Analysis and assessment of agroclimatic conditions of cultivation and yield of technical crops on the territory of Armenia

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Abstract. The necessary agroclimatic conditions for the growth and development of technical crops on the territory of the republic, the terms of the phenological phases, the prerequisites for the development of their cultivation space, the level of yield and crop yields have beenanalyzed and evaluated. As a source of information, the actual data of agrometeorological observations of the GEO «Center for Hydrometeorology and Monitoring» of the Ministry of Environment of the Republic of Armenia and the National Statistical Service are used. For the period 2012-2020, there is a tendency to reduce the acreage of technical crops. So that the Republic of Armenia is not only a country importing technical crops, but also an exporting country, apply modern high technologies of cultivation, expand irrigated areas, introduce new high-yielding varieties, pay special attention to more efficient use of microclimatic resources.

1 Introduction

The role and significance of the analysis and assessment of the agroclimatic conditions of agricultural crops from the point of view of the prospective development of agriculture, food and light industry is very important. They determine the role of heat supply and moisture supply of a given territory, growth and development of crops, conditions for their wintering, timing of field work, yield.

Agriculture is the most dependent on climate among the industrial sectors of the economy: it almost always suffers from weather changes, dangerous agrometeorological events and natural disasters. Food security risks are increasing as a result of expected climate change. Therefore, the strategic objective of the agriculture of the Republic of Armenia is to increase the food security of the republic, ensuring 75-80 % of its own production of basic food.

One of the issues with respect to climate change involves its influence on the distribution of future crop yields [6]. Projections of future climate change suggest that average crop yield will increase with warmer temperatures and a longer growing season which is only partially offset by forecast increases in the variability of temperature and rainfall. The projections would also depend on future technological developments, which have generated significant increases in yield over time despite changing annual weather conditions [5]. The estimation results indicate that changes in climate modify crop yield levels and variances in a cropspecific fashion. For sorghum, rainfall and temperature increases are found to increase yield level and variability. On the other hand, precipitation and temperature are individually found to have opposite effects on corn yield levels and variability [6].

Technical are considered those crops that are raw materials for production or are used after technical processing. The following groups of industrial crops are distinguished: sugar (sugar beet, sugar cane), oil (sunflower, soy, hemp, peanuts, rapeseed, sesame, flax, olive, oil and coconut palm, etc.), fibrous (cotton, fiber, etc.), invigorating (tea, coffee, cocoa), essential oil (geranium, rose, anisson, mint, cumin, lavender, etc.), rubbery (hevyea), tanning (valerian, ginseng, hawthorn, etc.), core plants (Amur velvet wood, etc.). Some types are used for different purposes.

Until 1988 sugar beet (Shirak and Lori regions), geranium (Armavir region) were cultivated in the republic, until 1965 – cotton (Ararat valley) [7].

The purpose of the work is to evaluate the necessary agroclimatic conditions for the growth of industrial crops on the territory of the republic, the timing of the phenological phases, the areas of their cultivation, the tendency of the development of the level of crop yield and yield.

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2 Study areas, Data and Methods

To solve these problems in the work as a theoretical and informational basis were the relevant research studies [1, 3, 8-9]. As a source material, the work used actual agrometeorological observations of the «Hydrometeorology and Monitoring Center» SNCO of the Ministry of Environmental Protection of the Republic of Armenia, as well as data from the NSS of RA, agroclimatic reference books and yearbooks [2-4].

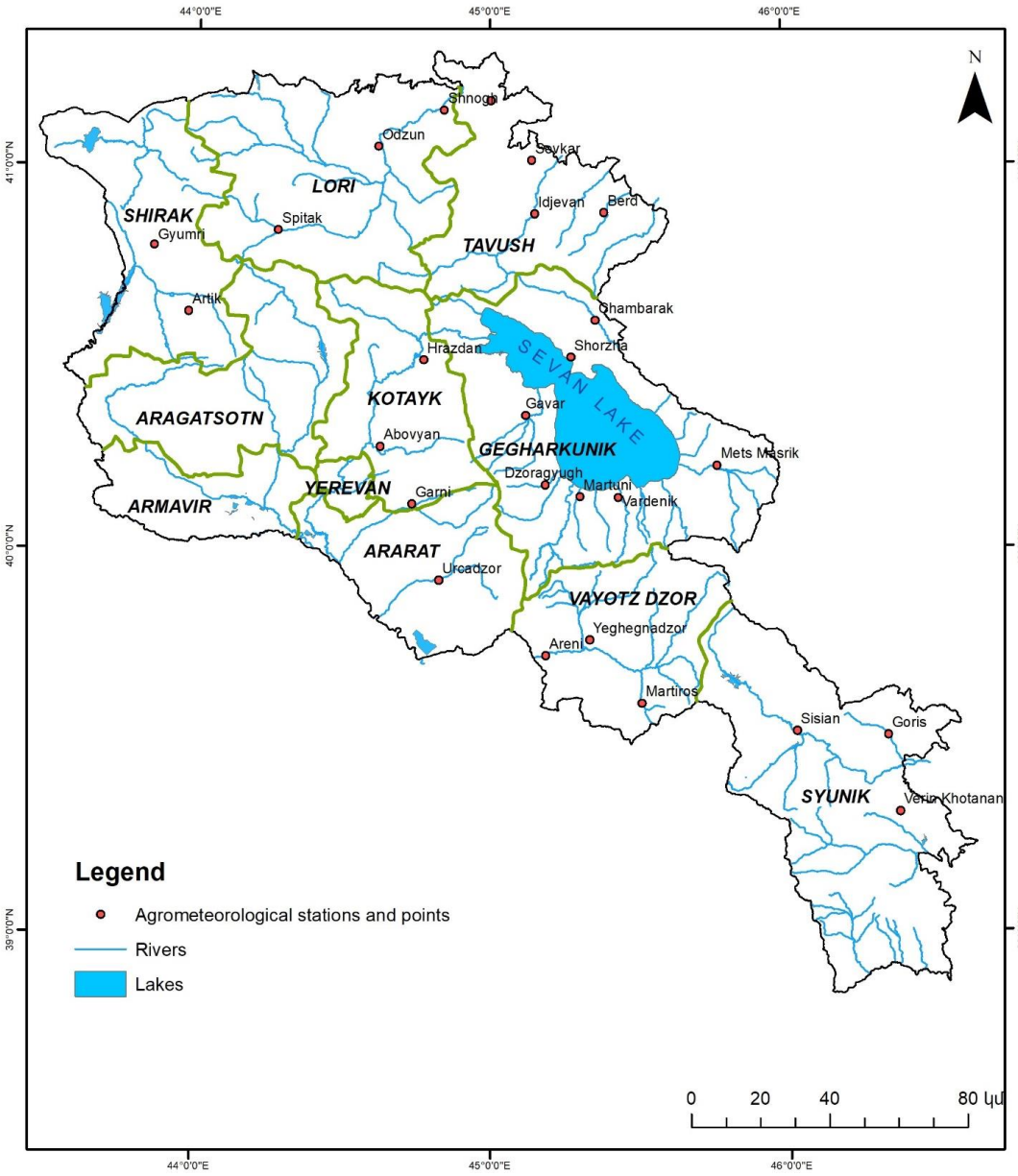

Fig. 1. Marzes (regions) of Republic of Armenia

At the meteorological stations and posts of Armenia, observations were carried out for a long time on the development periods of the phases of crops cultivated in a given area (that is, phenological observations were organized) [7]. In the republic from industrial crops phenological observations are carried out tobacco. In tobacco: 3rd leaf, 5th leaf, 7th leaf, steam growth, the appearance of the first stepsons, the appearance of inflorescences, flowering, technical ripeness of the leaves of the lower tier, the timing of leaf collection, as well as damage to plants due to adverse and dangerous phenomena (frost, hail, diseases, pests, etc.) during the growing season, the likelihood of frost damage.

It should be noted that the number of those stations that conduct phenological observations of industrial crops has sharply decreased (fig. 1). So, since 2000 phenological observations only of tobacco have been carried out in Urtsadzor.

Only industrial crops grown in the republic are discussed in the work.

As a methodological basis used are: statistical analysis, correlation methods.

3 Results and discussion

According to the results of actual observations of the «Hydrometeorology and monitoring center» SNCO, table 1 shows the average sowing time and development phases of sugar beet, and table 2 – agroclimatic conditions of the sowing-sprouting period at different sowing dates.

Table 1. Average sowing time and development phases of sugar beet [4]

Meteorological Stations	Sowing	Seedlings	5th true leaf	Thickening of the hypocotal knee
Lori				
Spitak	02/05	16/05	11/06	25/06
Shirak				
Gyumri	28/04	15/05	05/06	18/06
Artik	04/05	24/05	15/06	30/06

According to table 1, phenological observations of sugar beet were carried out on the territory of the republic at the meteorological stations Spitak, Gyumri and Artik. Sowing is mainly carried out from the third decade of April to the first decade of May.

Tobacco is an annual plant. It is grown mainly for the purpose of obtaining raw materials for smoking. The growing season of a tobacco plant is divided into two periods: seedling – from sowing seeds to plants ready for seedling, and field – from seedlings to the final collection of leaves or seed ripening. The duration of the planting period is 35-50 days. The best temperature for germination of tobacco seeds is 25,0-28,0 ºC, and in the future – 18,0-22,0 ºC. Tobacco is sensitive to late spring and early autumn frosts, it is damaged of temperatures from -1,0 to -3,0 ºC. The best period for transferring tobacco seedlings to the field is when the temperature in the soil reaches 10,0-12,0 ºC. Tobacco must be watered with grooves, 3-10 times, according to the needs of the culture [7].

Sugar beet (Bets Vulgaris L. v. saccharifera) – biennial plant. It has a wide range of consumption. When processed, sugar is obtained, which can be used as a final or as an average product. Currently about 40% of the sugar used in the world is obtained from sugar. In the process of sugar production, sugar beet kernels are obtained from sugar beet, which are a complete feed for animals. Sugar beet is also processed as a valuable juicy food. Sugar beet leaves are used as animal feed or mixed with soil to increase fertility [10]. In Armenia, the only large enterprise for the production of sugar was «Lus Astkh sugar», the Akhuryan sugar factory, after the operation of which (2010) in the republic there was a need to resume the production of sugar beet.

Sugar-beet – heat-loving, light-loving, moisture-loving, salt-tolerant and drought-tolerant technical crop. Sugar beet seedlings may be damaged due to frost in Gyumri, the probability of frost is 4-8% (table 2). In Artik and Spitak the probability of freezing of sugar beet seedlings is 0 %.

Table 2. Agroclimatic conditions of sugar beet during the sowing-germination period at different sowing dates [4]

Meteorological Stations	Sowing	The probability of the condition of the seed in the soil, %			Germination date	The probability of freezing of seedlings, %
		the temperature at a depth of 5 sm will be below 7°	the soil will be dry	the soil will be waterlogged		
Shirak						
Gyumri	11/04	61	20	16	02/05	8
	21/04	45	25	20	06/05	8
	01/05	7	33	20	13/05	4
	11/05	0	25	25	21/05	4
	21/05	0	29	20	28/05	0
Artik	11/04	58	8	0	04/05	0
	21/04	58	8	17	08/05	0
	01/05	17	17	8	14/05	0
	11/05	0	17	17	24/05	0
	21/05	0	8	25	31/05	0
Lori						
Spitak	11/04	36	36	4	03/05	0
	21/04	12	34	13	08/05	0
	01/05	0	33	18	14/05	0
	11/05	0	17	4	21/05	0
	21/05	0	31	5	31/05	0

Unlike sugar beet, phenological observations of tobacco on the territory of the republic were organized at many meteorological stations. Planting of seedlings is mainly carried out from the first decade of May to the first decade of June, and the collection of leaves – from July-August (first collection of leaves) to September-October (last collection of leaves). With height, there is a delay in the average timing of development of tobacco phases (table 3).

Table 3. Average periods of tobacco development phases [4]

Meteorological Stations	Variety	Transplanting	The appearance of inflorescences	Flowering	Leaf picking time	
					first	last
Ararat						
Urtsadzor	Ostrolist 2747	08/05	06/08	14/08	17/07	27/09
Gegharkunik						
Chambarak	Samsun 935	03/06	18/08	31/08	31/07	23/09
Shorzha	Ostrolist 2747	26/05	30/08	19/09		
Masrik	Samsun 36	08/06	13/09	23/09	02/08	23/09
Martuni	Samsun 935	12/06	26/08	05/09	02/08	07/10
Gavar	Samsun 935	08/06	27/08	07/09	28/07	25/09
Vardenik	Samsun 935	25/05	25/08	31/08	30/07	02/10
Dzoragyugh	Samsun 935	24/05	22/08	30/08	28/07	28/09
Lori						
Shnogh	Ostrolist 2747	09/05	19/07	27/07	05/07	17/10
Odzun	Trapezond	15/05	06/08	14/08	03/08	09/10
Kotayk						
Hrazdan	Samsun 935	05/06	05/09	14/09	06/08	27/09
Abovyan	Samsun 36	20/05	15/08	24/08	23/07	30/09
Garni	Samsun 935	21/05	15/08	31/08	25/07	01/10
Syunik						
Goris	Samsun 935	15.05	26/07	02/08	20/08	24/09
Khotanan	Samsun 935	13.05	16/08	29/08	16/07	08/09
Sisian	Samsun 935	27.05	25/08	04/09	02/08	23/09
Vayots Dzor						
Areni	Samsun 935	12/05	08/08	26/08	12/07	06/10
Eghegnadzor	Samsun 935	08/05	30/07	08/08	14/07	02/10
Martiros	Samsun 935	31/05	02/08	06/09	30/07	30/09
Tavush						
Ijevan	Ostrolist 2747	13/05	02/08	10/08	23/07	30/09
Noyemberyan	Ostrolist 2747	14/05	12/08	23/08	20/07	25/10
Berd	Peremozhets 83	13/05	16/08	25/08	13/07	12/10
Sevkar	Ostrolist 2747	19/05	04/08	15/08	15/07	07/10

According to the data of the National Statistical Service, table 4 shows the area of cultivation, gross yield and trends in the development of growth in the yield of the currently cultivated main technical crops (tobacco, flax, sunflower) in the territory of Armenia for 2010-2020. It turns out that among technical crops, the largest sown area on the territory of the republic is occupied by sunflower. Information on the sown area, gross yield and yield of sunflower is contained for 2015-2020.

Table 4. Area of cultivation of tobacco, flax and sunflower, gross yield and growth trends in yield in Armenia for 2010-2020

Characteristics	Years										
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Tobacco											
Sown area, ha	418	614	667	548	510	582	464	460	393	381	283
Harvested crop, centner	13758	23862	18170	16784	12528	15157	11321	10867	9140	9466	7158
Average crop capacity of hectare, center	33,0	38,9	27,2	30,6	24,6	26,0	24,4	23,6	23,3	24,8	25,3
Flax											
Sown area, ha	67	52	38	62	90	154	202	267	325	174	192
Harvested crop, centner	823	550	555	824	886	1785	2549	4718	5456	1396	2292

Average crop capacity of hectare, center	12,3	10,6	15,0	13,5	10,0	12,9	12,7	17,7	16.8	8,0	11,9
Sunflower (oil and confectionery)											
Sown area, ha	-	-	-	-	-	1976	1819	1353	863	797	601
Harvested crop, centner	-	-	-	-	-	31799	29262	22053	15365	21258	18240
Average crop capacity of hectare, center	-	-	-	-	-	17,4	16,1	16,7	17,8	26,7	30,3

The territories sown with industrial crops, including tobacco and flax, increased over the period 2005-2020 (Fig. 2a, 2b). Moreover, the sowing of tobacco for the period 2012-2020 decreased. In general, in recent years, there has been a tendency for a decrease in the area sown with industrial crops (tobacco, green, sunflower). Therefore, it is necessary to take appropriate measures and increase the sown area of industrial crops in the republic.

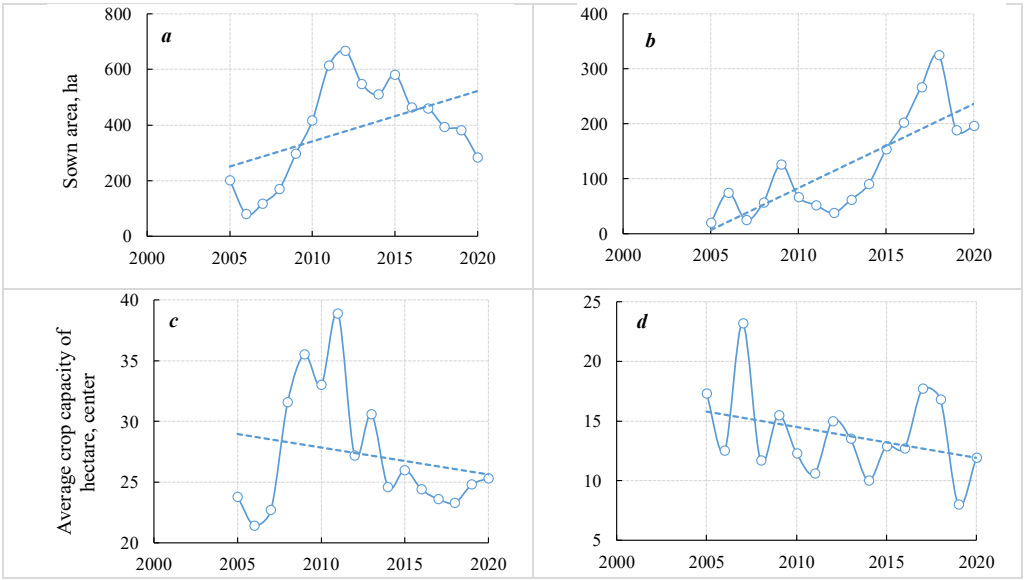

Fig. 2. Changes in cultivated areas of industrial crops (a, b) and average yield per hectare (c, d) for 2005-2020 in the republic. Tobacco - a, c, flax - b, d.

On the other hand, for the period 2005-2020, there is a tendency to decrease the yield of tobacco and flax (Fig. 2c, 2d).

Average crop yields increase at a decreasing rate with the quantity of inputs used, and decrease with the area planted to the crop. Climate variables have a major impact on mean yield with the length of the growing season being the primary determinant. Increases in the variability of temperature and precipitation decrease mean yield and increase its variance. Yield variance is poorly explained by both seasonal and monthly climate variable models [5].

4. Conclusions

So,

- ✓ Agroclimatic conditions of the territory of the republic are favorable for the growth and development of technical crops.
- ✓ On the territory of the republic there is tendency to crease the acreage of tobacco and flax, decrease their yield for the period 2005-2020.
- ✓ On the territory of the republic, in general, for the period 2012-2020, there is a tendency to reduce the acreage of technical crops.

It is necessary:

- ✓ So that the Republic of Armenia is not only a country importing technical crops, but also an exporting country.
- ✓ Apply modern high technologies of cultivation, expand irrigated areas, introduce new high-yielding varieties.
- ✓ Pay special attention to more efficient use of microclimatic resources.

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