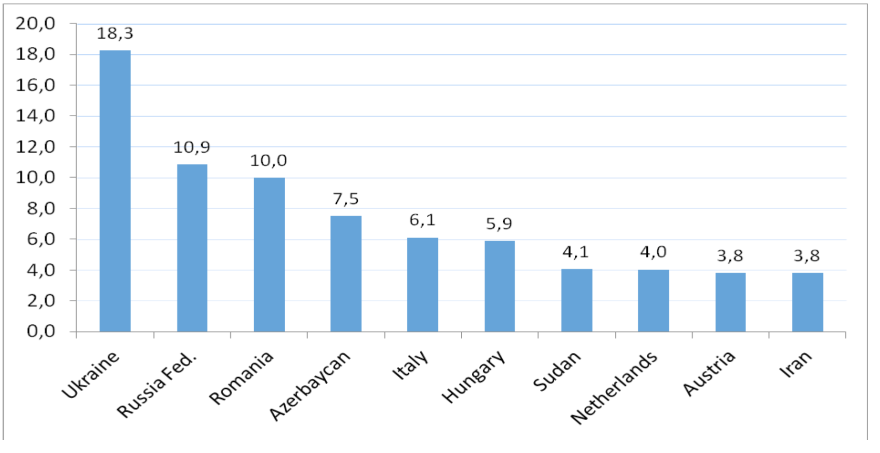

Figure 8. Seed Exports by countries in Turkey in 2017

Seed Supports in Turkey

Turkey have subsidized certified seed production for over 10 years for both seed producers and also certified seed users. This policy contributed a lot for developing seed sector and also for increasing certified seed use. Furthermore, certified seed use in the plant production helps more for increasing seed yield and profitability in Turkish agriculture. A total of 268 667 734 USD were paid to over 50.000 farmers in 2017 for certified seed subsidy (Figure 9). On the other hand, both seed producer

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companies and certified seed producer farmers get subsidy from government. A total of 85.286.517 USD were paid for this certified seed production of 600.000 MT in 2016 (Figure 10). With these supports, the Turkish seed sector increased a lot both for seed production and also for the number of seed companies and the seed exports in recent years. The Turkish government subsidy is especially for cereal and forage crops, except well-developed hybrid seeds in recently (Table 9 and 10). The highest amounts were given to alfalfa and potato certified seed users and producers.

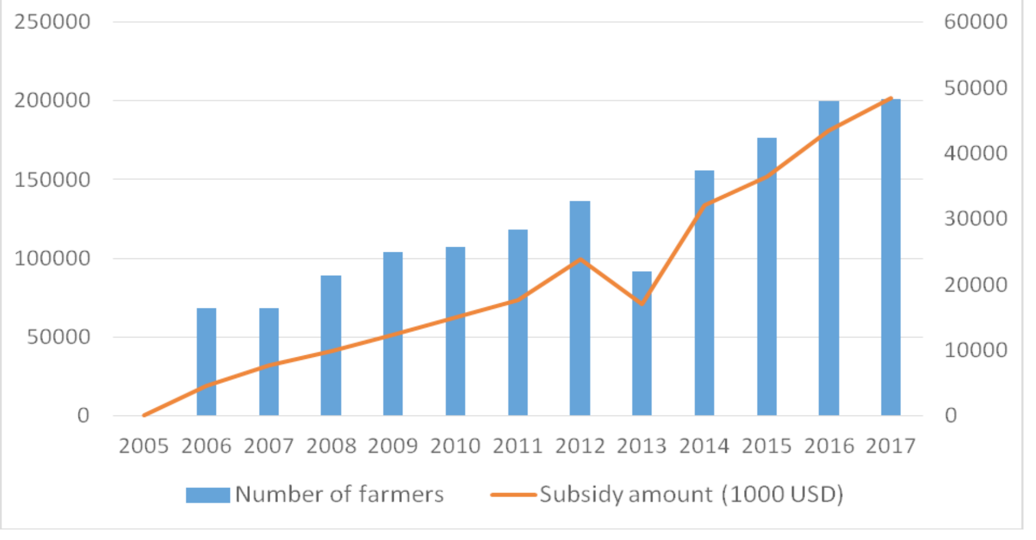

Figure 9. Subsidy paid to farmers for certified seed usage in Turkey

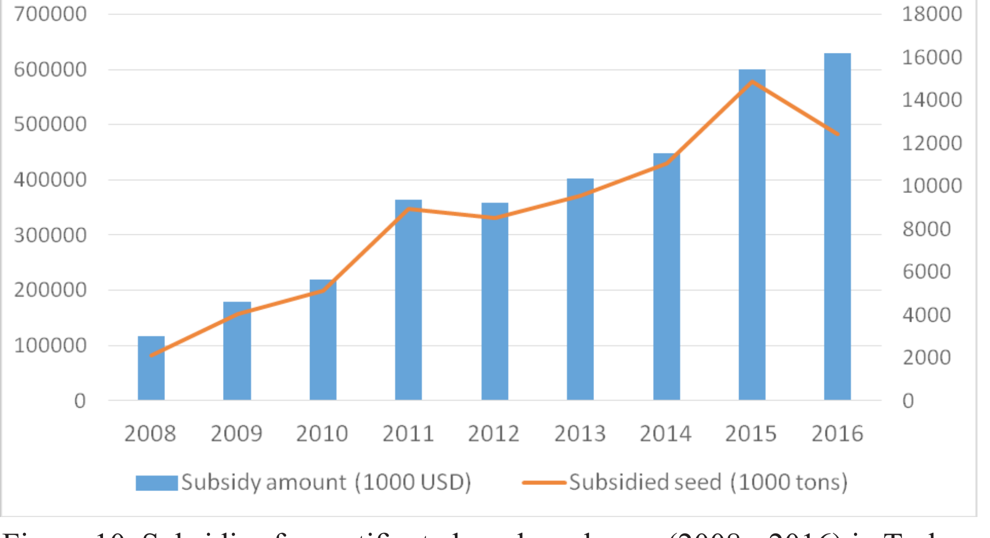

Figure 10. Subsidies for certificated seed producers (2008 - 2016) in Turkey

Table 9. Subsidies for certificated seed usage*

Crops	$/ha
Wheat, Barley,	13,0
Triticale, Oats, Rye	9,2
Rice	12,2
Chickpea, Dry bean, Lentil, Soybean	30,5
Sesame, Rapeseed, Safflower	11,0
Potato	122,1
Sainfoin, Vetch, Animal peas	30,5
Alfalfa	45,8
Peanut	22,9
Original and upper class seed users	50% more

*Republic of Turkey Ministry of Food, Agriculture and Livestock, 2018

Table 10. Subsidies to certificated seed producer*

Species	$/t
Wheat, Potato	15,3
Barley, Triticale, Oats, Rye	12,2
Rice	38,2
Chickpea, Dry bean, Lentil, Safflower	76,3
Sainfoin, Vetch, Forage pea	229,0
Soybean	53,4
Rapeseed	183,2
Sesame	91,6
Alfalfa	610,7
Peanut	122,1
Original and upper class seed users	50% more

*Republic of Turkey Ministry of Food, Agriculture and Livestock, 2018

Conclusions

Turkey exists in the top ten countries in the world seed sector with especially considerable attack and development in recent years. It reached the goals of the 100^{th} anniversary (1923-2023) 4 years ahead in seed sector. However, there is a huge potential to develop and a final goal yet to reach to become one of the top 5 countries in the world seed sector till 2023. Therefore, Turkey redefined 2023 goals to realize the production of over 1,5 million tons of certified seeds, increasing seed exports to cover 100% of import, setting up own research programs in the seed sector and increasing the percentage of rates of the local companies in the seed market.

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