RESEARCH PAPER

SUSTAINABLE AND COMPETITIVE AGRICULTURAL DEVELOPMENT OF A WATER-DEFICIENT REGION (CASE OF THE CRIMEAN PENINSULA)

Vladimir S. Pashtetsky[1], Vadim V. Khomenko[2], Nikolay P. Demchenko[1], Natalia Yu. Poliakova[1], Rinas V. Kashbrasiev[2*]

[1]FSBSI Research Institute of Agriculture of Crimea, Simferopol, Russia

[2]Kazan Federal University, Kazan, Russia

***Corresponding author:** rkashbra@gmail.com

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ABSTRACT. The transition of water-deficient regions to sustainable agricultural development requires taking into account natural, economic and social factors, and restructuring of the sectoral and territorial structure of agriculture. In the case of the Crimean Peninsula, the most important factor was the interruption of water supply through the North Crimean Canal (April 2014). Hence, there was a need to revise the possibility of growing crops in dryland conditions. It has become practically impossible to grow rice, soybean, some vegetables, potatoes, grain corn, pome and stone fruits, etc. Farmers were forced to review grain and fodder crop rotation. They stopped growing crops that required systematic irrigation. Given these realities, a special place in crop rotation should have such plants as pea, chickpea, lentil, sainfoin, etc. The studies conducted by Crimean scientists and experience in commercial production stimulated farmers to grow essential oil crops since they are among the most promising. Viticulture based on the well-developed agriculture and vine growing in favourable areas of the Republic is also promising. Some pome and stone fruits that demand less irrigation are very promising for the Crimea too. Special attention should be paid to filbert, jujube, sweet almond, hazelnut, etc. Considerable efforts should be made to develop animal husbandry. The search for water at depths of 1-1.2 kilometres should be one of the ways to solve problems in the agro-industrial complex (AIC) of the Crimea, as well as wastewater treatment and their use for irrigation purposes. All the aforementioned changes are already taking place in the AIC. But they require significant acceleration and investments in prospective economic sectors.

KEY WORDS: water-deficient area, structure of agriculture, sustainable development, agricultural competitiveness, food security, drought-resistant agriculture, soil-climatic zones

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INTRODUCTION

Sustainable development of the territories is possible when the use of natural, industrial and financial resources, as well as technological development and institutional transformations, are mutually agreed and meet the needs of present and future generations (Kotlyakov et al. 1999). In different regions of the world, depending on natural conditions, the goals of sustainable development are achieved differently (Golubchikov et al. 2017). In this article, we explore the conditions for sustainable development of water-deficient regions on the example of the Crimean Peninsula.

The purpose of this research was to identify trends in the agriculture of the Crimean Peninsula and changes in its territorial and sectoral structure depending on changing natural, social and economic conditions.

Dryland farming is labour-intensive and costly industry. Investing in it is associated with natural, technological and financial risks. An analysis of the production of grain crops in the Crimea shows that even under relatively favourable conditions it is impossible to harvest more than 25 cwt/ha (Gerasimova 2006; Gormashov 2006; Pashtetsky 2015; Morozov 2017). Hence, it is impossible to compete with farmers, for example, from the Krasnodar Territory, who harvested over 60 cwt/ha over the past five years.

Lack of water from the North Crimean Canal since April 2014 is further exacerbating the situation. Currently, a little over 13 thousand hectares are irrigated from various water sources in the Crimea, mainly by drip irrigation. In 2015, only 10.1 thousand hectares were irrigated, though in 2013 this number was nearly 136 thousand hectares.

The shortage of water resources led to the disappearance of entire sectors of agricultural production, such as rice growing, soybean cultivation, as well as the sharp decline in the production of fodder, vegetables, melons, etc. At the same time, resource – and energy-intensive technologies, as well as non-renewable natural resources are still being used

(Polovitskiy and Gusev 2004; Pashtetsky 2015). It does not contribute to the structural restructuring of the agricultural economy in terms of its sustainability and remains an obstacle to the production of high-quality and competitive agricultural products.

Crimean farmers will have to choose new and economically feasible ways to develop the AIC on the peninsula based on dryland farming.

There are many positive prerequisites on the peninsula, such as the large domestic demand for products due to the significantly increased number of tourists (more than 6 million in 2018), significant reserves of unused land, as well as the possibility to develop such attractive and economically viable industries like horticulture, viticulture and essential oil crop cultivation.

MATERIALS AND METHODS

The presented results are based on the data provided by the Ministry of Agriculture of the Republic of Crimea, primary data and analytical materials provided by the Federal State Budget Scientific Institution «Research Institute of Agriculture of Crimea» for 1989–2019.

In our research, we used the abstract and logical methods, comparative analysis, observation and collection of facts. They made it possible to study changes in the structure of agricultural production in the Crimea, as well as trends in the transition of agriculture of the Crimean Peninsula to sustainable and competitive development.

RESEARCH RESULTS

In Soviet times, agriculture in the Crimea developed rapidly due to the centrally planned economy. The economy of the peninsula had specific characteristics:

- Optimal, smart and proper work planning, efficient decision-making process and timely control of results for every region, district and even each agricultural enterprise taking into account soil, climate, economic and even social characteristics;
- Optimal balance of sectors in the agricultural enterprises, which allowed the rational use of land, agricultural machinery, and labour;
- There were irrigated arable lands on the peninsula. 460 thousand hectares were irrigated at the state level and 150 thousand hectares were so-called «satellites». At that time one irrigated hectare was said to work just like four hectares of dry land;
- There were such dynamically developed branches as horticulture, viticulture, olericulture (vegetable growing), and rice cultivation;
- Strong food-canning industry (there were five large state canning enterprises and 157 canning factories with refrigerators);
- Strong livestock farming based on a good fodder base and sectors of dairy and beef cattle breeding, poultry farming, pig, rabbit and sheep breeding;
- People's work ethic;
- High level of technologies in agriculture and animal husbandry based on the research results of Crimean scientists.

Since the 1990s, with the transition to a market economy, the above mentioned factors of intensive agricultural production have not worked anymore. Fig. 1 illustrates the outcome of the AIC reform process in the Crimea.

As we can see from Fig. 1, from 1985 to 2019 the number of sheep and goats has decreased by 5.8 times, cows – by 5.1 times. The trend is the same for other livestock industries. Over the past six years, the trend towards a decrease in the number of cattle and poultry continues. This leads to a decline in livestock production in the Crimea and to the need to import almost 400 thousand tons of milk and dairy products, as well as 38 thousand tons of meat from other regions.

An important factor for sustainable growth of milk and meat production is the development of cattle breeding in large agricultural enterprises. These enterprises have opportunities for investment to organize production at the global level, as well as for the development of the necessary fodder base, corresponding to high technologies for the production of final products (Van Lynden 2000). To date, this trend, for many reasons of a political and economic nature, is absent; there is a decrease in the number of livestock and volumes of its production. Sanctions against the Crimea continue to discourage both foreign investors and Russian banks and companies. There are no large Russian banks, insurance companies or large agricultural holdings in the region. The agriculture of the peninsula needs investment not only in the livestock, but also in the processing industry (Ingersent and Rayner 1999). The only example of serious investment – the development of the «Krym-farming» (Crimea-Farming) dairy enterprise. It works consistently and systematically; its activity is based on foreign investments.

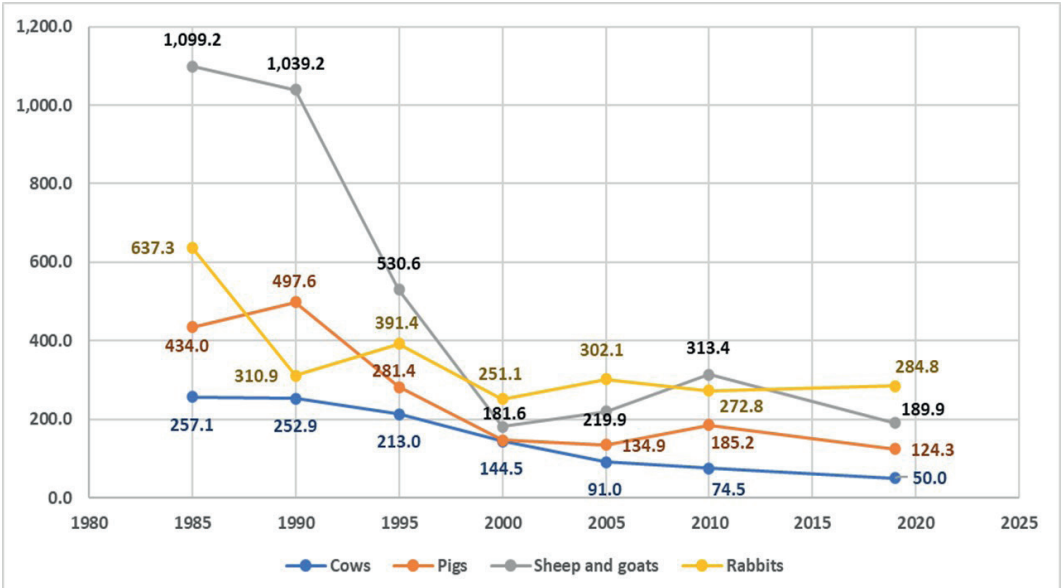

Fig. 1. Dynamics of livestock on the Crimean Peninsula, 1985–2019, thousands of head

This enterprise successfully solved the problems of building its own plant for processing dairy raw materials into high-quality products.

Under these conditions, the state budget is the main source of investment. Indeed, government investment in agriculture is effective, but it is clearly not enough to reverse stagnation in the Crimean economy.

Recovery of cattle, pig and sheep breeding and fattening is also a very promising way of farms and peasant enterprises development. During 1990-s and from 2000 to 2019, the number of cattle on farms increased (including cows), as well as the number of pigs, sheep and goats. Farmers more efficiently address issues on improving livestock arid fodder production, placing the animals in temporary barns without the significant costs on their maintenance and repair.

S. Garmashov (2006), V. Pashtetskiy (2016) and other scientists from the Crimea agree that the Crimea itself renews only half the amount of water resources needed for the peninsula. However, these water reserves clearly not enough for the development of agriculture, which is believed to be a priority in the life of any society and state. The situation in the region forces us to begin the search for a fundamentally new harmonious doctrine of economic policy on a qualitatively new level. New consistent state policy is critical for the Republic of Crimea. It should be aimed at striving to implement the environmentally sound principles of sustainable development into real business practices and social life (Van Lynden 2000; Gormashov 2006; Pashtetsky et al. 2016).

A serious challenge to the economy of the region is the impossibility to use the Dnieper water for irrigation. In this regard, the fodder supply on the peninsula has deteriorated. In the 1980s, there were 1.2 million hectares of agricultural lands (half of which was irrigated), in 2010 – 866 thousand hectares, and in 2017, agricultural lands were reduced to 768 thousand hectares.

With the interruption of water supply through the North Crimean Canal, the prospect of vegetable growing development on the peninsula has become insignificant. The cultivation of vegetables is possible only by individual private farms and households, as they can use water from the rivers and the moisture accumulated during the winter-spring period in ponds and reservoirs.

Furthermore, the growing demand for water caused changes in crop rotations. Farmers unwisely grow only grain and industrial crops, stop the production and use of organic fertilizers. The attitude of the Crimean authorities to the provision of eastern Crimea with drinking water is also short-sighted. The transfer of water to the North Crimean Canal from the reservoirs of the Belogorsky district, as well as replenishment of water from Novogrigoryevsky, Nezhinsky and Prostornensky intakes with a volume of 200 thousand cubic meters per day, are dangerous. Such water intake in the near future can lead to a limitation of drinking water supplies and can leave the population of Dzhankoy and Nizhnegorsk districts without fresh water.

A much more effective and promising option is to drill wells to a depth of 1.0-1.2 kilometres. It is necessary to use the similar experience of other countries, such as Saudi Arabia, which managed to grow 55 million palm trees in the desert using water from one-kilometre-deep wells.

The forage crop area and the fodder production decreased the most significantly during the 1990s. But even in 2010–2017, during a period of stabilization in agricultural production, this negative trend continueв to occur: for example, the sown area of annual plants decreased by 2.7 times, perennial plants – by 2.3 times (Fig. 2).

Fig. 2 illustrates that the fodder crop acreage decreased not very much after 2014. However, the lack of irrigation affects their productivity. For example, today agricultural enterprises receive 15-19 tons of fodder root crops per hectare, while in the 1980s the yield was 60-80 tons/hectare.

At the same time, there is a positive experience of a number of agricultural enterprises that demonstrate the benefits of the introduction of new technologies. They are «Karkinitsky», «Partizan», «Krym Farming», etc. They quickly responded to the interruption of water supply and changed fodder crop rotation. This experience shows that even without irrigation it is possible to have a stable fodder base, increase production volumes and improve economic indicators. Currently, the volumes of fodder production on the peninsula is approximately equal to that of one of the fourteen regions of the Crimea in the 1980s. This reflects potential prospects for growth in fodder and livestock production.

In recent years, unnecessarily significant areas were sown with sunflower (Pashtetsky et al. 2013). Some farmers began to plant sunflower every three and sometimes even every two years that sharply worsened the state of arable lands. Despite the fact that in some dry years the sunflower was not even harvested, the economic efficiency of this crop makes farmers violate the agricultural technology of its cultivation. In addition, soybean, which gives a good

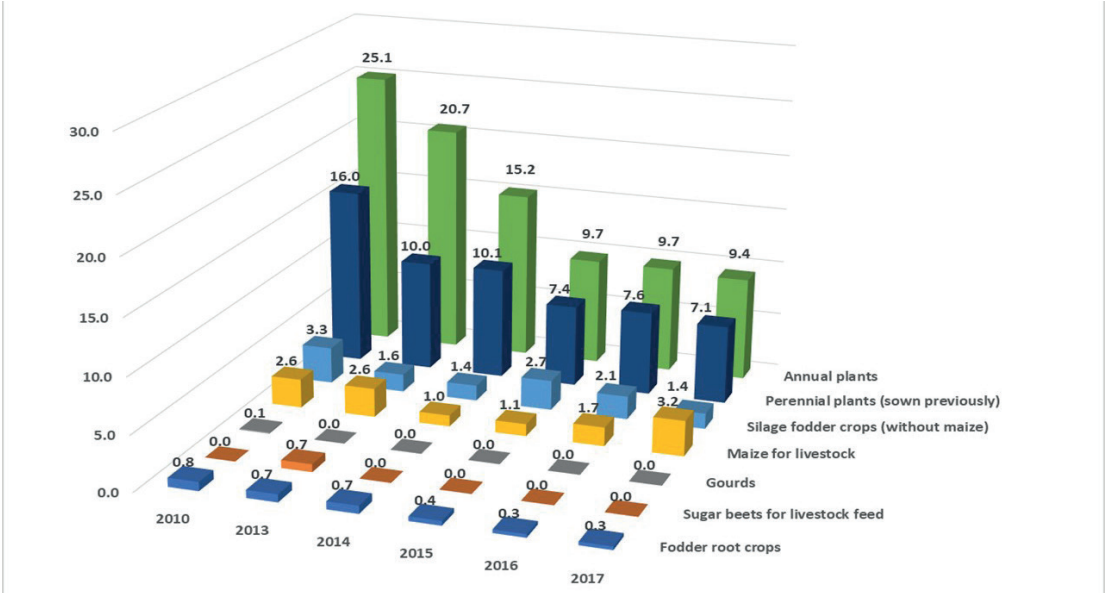

Fig. 2. Sown area of fodder crops on the Crimean Peninsula (thousand hectares)

yield under irrigation and was earlier cultivated on an area of up to 12 thousand hectares, stopped to be grown because of the interruption of water supply to the Crimea. Due to the lack of stable demand for rapeseed in the region, its cultivation areas decreased from 22 thousand hectares in 2010 to 11.8 thousand hectares in 2017 (Table 1).

The next aspect of sustainable and competitive development of the region is the cultivation of new types of crops. The Crimea, with its arid climate, cannot compete with agricultural producers of the Krasnodar Krai. After all, over the past five years, the yield of grain crops was up to 60 kg/ha there, and the costs were almost the same. This creates the prerequisites for the cultivation of essential oil crops. They can be grown on dry land and provide good economic indicators. In the 1980s Crimean essential oil industry was the leading one in the USSR. Crimean farmers produced 60% of the country's needs in lavender oil, 30% of rose oil and 52% of sage essential oil. However, like all other branches in the region, the cultivation of essential oil crops during the transition to a market economy was minimized (Fig. 3).

According to Fig. 3, from 1989 to 2017, the lavender growing area decreased by 4.4 times, the area of clary sage – by 5.5 times, of rose – by forty three times. Only coriander production volumes increased: from 2.556 hectares in 2007 to 30.547 hectares in 2017. The essential oil industry can quickly and greatly improve the economic situation in the Crimean villages due to significant demand for essential oil. The success of the industry is largely determined by the presence on the peninsula such institutions as FSBSI «Research Institute of Agriculture of Crimea» with its specialists, technologies, varieties and the ability to provide Crimean farms with seedlings and seeds of essential oil crops. Sustainable development of essential oil production requires also strengthening the role of the Ministry of Agriculture of the Crimea in involving farms in this promising industry.

For sustainable feed production and growth in livestock production, it is necessary to change radically not only the structure of crop rotations, but also optimize the use of water resources available on the peninsula (Pashtetsky 2015). They are groundwater reserves, river flows in the mountainous

Table 1. Industrial crops production on the Crimean Peninsula

	2010	2013	2014	2015	2016	2017
Sown area, thousand hectares						
Sunflower	26.6	81.3	83.8	82.7	117.0	122.3
Soybean	11.6	13.2	4.1	0.7	0.4	-
Rapeseed	18.4	8.5	17.8	6.4	0.9	6.0
including						
winter	18.4	8.4	17.4	6.4	0.8	6.0
spring	0.0	0.1	0.4	0.0	0.1	-
Production, thousand hectares						
Sunflower	36.2	109.3	101.2	107.4	152.0	119.2
Soybean	34.0	33.6	2.2	0.7	0.7	-
Rapeseed	22.0	16.4	14.1	10.9	1.7	11.8
including						
winter	21.9	16.4	13.7	10.9	1.5	11.8
spring	0.1	0.0	0.4	0.0	0.2	-

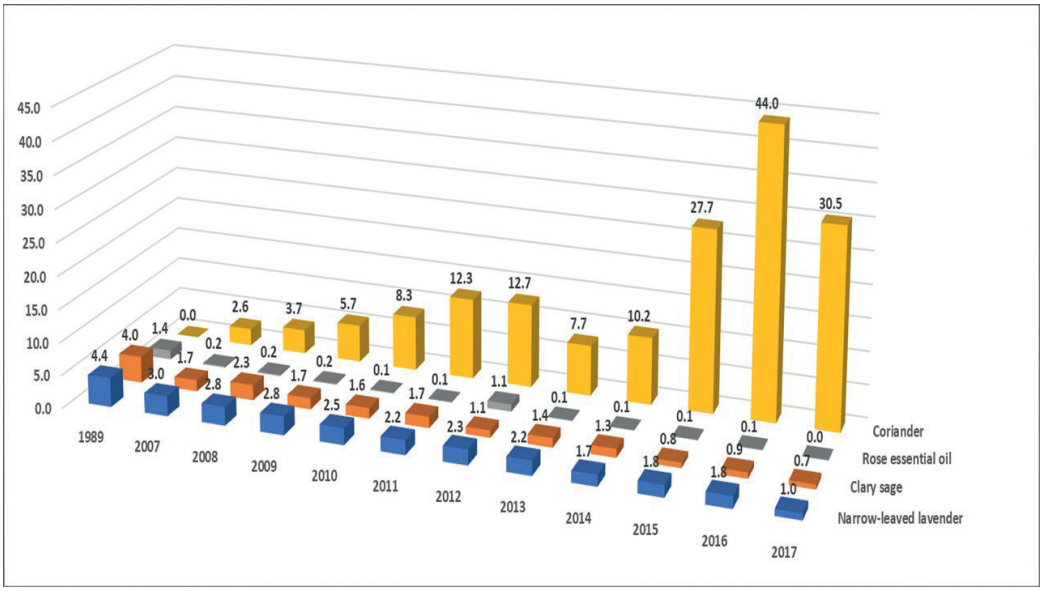

Fig. 3. Dynamics of the areas of the main essential oil crops in the Crimea in 1989–2017, thousand hectares

and foothill regions, reservoirs and ponds, water from other rivers of the peninsula. An example of the optimal use of water is the agricultural company «Chernomorets» (situated in the Bakhchisarai district), which accumulates the water of the Belbek River in irrigation ponds during the winter-spring period and irrigates 400 hectares of vineyards. It is necessary to monitor the availability of water everywhere in the peninsula, as well as adopt the measures to increase the number of water sources and rationally use it. As the experience of the Soviet period shows, excessive pumping of groundwater from horizons up to 200 meters led to the depletion of aquifers and the replacement of freshwater by the salt one from the Black Sea and Sivash (Pashtetsky et al. 2016). Currently, in the Crimea, a little over 13 thousand hectares are irrigated from various water sources, mainly by drip irrigation. In 2015, only 10.1 thousand hectares were irrigated, though in 2013 this number was nearly 136 thousand hectares.

The reuse of water resources is promising. In the future, wastewater treatment can provide up to 70 million cubic meters of water. It can be used in the steppe of the peninsula for irrigation agricultural crop (Pashtetsky et al. 2013).

Investment in agriculture is unattractive to investors, both foreign and domestic, due to the high risk of natural anomalies, the lack of short return periods and lower than in other sectors dividends. One of the problems is sanctions. They discourage large Russian banks, insurance companies, etc. and they do not open their branches in the region. Only the government is a reliable investor for the Crimea as a whole, and agriculture in particular. Stimulating investment activity in such conditions is vital and is the most important for the economic development of agriculture. Therefore, it will be extremely important to search for options for real investment in the near future (Bugaeva 2017). Moreover, there are many positive prerequisites on the peninsula, such as the large domestic demand for products due to the significantly increased number of tourists (more than 6 million in 2018), significant reserves of unused land, as well as the possibility to develop such attractive and economically viable industries like horticulture, viticulture and essential oil crop cultivation. In addition, the investment attractiveness of the Crimea is based on its favourable geographical position, popularity for tourists, high-quality winemaking, warm climate, and highly educated population.

The potential of the Crimean farmers is large. They are able to provide products not only for its residents and tourists, but also for the northern regions of Eurasia, as it was during the Soviet period. In this case, the role of a strong middle class is growing. Development of the village is impossible without farms and households that use natural resources and biological features and advantages of plants and animals much more efficient (Vorobeva 2014). In this regard, it should be noted that the Crimean authorities do not pay necessary attention to the emergence and functioning of private farms in the region. Farms have not yet become the locomotive of rural production in such industries as vegetable growing, viticulture, horticulture and livestock. In 2018, over 1,200 farms are registered in the Crimea. Their contribution to the sector of crop production was 16.0% in 2017, to livestock – 2.1%, and it is constantly growing. The state takes some measures to support financially some farms and allocates grants for dairy and beef cattle breeding and all branches of crop production (Vorobeva 2014; Bugaeva 2017).

Viticulture, in spite of the lack of water, is very promising too, because the Crimean winemakers have both traditions and experience in the field of winemaking.

The organization of vegetables production, by contrast, is not so promising. The most powerful factors influencing vegetable growing are warm climate, availability of water, and modern technologies. Additionally, the market infrastructure and the development of logistics seriously affect the efficiency of the vegetable growing industry. During the Soviet period, specialized collective farms of the vegetable and milk trust, the «Krymkonserv» associations, as well as many collective farms with their own canning plants and refrigerators, were engaged in the cultivation of vegetables. The vegetables were processed at five large canning plants located in Simferopol, Dzhankoy, Nizhnegorsk, and Bakhchisaray. All state farms specializing in the cultivation of vegetables had large areas of irrigated arable land, certain crop rotations, and considerable labor resources. Currently, the cultivation of vegetables is only possible near water sources. Despite the obvious shortage of vegetables on the peninsula, vegetable producers face challenges in their efforts to sell them, as it is unprofitable for trade enterprises to cooperate with a large number of small farms.

All the above listed has determined the specialization of regions of the Crimea, taking into account soil-climatic conditions, economic characteristics of the areas and location of markets. Early vegetables, as well as early potatoes, early cabbage, pumpkin, peppers, and eggplant must be grown in Simferopolsky, Bakhchisaraysky and Saksky districts. In Dzhankoy and Krasnogvardeisk districts, it is necessary to grow vegetables for conservation. The supply of cities of the southern coast, Simferopol, Sevastopol, and Yevpatorya with large stocks of onions for sale in winter should also be given to these districts. In the north-eastern and eastern zones of the peninsula, it is necessary to cultivate a full set of vegetables to meet the needs for fresh vegetables of residents and vacationers in the resorts of the cities of Feodosia, Sudak, and Kerch. In Krasnoperekopsky and Razdolnensky districts, it is necessary to develop melon farming, potato growing, as well as growing vegetables for canning production.

Such zoning will increase the efficiency of the industry and will contribute to meeting the urgent needs in the vegetables of the population and guests of the Crimea.

The sanctions also affect the activity of Crimean producers in foreign markets. The sanctions regime does not allow Crimean producers to sell grain, wine, and essential oil products of enterprises outside the Peninsula. It's difficult to buy abroad highly productive breeds of dairy cattle breeding, pigs and sheep, as well as raw materials, seeds, and equipment of foreign production. The most important consequence of the sanctions is the almost complete cessation of investment from abroad. All this affects the competitiveness of products, food security, profit, and quality of rural development.

The external factors mentioned above leading to an increase in the cost of production are not the only problems of the Crimean producers. There are also problems connected with land use, production equipment, and etc. Not all manufacturers have finished the preparation of the documents establishing the right to property and land. This creates significant organizational difficulties for sustainable and competitive agricultural development in the Crimea.

The practical implementation of the principles of sustainable development of a water-deficient region depends on the solution of many problems associated with the shortage of water resources, the development of an appropriate infrastructure for dryland farming, the system of financial support for agricultural production and rural areas. As for the Crimean Peninsula, these problems can be clarified as the tasks that require a priority solution. These include:

• moral and physical depreciation of basic production equipment,
• decrease in soil fertility of the peninsula,
• underdevelopment of drought-tolerant agriculture,
• application of organic fertilizers in volumes recommended by scientists,
• modification of crop rotations according to the changed economic conditions,
• recovery of livestock industries in the volumes necessary to ensure food security for the inhabitants of the peninsula,
• recovery of enterprises processing agricultural products,
• insufficient access to markets of agricultural products for Crimean producers,
• lack of introduction of innovative technologies in all sectors of the Crimean village,
• low level of rural social infrastructure.

The solution of these problems will allow organising agricultural production taking into account economic feasibility and addressing such an important and urgent social problems as the employment of the population in rural areas. So, the question of the proper financing of agriculture is relevant.

In 2019, the Ministry of Agriculture of the Republic of Crimea plans to allocate 212 million rubles for the development of small business in the countryside. 172 million rubles will be allocated to «new» farmers for the development of family livestock farms based on peasant enterprises and farms. The budget also provides 40 million rubles for the development of the material and technical base of the peasant enterprises and farms. Such an important issue as land reclamation will not be left without attention, too. 360 million rubles will be allocated to solve this problem. Money is also pledged to reimburse part of the costs incurred in the fight against especially dangerous pests, uprooting of unproductive perennial plantations, payment of electricity bills for the production of vegetables in greenhouses. The task of the Crimean producers is the targeted and reasonable use of the allocated funds to bring the agricultural economy of the Crimea to a sustainable development path.

Microloans today are the most popular among the Crimean businessmen. The micro-financing fund provides the opportunity to take a loan of up to five million rubles. 165 entrepreneurs used that opportunity in 2017. In 2018, 312 million rubles have already been allocated to 170 entrepreneurs. This gives the necessary benefits to the economy of the Republic of Crimea. Such financial help will be extended for several years (Borsch et al. 2016).

The second popular type of support for entrepreneurship is the lending programmes under which regional Guarantee Funds provide loan security for small and medium-sized enterprises. 164 representatives of small business have borrowed more than 1.2 billion rubles. Moreover, in 2018, the Crimean businesspersons have the opportunity to take agricultural machinery and equipment in leasing at six percent yearly. This will be continued in the future (Borsch et al. 2016).

Among the many problems existing in the agriculture of the Crimea is the reduction of soil fertility (Polovitskiy and Gusev 2004; Pashtetsky et al. 2013). Scientists from FSBSI «Research Institute of Agriculture of Crimea» found that the humus content has decreased on average from 2.7% to 2.2% over the past 50 years. This happened because of land resources long-time exploitation that was focused on meeting the current economic and social needs of society. Other problems, including environmental ones, were solved on the «residual principle». During the Soviet period, accumulation and application of fertilizers were organized systematically. From 10 to 12 tons of organic fertilizers were introduced in all crop rotations annually. In the vegetable crop rotations or fields where fodder beets or corn were grown, up to 60 tons of manure was introduced. This provided high yields and fertility conservation. However, the organic fertilizer application in recent years has decreased in the Peninsula to 0.4 tons per hectare. A clear violation of crop rotation (e.g., cultivation only winter crops and sunflower) has exacerbated the problem of humus accumulation and preservation. The decrease of soybean, forage and other crops that accumulate nitrogen in the soil in the structure of crop rotation led to the same results. Organizational problems also «work» in the same way when the owner of 3-5-8 hectares of land, even having cattle on the farm, without the necessary equipment for introducing manure into the soil, cannot bring organic fertilizer to his/her land. We can say that society continues to exploit land haphazardly. At the same time, agricultural enterprises «Karkinitsky», «Partizan» and a number of other farms work systematically and introduce organic fertilizers into the soil.
It was readily recognized by experts (Pashtetsky 2015) that sustainable agricultural development is possible if the following preconditions are in place: ecological conversion of human activities aimed at implementing state and regional programmes of the environmental protection; rational use of natural resources; environmental and food security.

However, over the last three decades, an unbalanced structure of the resources using has developed because of unsustainable agricultural activity. They are the use of resource- and energy-intensive technologies, the predominant use of non-renewable natural resources that do not contribute to the structural transformation of the agrarian economy from the point of view of its stability, the impede production of high-quality and competitive agricultural products. Insufficient investment in the development of agriculture and resources-protected-activity increase the risk of the accelerating economic decline of the AIC of the Crimea.

Therefore, now it is a necessity to find new ways of balanced development of agriculture of the Peninsula. Each agrarian should direct his/her efforts to ensure agricultural balance. It is necessary to form an agricultural mechanism that ensures appropriate sustainable development of the environment. Consideration of characteristics, resource, landscape, economy, and prospect specific to each farm are the most important tasks. A long period of growing crops on the same field leads to the spread of such weeds as bentgrass, scentless chamomile, brome grasses, Atriplex cana and other like ragweed (Ambrosia), Chenopodium album L., and field thistle. Experience has shown that after three years of growing spring barley, even the double treatment with herbicides could not fully suppress weeds (Ivanov 1976; Polovitskiy and Gusev 2004).

It is well known that different weeds have different biological characteristics and they can grow in any agriculturally-valuable crop. So, in winter crops grow winter and perennial weeds; in spring crops – spring weeds. In vegetable crop rotations weeds that are adapted to their biology are common. And, here, the role of the scientifically substantiated crop rotation, which without the use of chemical fertilizer can get rid of most types of weeds, is very important

Crops i.e. winter rye and winter wheat that are sown densely effectively compete with weeds. Such row crops as corn and sunflower, the plants which come close only in summer, require at first inter-row cultivation. Weed-sensitive crops must be sown after those that contribute to cleaning the fields of weeds, for example, spring crops after row crops.

After that, it is necessary to grow crops that contribute to reducing the number of weeds.

In 2018, weather conditions in the Crimea were unfavourable for the cultivation of agricultural crops. In spring, in the meter layer of soil, there were 70-90 mm of moisture, which is clearly insufficient for the development of the crops. The same situation with moisture was in the spring and summer. This created great problems for the farmers because the harvest of grain and forage crops almost throughout the Peninsula was very low. Precipitations in May were only in the foothill areas (Bakhchisaraysky, Belogorsky and Simferopolsky district). Only some farms could harvest the amount of grain usual for these regions. For example, Research Institute of Agriculture of Crimea harvested 36 cwt/ha (in Simferopolsky and Bakhchisaraysky districts). At the same time, agricultural enterprise «Karkinitsky» (situated in the Razdolnensky district), consistently receiving more than 40 cwt/ha, got only 17.9 cwt/ha. Grain yield in the Crimea as a whole was only 1.6 t/ha, oilseeds – 5.5 cwt/ha.

For timely agricultural operations, the critical issue is the availability of the necessary number of machines. On the first of January 2019, the Republic of Crimea had 20,878 units of agricultural machinery, including 5,270 tractors, 1,317 harvesters, 1,596 plows, 2,393 cultivators, 1,910 seed drills, and 1,129 harrows. To harvest crops in optimal agro-technological terms, there are three main organizations that assist farmers in harvesting grain and leguminous crops, mulching crop residues, tillage, sowing, fertilization, and plant protection.

Agrarians of the Crimea should know and use agro-climatic conditions of the territory. Concluding our investigation, we distinguish 7 zones in the Crimea according to various sources (Ivanov 1976; Polovitskiy and Gusev 2004; Pashtetsky 2015). These 7 soil-climatic zones are important for the sustainable and competitive development of AIC of the Crimea:

The zone of solonetzic steppes. In this zone (Krasnoperekopsky, Dzhankoysky area, Nizhnegorsky, Sovetsky and Kirovsky districts) the climate is very dry, moderately hot with mild winters. The soil cover of this zone is represented by dark-chestnut weakly and medium solonetzic soils. These should orient the farmers on the cultivation of such winter crops like wheat, barley, rye, and perennial grasses. To obtain stable yields, wheat should be planted after bare fallows, cropped fallows, and perennial grasses. Onobrychis and Melilotus are the most promising perennial grasses in this area. And if the irrigation is possible, Medicago can be grown too. High-quality winter wheat should be grown there, as well as perennial grasses to provide feed and livestock industry.

The zone of the steppe with chestnut soils. This zone includes Pervomaysky, Razdolnensky districts, and southern part of the Dzhankoysky and Krasnoperekopsky districts. Here climate is very dry with moderately mild winters. The soil represented by dark-chestnut weakly and medium solonetzic soils. These natural factors «help» in cultivating high-quality winter wheat, large areas of perennial grasses, and essential oil crops such as mint, coriander, wormwood, sage, and lavender.

The zone of black soil steppe. It includes Krasnogvardeisky district, northern part of Simferopol and Belogorsky district, south of Nizhnegorsky, Sovetsky and Kirovsky districts, and eastern part of Saksky district. The climate of the region is arid and hot with temperate mild winters. The largest area in the zone is presented by southern and calcareous chernozems. The area is the most suitable for growing traditional for the Peninsula crops: winter wheat and winter barley, early spring crops (oats and barley), pea and bean, sunflower, mustard and flax. Sainfoin, alfalfa, clover, and winter vetch should be sown as the basis for forage. To balance fodder in sugar, triticale, sudangrass or sorghum-sudangrass hybrids are the best. The area is prospective for growing traditional oil-bearing plants. And if the irrigation is available, it is possible to grow vegetables and sugar beet seeds.

The zone of high rocky steppes. Farms of Chernomorsky and the eastern part of the Saksky district are located in the rocky steppes. The region's climate is very arid, with mild winters. In dry years, winter and spring crops begin to die here first of all because of lack of moisture in the soil. The soils in the area are calcareous chernozems, weak and sod-calcareous soils. The only crop that provides the best yields is winter barley. Farmers should focus on such perennial herbs as Onobrychis and Melilotus, and such forage crops as winter vetch, triticale, and sudangrass. The area fits for growing lavender, sage, and coriander.

The zone of the lowland complex solonetzic steppe. There are the farms of Leninsky district. The climate of the zone is arid, of the coastal strip – very arid, with moderately hot summers and mild (centre and Priazovye) and very soft (Prichernomorye) winter. The soils in the area are very diverse. They are represented by southern chernozems, weak and medium solonetzics, as well as by the solonetzic chernozems in the Western part of the Peninsula. Soil and climatic conditions of the zone are hard for crop growing. For agricultural activities in the area, there should be 20% of bare fallows and the same amount of cropped ones. This allows cultivating winter wheat. Forage should be based on Onobrychis and Melilotus. It is possible to cultivate aromatic crops. And if the irrigation is possible, sugar beet for seeds may be grown.

The zone of the foothill calcareous-chernozem steppe. It includes the agroenterprises of Bakhchisaraysky, Belogorsky, Bakhchisaraysky districts, southwestern part of the Kirovsky district, the Simferopolsky district (except the northern part), and the city of Sevastopol. The climate of the region is arid, warm with moderately mild winters. The soils of the region are calcareous chernozems, in some places sod-calcareous. The region is suitable for growing fruit crops, grapes, as well as essential oil crops and tobacco. The basis of the feed is alfalfa and sainfoin. In the eastern foothill region of the zone, there are agricultural enterprises of Simferopolsky, Belogorsky and the southwestern part of Kirovsky districts. The climate is semi-arid, moderately warm with mild winters. This makes it possible to grow traditional Crimean crops, namely essential oil crops, tobacco, medicinal herbs, pome and stone fruits, grapes.

The southern coastal mountain zone. They are agricultural lands of the cities of Yalta, Alushta and Sudaksky district. The climate of the zone is subtropical (western part of the zone), arid, with warm winters. In the central part – arid, hot, with mild winters. In the eastern – very arid. The soil is represented mainly by brown soils. Due to insufficient moisture in the soil and air, all agricultural methods of crop cultivation should be aimed at preserving and accumulating it in the soil. The main crop in the area is grapes, which accumulate 26% of sugar in berries and is used for the production of strong and dessert wines.

CONCLUSIONS

1. The most important tasks for the AIC of the Crimea in the current economic situation should be: a) formation of a competitive, investment-active agricultural producer; b) development of the most economically profitable industries, which will ensure the needs of the region in the food and raw materials for the food industry.

2. All farms of the peninsula need to review production plans as soon as possible and change crop rotation in the light of the current economic situation.

3. The only real and effective option for investing in the Crimean village is the financial support of the state that provides a transition to dryland farming, create conditions for the active economic growth and ensure food security for the residents of the Crimea and vacationers.

4. Production experience and the effectiveness of cultivation in arid climate orient the AIC of the Crimea on the cultivation of essential oil crops.

5. The promising industry is viticulture, based on existing experience in cultivating crops in favourable soil-climatic zones of the Crimea.

6. In horticulture, it is necessary to develop plantations of undemanding (drought resistant) pome and stone fruit crops, as well as cultivate hazelnuts, sweet almonds, and walnuts.

7. Special efforts of farmers should be aimed at expanding the food supply and developing all branches of animal husbandry.

8. The development of vegetable growing sectors should be guided by the availability of local irrigation and meet the needs of the residents of the Crimea with fresh vegetables throughout the year.

9. Sustainable cultivation of crops depends on the soil and climatic characteristics of the regions of the Crimean Peninsula, which can be distinguished as 7 soil-climatic zones.

10. The most intensively developing forms of integration in the AIC of the Crimea should be processing enterprises for joint processing and sale of products that ensure its competitiveness.

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