UDC 631.153.3:551.583

R.A.Vozhegova, Doctor of Science
INSTITUTE OF IRRIGATED AGRICULTURE OF NAAS

ADAPTATION OF FARMING SYSTEMS TO CLIMATIC CONDITIONS OF THE SOUTHERN UKRAINE

System of farming in each region are always adapted to climatic conditions. Associated with them is the selection of the ratio and placement of crops, varietal composition and characteristics of the technology of cultivation. Analysis of the climatic situation in the Southern Steppe indicates increased over the past 40 years the average annual temperature of 2.0 ° C, and in the summer months, 2.9 to 4.2 ° C and an increase in thermal resources in connection with the increasing duration of vegetation period and the sum of active temperatures. It has been established that adaptation to climate change requires the development of new technologies and methods of cultivation of crops aimed at increasing savings and economical use of precipitation and moisture of the soil.

Keywords: *farming systems, climate changes, crop rotation, forest, irrigation efficiency.*

Systems of farming in each region are always adapted to its natural and climatic conditions. Associated with them is the selection of the ratio and placement of crops, varietal composition and characteristics of the technology of cultivation. Such adaptation of agriculture to climatic conditions of each region was carried out during the whole time of the existence of agricultural production in the country.

In recent years, however, there are significant climate change requires the development and improvement of existing farming systems that fully correspond to climatic conditions that now exist. Since the 1970s, droughts have become longer and cover a significant territory. During this period there were changes in the frequency of extreme temperatures. More frequent hot days and nights and hot atmospheric waves [1-4].

In Ukraine in the recent past conducted a fairly large volume of studies on the impact of climate change in the steppe zone on the productivity of crops. They suggest that further application of the traditional system of farming in the region can be a considerable reduction of productivity of agricultural crops [5]. To overcome the negative effects associated with climate changes in the region, a number of measures aimed at adapting agriculture to new conditions is proposed [6, 7].

However, despite this, assessment of the impact of climate change on productivity of agricultural crops in the Steppe zone requires further generalization and development of measures to adapt agriculture to the possible changes.

The purpose of the research. The objective of the research consisted in the analysis of the climatic situation in the Southern Steppe for the past decades and understands its impact on the productivity of winter and spring crops.

Analysis of climate change was conducted according to the Kherson weather station observations, which is located in the Central part of the Southern Steppe. Were used annual agrometeorological reviews of Kherson regional center for 40 years (1976 – 2014) [8].

The results of the formation of crop productivity are the results of research conducted at the Institute of irrigated agriculture of NAAS on the dark chestnut of cerebrospinal soils with generally accepted farming practices.

The status of protective forest belts were data forwarding surveys. Their influence and existence was determined on the basis of research Prisivashskiy agro forest and reclaim experimental station.

The research results. About the climate change shown by the analysis of observations of air temperature regime in the region (Fig. 1). So, according to our data for the last 40 years by the meteorological station of Kherson, which is located almost in the center of the Southern Steppes, the average annual air temperature from 1976-1980 for 2011-2014 has increased from 9.3 to 11.3 ºC, i.e. by 2.0 ºC.

The largest increase in air temperature occurred in late summer – in July and August – 4.2 and 3.6 ºC, respectively. Quite noticeable is the increase of air temperature in September and October by 2.2 and 2.1 ºC. It was a little smaller in the spring. So, in March it amounted to 1.1 °C, and in April to 2.1 ºC. Winter (December, January and February) also became a little warmer.

The increase in air temperature during this period led to the increase of heat during the growing season (Fig. 2). Thus, the sum of positive temperatures during this period increased by 735,9 ºC and effective above 5 ºC – on 673,4. This is especially noticeable growth occurred over the last 10-12 years.

Along with the clear direction of changes in precipitation for the year, analyzing the same period, cannot be traced. If we consider them in five-year blocks, it is mainly at the level 463 – 487 mm, with a variance from 376.6 mm in 1991-1995 to 542,8 mm in 1976-1980. We can also note a significant decrease of precipitation in the last two years – 283,7 mm in 2011 and 369,9 mm in 2012, 258,7 mm in 2013 and 363,5 mm in 2014, i.e. 31.2% with an average number over 40 years 429,1 mm (Fig. 3). It should also be noted a significant decrease of rainfall in April (almost twice) and September (17-62 %). In the last period increased the proportion of rainfall of shower nature, leading to significant losses by runoff in low places.

In consequence of the fact that the air temperature in the summer period increased by 2.0-4,10 ºC and precipitation decreased, the water deficit significantly increased, which increased the aridity of the climate in the region (Fig. 4).

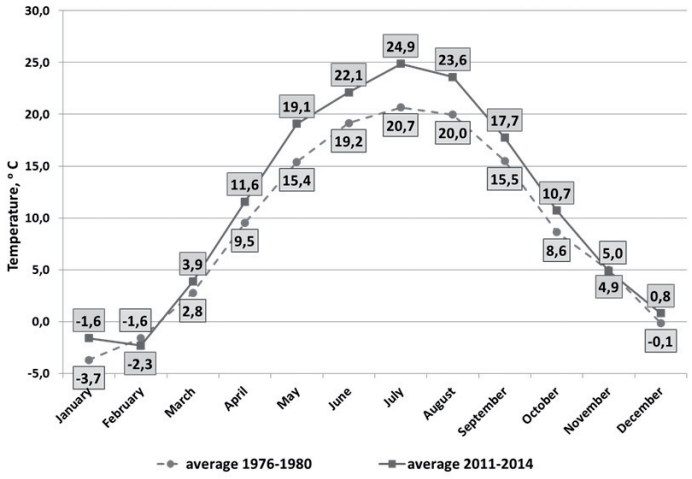

Fig. 1.

Air temperature according to the Kherson's weather station

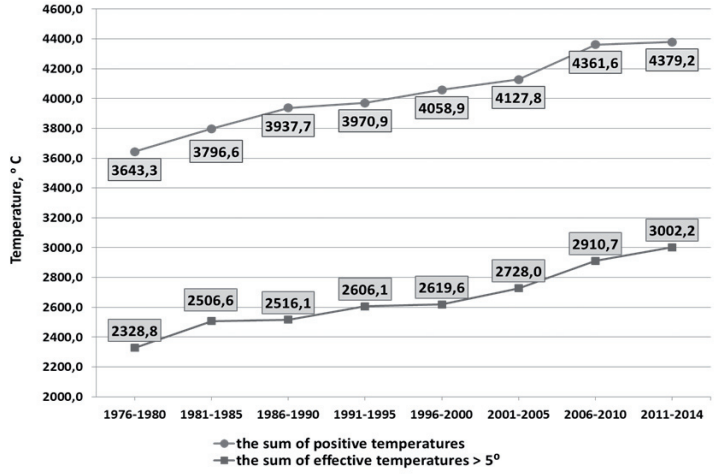

Fig. 2.

The amount of positive and effective temperatures according to the Kherson's weather station

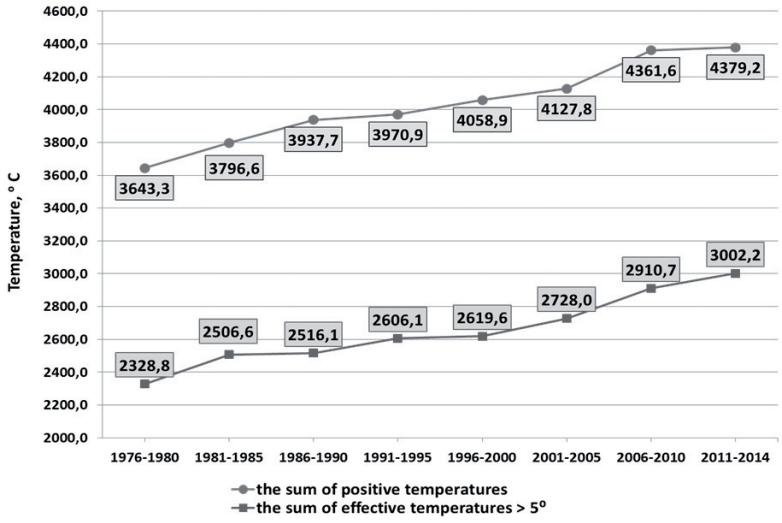

Fig. 3.

The amount of precipitation according to the Kherson's weather station

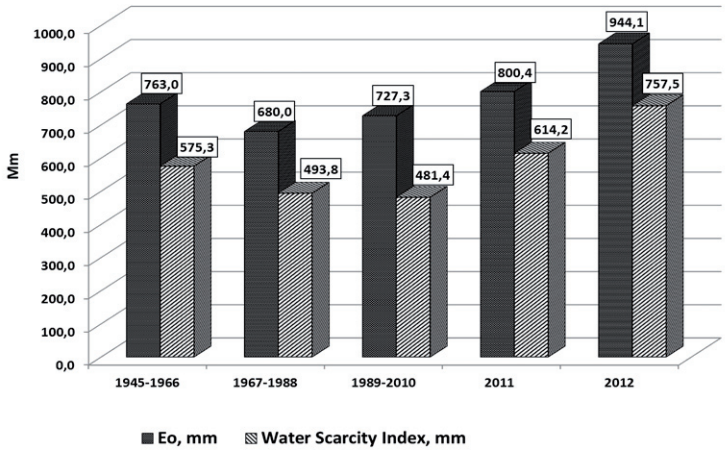

Fig. 4.

Evaporation (Eo, mm) and Water Scarcity Index (mm) during the vegetation period in the Southern Steppe zone

Presents an analysis of agroclimatic indicators shows that in the Southern Steppes of them have been significant changes, which are shown as follows:

– increased average annual temperature, especially in the second half of the summer;

– increases the flow of thermal resources in connection with the increasing duration of vegetation period and the sum of active temperatures;

– increasing rainfall of shower nature;

– increases water evaporation from the soil during the growing season;

– there is a growing aridity of the climate.

Such changes of agro-climatic conditions most affect in early spring early spring crops and in the autumn to winter cereals. So, for early spring crops (barley, wheat, etc.) increase of air temperature in March, April and may, while reduced precipitation is a negative factor. This reduces the optimal sowing time, inhibits the growth processes and the formation of nodal roots with the rapid increase of air temperature and soil and reduce its humidity. Increasing the duration of the thermal regime of the autumn period is favourable for winter crops. It can expand the boundaries of the optimal time of sowing, and create good conditions for normal plant development until the cessation of the autumn growing season.

These climate change require improvement, development, and adaptation of existing systems of farming and the technology of cultivation of agricultural crops in the Southern Steppes. Although in this direction have already been a lot of research and accumulated a significant amount of effective development, in the future it is necessary to broaden and deepen the study of these issues. Despite the increasing research in this direction, the dependence of yield on weather conditions remains high – they determine almost 52%.

Future direction of research on the development of measures aimed at reducing the risk of and degree of sensitivity to the impacts of climate change should primarily be of a preparatory nature to be aimed at reducing potentially harmful effects, and to improve sustainability of agricultural systems. But it should be also developed and agricultural practices, which would allow to have a sustainable production of crops and under conditions when it occurred certain changes in climate.

It should be noted that changing climatic conditions can obtain some benefits. Not all effects of climate change will be negative. It is therefore necessary to develop activities that will help to benefit from changes in climatic conditions. To this end it is necessary to conduct research in the following areas:

– creation of new varieties and hybrids of agricultural crops, resistant to temperature changes and water scarcity, and for early spring crops varieties which reveals the rapid growth of both above-ground biomass and root system that would enable them to avoid high temperatures in the initial period of plant development;

– development, improvement and expansion of sustainable and efficient methods of irrigation to reduce dependence on rainfall;

– development of new technologies and methods of cultivation of crops aimed at increasing savings and economical use of moisture precipitation and soil;

– to determine the optimal and possible terms of sowing of winter crops in terms of an extended period of autumn vegetation that would ensure good growth and development in the autumn and contributed to the stabilization of grain production;

– reducing the risk of water and wind erosion on agricultural lands by determining the optimal share of fodder crops and shelter belts.

Although all activities listed above have their own clear objectives, they are closely connected. To form a programme of action to mitigate climate change, benefit from this, you need to thoroughly understand the potential consequences and risks that relate to the southern region.

In arid conditions of southern Ukraine the most effective measure of the accumulation of moisture in the soil to overcome the drought is irrigation. It completely changes the conditions of farming, gives the opportunity to maintain the soil moisture to the desired crops optimum level and thus creates favorable conditions for normal growth and development of plants. Thus, long-term data of Institute of irrigated agriculture, the average

yield of winter wheat under irrigation 60.4 kg/ha, corn – 95,7 kg/ha, soybean – 29,4 kg/ha. Irrigation provides yields of all crops in 2-6 times higher than without it. It is therefore necessary to accelerate work on the restoration of the functioning of the irrigation systems, and in the future new construction. Thus it is necessary to expand research to develop more effective use of irrigated lands and the use of drip irrigation.

For the purpose of more effective utilization of thermal resources, which are now substantially increased, it is necessary to expand on the irrigated lands of the research on the development and perfection of technology of cultivation of intermediate crops of soybeans, millet and buckwheat for grain and corn and annual mixes for green fodder and silage, which has already found its effectiveness (tab. 1).

Under climate crises, the role of host crops by region taking into account the biological characteristics of the crops. Therefore, the structure of sown areas should be the main biological factor in the regulation of the water regime. It is necessary to increase the share of drought resistant crops and to optimize the area of a fallow, which affects the productivity of not only wheat, but also the next 2 to 3 crops.

Special attention should be given to the expansion of cultivation of the most drought-tolerant and most productive when the soil moisture deficit the culture of sorghum. So, in a rather arid conditions 2012 -2014 years it provided grain yield in our demonstration experiments at the level of 1.44 – 3.68 t/ha. At the same time, grain yield is most common on dry lands of the region of spring grain crops – spring barley only 1.31 – 1.61 t/ha. However, for more efficient use of the potential of this culture need to adapt the technology of its cultivation to the Southern Steppes and improvements.

A special attention should be paid to the black fallow. About important role of the black fallow shows the year 2012, when, after his farms in Kherson region remained alive 84-86% of crops of winter wheat, whereas after other predecessors only 12 – 14%. In this context, given the new agro-climatic conditions in the southern region, it is necessary to pay more attention to optimizing the structure.

It should be noted that the cause of crop failures in the steppe zone is not only low rainfall, but large unproductive their losses and soil moisture. The system of agrotechnical measures, to successfully counter the drought, should ensure as much as possible the accumulation of moisture in the soil. To improve the absorption of water by soil is necessary appropriate measures to maintain its high permeability and to reduce evaporation of moisture from the upper soil layers, it should be system of agrotechnical measures to stop the capillary movement of water to the surface, turning the top layer of soil in a protective against moisture evaporation. A loose top layer, and the presence of mulch greatly slows the flow of water to the soil surface and thus reduces evaporation. This direction of research now needs attention. This is a pretty quick way to solve the problems of the improvement of the water balance.

Improvement of soil properties to increase the accumulation of moisture possibly at the expense of manure and organic residues under the core processing, the introduction of crop rotation with perennial grasses. Saturation of soil organic matter is extremely important to improve water-physical properties of soil, since the water-holding capacity of organic matter in 5-10 times more mineral fraction of the soil. By incorporation of straw into the soil in dry years in the topsoil accumulates at 15-20% more moisture than without it. Unfortunately now there has been limited research in this direction.

In modern agriculture tillage allows you to adjust the absorption of water, reduce runoff from fields and surface evaporation. It is therefore important to devise a system of tillage, which makes it easier to accumulate moisture, store it and use it efficiently. To increase absorption of water by soil promotes the deepening of the arable and subsurface layer, paraplowing, application of organic and green manures, differentiated soil cultivation, planting crops across the slope. So according to our data on the sowing of wheat, which was used paraplowing , precipitation absorbed by the soil at 77.5%, and without it is only 40.5%. Due to better absorption of precipitation during autumn-winter in the soil layer of 0-100 cm additionally accumulate up to 45 mm of moisture.

In the system of moisture accumulation and drought in the Southern Steppes of the critical role played by field protective forest belts. They reduce the strength of the wind, retain snow and water on the fields, prevent soil erosion, protect the territory from deflation and improve the microclimate in the fields. Their influence on the yield of agricultural crops is manifested in all years – droughts, dust storms and even under favorable conditions the growing season.

According to the observations of the scientific institutions of the steppe zone in the fields protected by shelterbelts, crop was significantly higher than in the open (table. 2). Thus, conservation of crops and grain yield increased with increasing afforestation of arable land. But after the separation of land shelterbelts are

Table 1.

Crop yields in crop crops, t/ha (average over 5 years)

Crop	Yield of winter crops grain	Crop yield of stubble crops			Yields of green mass of stubble crops	
		millet	buckwheat	soybean	corn	annual mixture
Barley	54,8	20,1	12,4	22,1	38,6	28,7
Winter wheat	66,7	14,8	8,3	13,5	31,7	26,4

Table 2.

Effect of density of forest belts on the territory on crop yields, t/ha

Crop	Messagewe distance, m		
	250	500	1260-1400
Winter wheat	3,14	2,84	2,61
Barley	2,43	2,16	1,94
Oats	2,18	1,96	1,79
Sunflower	2,04	1,73	1,66

left unattended, they began to decrease. They gradually disappear from the fields. This may have very negative consequences: frequent dust storms, droughts, will occur desertification of the territory. To avoid this, you need to recreate old plantings and restore the afforestation programme, which until recently operated in Ukraine effectively, and to expand research in this direction.

An important direction of the confrontation, the deterioration of the agro-climatic conditions of the region is the deliberate creation of modern high-yielding varieties and hybrids of agricultural crops, resistant to temperature and water stresses, which have a low transpiration coefficients, are able to consistently generate high yields under conditions of drought and high temperature. They must have high production rates of photosynthesis under stress conditions the growing season.

Special attention should be paid to the breeding work aimed at creating new varieties and hybrids of the most drought-resistant grain sorghum, which in countries with similar climatic conditions takes a leading place.

Should provide that, in the future, as now, quite productive crops will remain winter, they better use the moisture accumulated in the cold period of the year. Therefore, it is necessary to create varieties that are better used long period autumn growing season and had intensive growth after the renewal of spring vegetation.

In the face of climate change there must be a programme of research on adaptation of farming systems to a new agro-ecological situation, which includes:

– development of irrigated farming, as a guarantor to obtain a stable yield of crops, development of water-saving methods and irrigation regimes in an arid conditions;

– the creation of new varieties and hybrids with optimal parameters of adaptability in hot, dry conditions that rationally expend moisture;

– in-depth research on the optimization of the zoning of the leading agricultural crops based on the assessment of agroclimatic resources natural in terms of future climate change;

– the study of processes of soil formation and the development of measures for the conservation of soil fertility, the maximum accumulation and rational use of moisture;

– optimization degree plowing farmland with a consequent increase in soil-conservation measures that will contribute to the improvement of the water balance.

Conclusions. Analysis of the climatic situation in the Southern Steppe indicates increase over the past 40 years the average annual temperature of 2.0 ºC, and in the summer months, 2.9 to 4.2 ºC and an increase in thermal resources in connection with the increasing duration of vegetation period and the sum of active temperatures. There is also the deteriorating structure of the ratio of various lands, reduced the area of shelter belts, and areas covered with natural grass vegetation.

To overcome the effects of increasing climate aridity in the region to restore and expand the water system reclamation of arable land using the most modern technologies of use of irrigation water, to enter the land management system with a complex of soil - and water protection measures that will ensure the preservation of soil fertility.

It is necessary to develop a system of forest reclamation, which will ensure the restoration of forest shelter-belts in full.

Requires the creation of new varieties and hybrids of agricultural crops, resistant to temperature changes and water scarcity, and for early spring crops - varieties which reveals the rapid growth of both above-ground biomass and root system that would enable them to avoid high temperatures in the initial period of plant development.

For adaptation to climate change requires the development of new technologies and methods of cultivation of crops aimed at increasing savings and economical use of precipitation and moisture of the soil.

Thus, the main directions of scientific research for the future should be the development of measures to confront the increasing aridity of the climate in the southern region. They should be comprehensive and cover all possible agricultural practices that could improve conditions for plants on climate change.

References

1. Climat Ukraïni: u minulomu… i mai`butn`omu ?: Monografiia / za red. M.I. Kul`bidi, M.B. Barabash. – K.: Stal`, 2009. – 234 s.

2. Barabash M. Zmina global`nogo climatu i problema opusteliuvannia v Ukraïni / M. Barabash, M. Kul`bida, T. Korzh // Nauk. zapiski Ternopil`s`kogo derzh. ped. un-tu im. V. Gnatiuka. Ser. Geografiia. – 2004. - № 2, ch. 1. – S. 82-88.

3. Anisimov O.A. Sovremennoe poteplenie kak analog climata budushchego / O.A. Anisimov, M.A. Beloutckaia // Izv. RAN. Fizika atmosfery` i okeana. – 2003. - № 2. – S. 211-221.

4. Kamins`kii` V.F. Rol` sivozmin u suchasnomu zemlerobstvi / V.F. Kamins`kii`, P.I. Boi`ko // Visnik agrar. nauki. – 2013. - № 6. – S. 5-9.

5. Ivashchenko O.O. Napriami adaptatciï agrarnogo virobnitctva do zmin climatu / O.O. Ivashchenko, O.I. Rudnik – Ivashchenko // Visn. agr. nauk. – 2011. - №8. – S. 10-12.

6. Kovalenko O.A. Optimizatciia strukturi posivnikh ploshch za umov zmini climatu v pivdennomu Stepu / O.A. Kovalenko, P.S. Kizub // Adaptatciia zemlerobstva do zmin climatu – shliakh pidvishchennia efektivnosti funktcionuvannia sil`s`kogo gospodarstva: Mat. Vseukr. nauk. prakt. internet-konf. (KHerson, 15 sichnia 2013 r.). – KHerson: Ai`lant, 2013. – S. 26-27.

7. Kovalenko A.M. Adaptatciia zemlerobstva stepovoï zoni do pidvishchennia posushlivosti climatu / A.M. Kovalenko // Mizhv. tem. nauk. zb. "Zroshuvane zemlerobstvo". - KHerson: Ai`lant, 2012. – Vip. 58. – S. 21-23.

8. Agroclimatichni biuletni po KHersons`kii` oblasti. - KHerson: Oblasnii` centr z gidrometeorologiï, 1976 – 2014 rr.

Вожегова Р.А.

Адаптація систем землеробства до кліматичних умов Півдня України

Системи ведення землеробства в кожному регіоні завжди адаптуються до природно – кліматичних умов. З ними пов'язано добір, співвідношення і розміщення культур, їх сортовий склад та особливості технології вирощування. Аналіз кліматичної ситуації в Південному Степу свідчить про підвищення за останні 40 років середньорічної температури повітря на 2,0 ºС, а в літні місяці на 2,9 – 4,2 ºС та збільшення надходження теплових ресурсів у зв'язку зі зростанням тривалості вегетаційного періоду та суми активних температур. Встановлено, що для адаптації до змін клімату необхідне розроблення нових технологій і методів вирощування сільськогосподарських культур, спрямованих на збільшення накопичення та економне використання вологи опадів і ґрунту.

Ключові слова: *системи землеробства, зміни клімату, сівозміна, лісосмуга, ефективність зрошення.*

Вожегова Р.А.

Адаптация систем земледелия к климатическим условиям Юга Украины

Системы ведения земледелия в каждом регионе всегда адаптируются к природно – климатическим условиям. С ними связаны подбор, соотношение и размещение культур, их ортовой состав и особенности технологии выращивания. Анализ климатической ситуации в Южной Степи свидетельствует о повышении за последние 40 лет среднегодовой температуры воздуха на 2,0 ºС, а в летние месяцы на 2,9 – 4,2 ºС и увеличение поступлення теплових ресурсов в связи с ростом продолжительности вегетационного периода и суммы активных температур. Установлено, что для адаптации к изменениям климата необходима разработка новых технологий и методов возделывания сельскохозяйственных культур, направленных на увеличение накопления и экономное использование влаги осадков и почвы.

Ключевые слова: *системы земледелия, изменения климата, севооборот, лесополоса, эффективность орошения.*

Рецензенти

Слюсар І.Т. – д. с.-г. н.

Шевченко І.П. – к. с.-г. н.

Стаття надійшла до редакції 29.05.2015 р.